No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1	物化	Zhang, MK; Yamada, K; Bourguet, S; Guelfo, J; Suuberg, EM	Vapor Pressure of Nine Perfluoroalkyl Substances (PFASs) Determined Using the Knudsen Effusion Method	2020	J. Chem. Eng. Data. 2020 May:65(5):2332-2342. doi: 10.1021/acs.jced.9b00922.	Sublimation vapor pressures of nine pure perfluoroalkyl substances, including ammonium perfluoro(2-methyl-3-oxahexanoate) (GenX), 1H,1H,2H,2H- perfluoro-1-decanol (8:2 FTOH), 1H,1H,2H,2H-perfluoro-1-dodecanol (10:2 FTOH), and C6 to C11 perfluorocarboxylic acids (PFCAs), were measured using the Knudsen technique at near-ambient temperatures. Melting temperatures and fusion enthalpies of these compounds were also measured by differential scanning calorimetry. The vapor pressure of GenX ammonium salt is comparable to that of the much higher molecular weight perfluoroundecanoic acid. GenX ammonium salt also did not show actual melting behavior but instead decomposed at around 470 K. The measured near-ambient temperature sublimation vapor pressures of the PFCAs and FTOHs were compared with some earlier reported liquid phase vapor pressures obtained at higher temperatures, and reasonable agreement exists between the data obtained in the different studies. The sublimation enthalpies of the PFCAs indicate that the contribution to the sublimation enthalpy of the CF2 group in the alkyl chain is comparable to that of the CH2 group in the corresponding nonfluorinated analogues, even though the PFCAs show consistently higher vapor pressures than do the corresponding carbon number alkanoic acids.					1		1	A	-	PFASの環境中への放出ルートとして気化・昇華の定量的な把握は重要.	
D2	物化	Nouhi, S; Ahrens, L; Pereira, HC; Hughes, AV; Campana, M; Gutfreund, P; Palsson, GK; Vorobiev, A; Hellsing, MS	Interactions of perfluoroalkyl substances with a phospholipid bilayer studied by neutron reflectometry	2018	J. Colloid Interface Sci. 2018 Feb:511:474-481. doi: 10.1016/j.jcis.2017.09.102	The interactions between perfluoroalkyl substances (PFASs) and a phospholipid bilayer (1,2-dimyristoyl-sn-glycero-3-phosphocholine) were investigated at the molecular level using neutron reflectometry. Representative PFASs with different chain length and functional groups were selected in this study including: perfluorobutane sulfonate (PFBS), perfluorohexanoate (PFHxA), perfluorohexane sulfonate (PFHxS), perfluorononanoate (PFNA), perfluorooctane sulfonate (PFOS), and perfluorooctane sulfonamide (FOSA). All PFASs were found to interact with the bilayer by incorporation, indicating PFAS ability to accumulate once ingested or taken up by organisms. The interactions were observed to increase with chain length and vary with the functional group as SO2NH2(FOSA) > SO2O-(PFOS) > COO-(PFNA). The PFAS hydrophobicity, which is strongly correlated with perfluorocarbon chain length, was found to strongly influence the interactions. Longer chain PFASs showed higher tendency to penetrate into the bilayer compared to the short-chain compounds. The incorporated PFASs could for all substances but one (PFNA) be removed from the lipid membrane by gentle rinsing with water (2 mL min(-1)). Although short -chain PFASs have been suggested to be the potentially less bioaccumulative alternative, we found that in high enough concentrations they can also disturb the bilayer. The roughness and disorder of the bilayer was observed to increase as the concentration of PFASs increased (in particular for the high concentrations of short-chain substances i.e. PFHxA and PFBS), which can be an indication of aggregation of PFASs in the bilayer.		1	1	1			1	A	-	PFASが脂質二重層の構造乱れに与える影響を調べたもので，生体への影響を考える基礎として重要.	
D3	物化	Brusseau, ML; Guo, B; Huang, DD; Yan, N; Lyu, Y	Ideal versus Nonideal Transport of PFAS in Unsaturated Porous Media	2021	Water Res. 2021 Sep:202:117405. doi: 10.1016/j.watres.2021.117405.	Per- and poly-fluoroalkyl substances (PFAS) adsorb at air-water interfaces during transport in unsaturated porous media. This can cause surfactant-induced flow and enhanced retention that is a function of concentration, which complicates characterization and modeling of PFAS transport under unsaturated conditions. The influence of surfactant-induced flow and nonlinear air-water interfacial adsorption (AWIA) on PFAS transport was investigated with a series of miscible-displacement transport experiments conducted with a several-log range in input concentrations. Perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and ammonium perfluoro 2-methyl-3-oxahexanoate (GenX) were used as model PFAS. The results were interpreted in terms of critical reference concentrations associated with PFAS surface activities and their relationship to the relevancy of transport processes such as surfactant-induced flow and nonlinear AWIA for concentration ranges of interest. Analysis of the measured transport behavior of PFAS under unsaturated-flow conditions demonstrated that AWIA was linear when the input concentration was sufficiently below the critical reference concentration. This includes the absence of significant arrival-front self-sharpening and extended elution tailing of the breakthrough curves, as well as the similarity of retardation factors measured for a wide range of input concentrations. Independentlypredicted simulations produced with a comprehensive flow and transport model that accounts for transient variably-saturated flow, surfactant-induced flow, nonlinear rate-limited solid-phase sorption, and nonlinear ratelimited AWIA provided excellent predictions of the measured transport. A series of simulations was conducted with the model to test the specific impact of various processes potentially influencing PFOS transport. The simulation results showed that surfactant-induced flow was negligible and that AWIA was effectively linear when the input concentration was sufficiently below the critical reference concentration. PFAS retention associated with AWIA can be considered to be ideal in such cases, thereby supporting the use of simplified mathematical models. Conversely, apparent nonideal transport behavior was observed for experiments conducted with input concentrations similar to or greater than the critical reference concentration.					1		1	A	-	多孔質媒体を抜ける際の吸着挙動を考えた計算機シミュレーションと実験による結果，PFASの種類によってかなりの違いが明確に現れた.	
D4	物化	Lai, TT; Eken, Y; Wilson, AK	Binding of Per- and Polyfluoroalkyl Substances to the Human Pregnane X Receptor	2020	Environ. Sci. Technol. 2020 Dec:54(24):15986-15995. doi: 10.1021/acs.est.0c04651.	Per- and polyfluoroalkyl substances (PFASs) are a class of environmentally persistent industrial compounds that disrupt various metabolic pathways. Among the protein receptors to which PFASs bind, the human pregnane X receptor (hPXR) is found to be a host for a variety of long- and short-chain PFASs that lead to its overactivation. Overactivation of hPXR is linked to potential endocrine disruption, oxidative stress, hepatic steatosis, and adverse drug interactions. In this study, molecular dynamics (MD) is used to study the binding between hPXR and a number of PFAS compounds, including alternatives whose activity on hPXR has not been experimentally tested. This is the first-time MD is used to study the interactions between PFASs and hPXR, showing how relative binding free energies of PFASs relate to hPXR agonism. Binding free energy calculations, hydrogen bond analysis, per-residue decomposition calculations, and alanine scanning studies are done to provide further insight. Activities on hPXR for several short-chain and alternative PFAS compounds to long-chain PFASs that have yet to be reported will also be considered. These short-chain and alternative species include perfluorobutane sulfonic acid (PFBS), Gen-X (trade name for 2,3,3,3-tetrafluoro-2-heptafluoropropoxy propanoic acid), ADONA (trade name for 4,8-dioxa-3H-perfluorononanoic acid), and 6:2 fluorotelomer carboxylic acid (6:2 FTCA). The study shows key aspects of PFAS recognition on the hPXR, the link between PFAS binding to hPXR and the hPXR activity change observed upon the PFAS exposure, and the potential effects of alternative PFASs on hPXR activity.			1	1			1	A	-	PFASのhPXRへの結合とPFAS曝露時に観察されるhPXR活性変化との関連，GenXのhPXR活性への潜在的影響.	
D5	物化	Kancharla, S; Choudhary, A; Davis, RT; Dong, DP; Bedrov, D; Tsianou, M; Alexandridis, P	GenX in water: Interactions and self-assembly	2022	J. Hazard. Mater. 2022 Apr:428:128137. doi: 10.1016/j.jhazmat.2021.128137.	2,3,3,3-tetrafluoro-2-(heptafluoropropoxy) propanoate, a.k.a. GenX, is a surfactant introduced as a safer alternative to replace perfluorooctanoate (PFOA) in the manufacturing of fluorinated polymers, however, GenX is shown to cause adverse health effects similar to, or even worse than, those of the legacy PFOA. With an overarching goal to understand the behavior of GenX molecules in aqueous media, we report here on GenX micelle formation and structure in aqueous solutions, on the basis of results obtained from a combination of experimental techniques such as surface tension, fluorescence, viscosity, and small-angle neutron scattering (SANS), and molecular dynamics (MD) simulations. To our best knowledge, this is the first report on GenX micelles. The critical micelle concentration (CMC) of GenX ammonium salt in water is 175 mM. GenX forms small micelles with association number 6-8 and 10 angstrom radius. GenX molecules prefer to align along the micelle surface, and the ether oxygen of GenX has very little interaction with and exposure to water. Information on the surfactant and interfacial properties of GenX is crucial, since such properties are manifestations of interactions between GenX molecules and between GenX and water molecules and, in turn, the amphiphilic character of GenX dictates its fate and transport in the aqueous environment, its interactions with various biomolecules, and its binding to adsorbent materials.					1		1	A	-	GenXの界面科学的な挙動を計算科学と実験で調べた基礎データ.	
D6	物化	Wang, JL; Niven, RK	Unification of surface tension isotherms of PFOA or GenX salts in electrolyte solutions by mean ionic activity	2021	Chemosphere. 2021 Oct:280:130715. doi: 10.1016/j.chemosphere.2021.130715.	The surface tension isotherms of soluble salts of per- and polyfluoroalkyl substances (PFAS) in electrolyte solutions are typically reported as functions of the PFAS concentration. However, for univalent salts and electrolytes, the Langmuir-Szyszkowski equation is a function of the mean ionic activity a*. Using previously reported data, we show that for salts of perfluorooctanoic acid (PFOA) or hexafluoropropylene oxide dimer acid (GenX (TM)), use of a* rather than concentration provides a unified surface tension isotherm, independent of the electrolyte concentration. This suggests that the electrolyte dependence of the isotherm arises purely from its effect on PFAS activity, rather than an intrinsic surface property. This finding has important implications for the understanding of PFAS retention in saline unsaturated soils, and for PFAS extraction from saline waters by foam fractionation.					1			C	-	PFASの濃度ではなく活量の関数として調べなおしたもの.	
D7	物化	He, Q; Yan, Z; Qian, SH; Xiong, TT; Grieger, KD; Wang, XM; Liu, CH; Zhi, Y	Phytoextraction of per- and polyfluoroalkyl substances (PFAS) by weeds: Effect of PFAS physicochemical properties and plant physiological traits	2023	J. Hazard. Mater. 2023 Jul:454:131492. doi: 10.1016/j.jhazmat.2023.131492.	Phytoextraction is a promising technology that uses plants to remediate contaminated soil. However, its feasibility for per-and polyfluoroalkyl substances (PFAS) and the impact of PFAS properties and plant traits on phytoex-traction efficacy remains unknown. In this study, we conducted greenhouse experiment and evaluated the potential of weeds for phytoextraction of PFAS from soil and assessed the effects of PFAS properties and plant traits on PFAS uptake via systematic correlation analyses and electron probe microanalyzer with energy dispersive spectroscopy (FE-EPMA-EDS) imaging. The results showed that 1) phytoextraction can remove 0.04%-41.4%wt of PFAS from soil, with extracted PFAS primarily stored in plant shoots; 2) Weeds preferentially extracted short-chain PFAS over long-chain homologues from soil. 3) PFAS molecular size and hydrophilicity determined plant uptake behavior, while plant morphological traits, particularly root protein and lipid content, influenced PFAS accumulation and translocation. Although plants with thin roots and small leaf areas exhibited greater PFAS uptake and storage ability, the impact of PFAS physicochemical properties was more significant. 4) Finally, short-chain PFAS were transported quickly upwards in the plant, while uptake of long-chain PFOS was restricted.								B	-	植物（雑草）による土壌中のPFASの除去を想定した基礎研究.	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D8	物化	Mohona, TM; Ye, ZJ; Dai, N; Nalam, PC	Adsorption behavior of long-chain perfluoroalkyl substances on hydrophobic surface: A combined molecular characterization and simulation study	2023	Water Res. 2023 Jul:239:120074. doi: 10.1016/j.watres.2023.120074.	Hydrophobic interaction is a prevalent sorption mechanism of poly- and perfluoroalkyl substances (PFAS) in natural and engineered environments. In this study, we combined quartz crystal microbalance with dissipation (QCM-D), atomic force microscope (AFM) with force mapping, and molecular dynamics (MD) simulation to probe the molecular behavior of PFAS at the hydrophobic interface. On a CH3-terminated self-assembled monolayer (SAM), perfluorononanoic acid (PFNA) showed similar to 2-fold higher adsorption than perfluorooctane sulfonate (PFOS) that has the same fluorocarbon tail length but a different head group. Kinetic modeling using the linearized Avrami model suggests that the PFNA/PFOS-surface interaction mechanisms can evolve over time. This is confirmed by AFM force-distance measurements, which shows that while the adsorbed PFNA/PFOS molecules mostly lay flat, a portion of them formed aggregates/hierarchical structures of 1-10 nm in size after lateral diffusion on surface. PFOS showed a higher affinity to aggregate than PFNA. Association with air nanobubbles is observed for PFOS but not PFNA. MD simulations further showed that PFNA has a greater tendency than PFOS to have its tail inserted into the hydrophobic SAM, which can enhance adsorption but limit lateral diffusion, consistent with the relative behavior of PFNA/PFOS in QCM and AFM experiments. This integrative QCM-AFM-MD study reveals that the interfacial behavior of PFAS molecules can be heterogeneous even on a relatively homogeneous surface.			1					B	-	CH3を末端に持つSAM膜にPFNAとPFOSが吸着する程度や入り込み方を調査．QCM-D，AFM，MDを用いている．	
D9	物化	Yue, YY; Sun, YY; Yan, XY; Liu, JM; Zhao, SF; Zhang, J	Evaluation of the binding of perfluorinated compound to pepsin: Spectroscopic analysis and molecular docking	2016	Chemosphere 2016 Oct:161:475-481. doi: 10.1016/j.chemosphere.2016.07.047	In this paper, we investigated the binding mode of perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) to pepsin using spectroscopies and molecular docking methods. Fluorescence quenching study indicated that their different ability to bind with pepsin. Meanwhile, time-resolved fluorescence measurements established that PFOA and PFNA quenched the fluorescence intensity of pepsin through the mechanism of static quenching. The thermodynamic parameters showed that hydrophobic forces were the main interactions. Furthermore, UV-vis, FTIR, three-dimensional fluorescence and molecular docking result indicated that PFCs impact the conformation of pepsin and PFOA was more toxic than PFNA. The conformational transformation of PFOA/PFNA-pepsin was confirmed through the quantitative analysis of the CD spectra. The present studies offer the theory evidence to analyze environmental safety and biosecurity of PFCs on proteases.			1				1	A	-	PFCはペプシンのコンフォメーションに影響を与え、PFOAはPFNAよりも毒性が強いことが示された。	
D10	物化	Miao, WL; Jia, D; Xu, J; Yong, L; Yi, ZS	Probing the binding interactions between perfluoroalkyl carboxylic acids and adenosine A2A receptors by spectroscopic techniques, molecular simulations and quantum chemistry	2023	J. Mol. Liq. 2023 May:377:121565. doi: 10.1016/j.molliq.2023.121565.	The binding interactions of perfluorobutyric acid (PFBA), heptafluorobutyric anhydride (HFBA), and ethyl heptafluorobutyrate (NSC3936) with the adenosine A2A receptor (A2AR) were investigated using multiple -spectral (fluorescence, ultraviolet-visible (UV-Vis) absorption, three-dimensional (3D) fluorescence, and Fourier Transform infrared (FT-IR) spectroscopy) and computational simulation methods. Steady-state fluorescence and UV-visible spectroscopy indicated that PFBA, HFBA, and NSC3936 caused an intrinsic fluorescence quenching of A2AR by static quenching and non-radiative energy transfer. The results of 3D fluorescence and FT-IR spectroscopy showed that the presence of PFBA, HFBA, and NSC3936 induced changes in the secondary structure of A2AR. Combined with thermodynamic analysis, molecular docking and quantum chemistry investigations, our results suggest that the association of PFBA, HFBA, and NSC3936 with A2AR was driven by hydrophobic forces and the formation of hydrogen bonds (H -bonds). The binding constants for the three PFCAs studied range from 8.27 x 106 L center dot mol-1 to 1.80 x 107 L center dot mol-1 at 298 K. Molecular dynamics (MD) simulations indicated that A2AR formed stable complexes with PFBA, HFBA, and NSC3936, and validated the existence of electrostatic interactions in the HFBA-A2AR complex. Furthermore, the results from the MD simulations were consistent with the thermodynamic analysis results.CO 2023 Elsevier B.V. All rights reserved.	1							C	-	短鎖のPFBAなどがアデノシンA_2A受容体に結合する機構を蛍光，UV，IRなどで調べ，結合定数も求めた．	
D11	物化	Zhang, CH; Tang, TFY; Knappe, DRU	Oxidation of Per- and Polyfluoroalkyl Ether Acids and Other Per- and Polyfluoroalkyl Substances by Sulfate and Hydroxyl Radicals: Kinetic Insights from Experiments and Models	2023	Environ Sci Technol. 2023 May 24. doi: 10.1021/acs.est.3c00947.	Per- and polyfluoroalkyl substances (PFAS) are widely used anthropogenic chemicals. Because of the strength of the carbon–fluorine bond, PFAS are not destroyed in typical water treatment processes. Sulfate (SO4•−) and hydroxyl (•OH) radicals can oxidize some PFAS, but the behavior of per- and polyfluoroalkyl ether acids (PFEAs) in processes involving SO4•− and •OH is poorly understood. In this study, we determined second-order rate constants (k) describing the oxidation of 18 PFAS, including 15 novel PFEAs, by SO4•− and •OH. Among the studied PFAS, 6:2 fluorotelomer sulfonate reacted most readily with •OH [k•OH = (1.1–1.2) × 107 M–1 s–1], while polyfluoroalkyl ether acids containing an -O-CFH- moiety reacted more slowly [k•OH = (0.5–1.0) × 106 M–1 s–1]. In the presence of SO4•−, polyfluoroalkyl ether acids with an -O-CFH- moiety reacted more rapidly [kSO4•− = (0.89–4.6) × 106 M–1 s–1] than perfluoroalkyl ether carboxylic acids (PFECAs) and a chloro-perfluoro-polyether carboxylic acid (ClPFPECA) [kSO4•− = (0.85–9.5) × 104 M–1 s–1]. For homologous series of perfluoroalkyl carboxylic acids, linear and branched monoether PFECAs, and multiether PFECAs, PFAS chain length had little impact on second-order rate constants. SO4•− reacted with the carboxylic acid headgroup of perfluoroalkyl carboxylic acids and PFECAs. In contrast, for polyfluoroalkyl ether carboxylic and sulfonic acids with an -O-CFH- moiety, the site of SO4•− attack was the -O-CFH- moiety. Perfluoroalkyl ether sulfonic acids were not oxidized by SO4•− and •OH under the conditions evaluated in this study.								B	-	PFASの酸化分解に向けて，スルホン酸および水酸基のラジカルによる酸化反応を詳しく調べ，反応定数などを明らかにした．	
D12	物化	Vyas, SM; Kania-Korwel, I; Lehmler, HJ	Differences in the isomer composition of perfluorooctanesulfonyl (PFOS) derivatives	2007	J. Environ. Sci. Health Part A-Toxic/Hazard. Subst. Environ. Eng. 2007 Feb:42(3):249-255. doi: 10.1080/10934520601134031.	Perfluorooctanesulfonyl (PFOS)-based materials and related compounds are an emerging group of environmental pollutants. Perfluorooctanesulfonyl fluoride, the key intermediate for the production of these materials, was manufactured by an electrochemical fluorination process that resulted in complex mixtures containing linear and branched PFOS derivatives and other perfluorinated compounds. This study uses F-19-NMR spectroscopy to investigate differences in the composition between commercial samples of PFOS and PFBS (perfluorobutanesulfonyl) derivatives. While PFBS derivatives, which are under evaluation as substitutes for PFOS-based materials, contained no detectable levels of branched impurities, all PFOS derivatives contained significant levels of branched and other impurities. Analysis of the NMR data reveals that PFOS fluorides typically have a higher content of internally branched and similar levels of isopropyl branched PFOS isomers compared to PFOS potassium salts. Furthermore, the isomer distribution of PFOS derivatives may vary depending on their source. These findings suggest that it is important to determine the isomer composition of PFOS samples used in both environmental and toxicological studies.				1				D	-	F19-NMRを用いて，化合物に含まれる不純物を調べた．短鎖のPFBSには分岐構造を持つ不純物は見つからなかったが，PFOSからは不純物が見つかった．	
D13	物化	Stults, JF; Choi, YJ; Rockwell, C; Schaefer, CE; Nguyen, DD; Knappe, DRU; Illangasekare, TH; Higgins, CP	Predicting Concentration- and Ionic-Strength-Dependent Air-Water Interfacial Partitioning Parameters of PFASs Using Quantitative Structure-Property Relationships (QSPRs)	2023	Environ. Sci. Technol. 2023 Apr:57(13):5203-5215. doi: 10.1021/acs.est.2c07316.	Air-water interfacial retention of poly-and perfluoroalkyl substances (PFASs) is increasingly recognized as an important environmental process. Herein, column transport experiments were used to measure air-water interfacial partitioning values for several perfluoroalkyl ethers and for PFASs derived from aqueous film-forming foam, while batch experiments were used to determine equilibrium Kia data for compounds exhibiting evidence of rate-limited partitioning. Experimental results suggest a Freundlich isotherm best describes PFAS air-water partitioning at environmentally relevant concentrations (101-106 ng/L). A multiparameter regression analysis for Kia prediction was performed for the 15 PFASs for which equilibrium Kia values were determined, assessing 246 possible combinations of 8 physicochemical and system properties. Quantitative structure-property relationships (QSPRs) based on three to four parameters provided predictions of high accuracy without model overparameterization. Two QSPRs (R2 values of 0.92 and 0.83) were developed using an assumed average Freundlich n value of 0.65 and validated across a range of relevant concentrations for perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), and hexafluoropropylene oxidedimer acid (i.e., GenX). A mass action model was further modified to account for the changing ionic strength on PFAS air-water interfacial sorption. The final result was two distinct QSPRs for estimating PFAS air-water interfacial partitioning across a range of aqueous concentrations and ionic strengths.					1			A	-	気水界面に補足されるPFASの量を15種類について調べた．	
D14	物化	Ran, XQ; Goddard, JD	Theoretical studies of the structural, electronic, and F-19 NMR properties of linear and branched perfluorobutanesulfonate	2013	Can. J. Chem.-Rev. Can. Chim. 2013 Dec:91(12):1272-1280. doi: 10.1139/cjc-2013-0294.	The structural and electronic properties of linear and branched perfluorobutanesulfonate (PFBS) in its anionic, acidic, and potassium or sodium salt forms were studied in a polarizable continuum model (PCM) of methanol solvent with the B3LYP functional and the 6-31G(d,p) basis set. The F-19 chemical shifts and F-19-F-19 J-coupling constants were determined in a PCM of methanol solvent with GIAO B3LYP/6-31++G(d, p). The differences in energy, enthalpy, and free energy of the four PFBS isomers were compared. The data indicate that the linear PFBS species is less stable than the branched isomers and the isomer with the tert-butyl-like structure is the most stable. The J-coupling contributions via both a non-Fermi contact mechanism and a long chain of bonds (through-bond) indicate that F-19-F-19 J-coupling constants are long range in these branched PFBS isomers. The calculated and experimental F-19 chemical shifts for the linear PFBS species are in good agreement. In addition, the results obtained establish the similarities between the geometries and electronic and NMR properties of linear PFBS and linear perfluorooctanesulfonate (PFOS).								A	-	直鎖状PFBSは分岐状異性体よりも安定性が「低く」，tert-ブチル様構造を持つ異性体が最も安定	

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D15	物化	Wiens, JP; Miller, TM; Ard, SG; Viggiano, AA; Shuman, NS	Elementary Reactions Leading to Perfluoroalkyl Substance Degradation in an Ar plus /e- Plasma	2022	J. Phys. Chem. A. 2022 Dec:126(48):9076-9086. doi: 10.1021/acs.jpca.2c04898.	The reactivities of three perfluoroalkyl carboxylic acids (PFCAs) (perfluoropropanoic acid (C2F5COOH, PFPA), perfluorobutanoic acid (C3F7COOH, PFBA), and perfluorooctanoic acid (C7F15COOH, PFOA)) in a thermal, weakly ionized, argon/electron plasma were investigated from 300 to 600 K using a Langmuir probe-flowing afterglow apparatus. The results are supported by density functional theory calculations of the energetics of PFCA, CnF2n+1COOH, from n = 1 to 7. PFPA and PFBA attach electrons at a substantial fraction of the calculated capture rate; PFOA likely attaches electrons with similarly high efficiency, but the low vapor pressure of PFOA resulted in only qualitative results. All three compounds attach electrons dissociatively via HF elimination. The acidity channel (i.e., formation of H + CnF2n+1COO-), calculated to be slightly endothermic, is never observed even at higher temperatures where this channel would be energetically allowed. Attachment to perfluorooctanesulfonic acid (n-C8F17SO3H) is rapid, yielding the conjugate base n-C8F17SO3- as proton transfer to the electron is exothermic. At temperatures near 450 K (PFOA), 550 K (PFBA), or 600 K (PFPA), the parent neutrals thermally decompose as evidenced by abrupt changes in rate constants and branching ratios. PFPA and PFBA react with Ar+ close to the calculated capture rate, and PFOA likely does as well. The reaction mechanism starts via charge transfer, which can then lead to a range of product ions. Reactions with Ar+ yield fluorocarbon radicals, clarifying and supporting a previously proposed mechanism of PFCA degradation in an argon plasma.	1							C	-	電荷移動から始まり、さまざまな生成物イオンにつながる可能性。Ar+との反応によりフルオロカーボンラジカルが生成し、アルゴンプラズマ中でのPFCA分解する。	
D16	物化	Koyama, Y; Shimono, S; Abe, H; Matsuishi, K	Crystal polymorphs in 1-alkyl-3-methylimidazolium perfluorobutanesulfonate ionic liquids	2020	J. Mol. Liq. 2020 Nov:317:113908. doi: 10.1016/j.molliq.2020.113908.	Hidden crystal phases of fluorinated ionic liquids (fILs) at low temperature were clarified by simultaneous measurements using X-ray diffraction and differential scanning calorimetry. The fILs studied are 1-alkyl-3-methylimidazolium perfluorobutanesulfonate, [C(n)mim][PFBS] (n = 4, 6, and 8). The crystal polymorphs of all [C(n)mim][PFBS] appeared both upon cooling and heating. The phase varieties of fILs increased with an increase in the alkyl chain length, n. Density functional theory calculations provided the anisotropic electrostatic potential surface of the [PFBS](-) anion. The complicated phase behaviors of fILs, including metastable phases, were derived from two conformations and the anisotropic electrostatic potential surface of the [PFBS](-) anion.				1				D	-	イオン液体関連の研究で，対象外。	
D17	物化	Abe, H; Koyama, Y; Shimono, S; Kishimura, H; Matsuishi, K	High-pressure crystal polymorphs and multiple pathways in 1-hexyl-3-me-thylimidazolium perfluorobutanesulfonate ionic liquid	2022	Chem. Phys. 2022 May:557:111479. doi: 10.1016/j.chemphys.2022.111479.	1-Hexyl-3-methylimidazolium perfluorobutanesulfonate ([C6mim][PFBS]), a fluorinated ionic liquid (fIL), exhibited complicated phase behaviors under high pressure (HP). The asymmetric [PFBS]- anion possesses conformational degrees of freedom. Using X-ray diffraction, HP crystal structures were determined upon compression and decompression. 00l Bragg reflections at the small scattering angle representing the layered structures appeared reentrantly. The reentrant phase behavior is described by layering of [PFBS]-(layering I) below 3.7 GPa (P1) and the hybrid layered structure of [PFBS]- (layering II) above 7.6 GPa. The layering II caused irreversible crystal polymorph in the pressure cycle. Below P1, HP-phase transition changed to reversible crystal polymorph. The complicated HP-crystal polymorphs and multiple pathways were derived from the conformation-driven molecular packing states.				1				D	-	イオン液体関連の研究で，対象外。	
D18	物化	Schindler, BJ; Buchanan, JH; Mahle, JJ; Peterson, GW; Glover, TG	Ambient Temperature Vapor Pressure and Adsorption Capacity for (Perfluorooctyl) Ethylene, 3-(Perfluorobutyl)propanol, Perfluorohexanoic Acid, Ethyl Perfluorooctanoate, and Perfluoro-3,6-dioxaheptanoic Acid	2013	J. Chem. Eng. Data. 2013 Jun:58(6):1806-1812. doi: 10.1021/je400205g.	With increased use of highly fluorinated compounds has come an increased need for knowledge of the fundamental properties of these chemicals, such as vapor pressure, to determine how they will behave in the environment and how to remove them. A modified vapor saturation method was used to measure the ambient temperature vapor pressure of 3-(perfluorobutyl)propanol, (perfluorooctyl)ethylene, perfluorohexanoic acid, ethyl perfluorooctanoate, and perfluoro-3,6-dioxaheptanoic acid between (254.15 and 309.15) K. The freezing point for perfluorohexanoic acid was determined to be between (291.15 and 293.15) K The vapor pressures, which ranged from (0.87 to 978) Pa, were used to generate saturated vapor streams of the compound so that adsorption capacities on BPL activated carbon could be determined. Adsorption equilibrium data for three of the chemicals, measured at a feed concentration of 139 mu L.L-1 at high and low relative humidity, are presented and discussed.		1						C	-	高濃度の湿った空気から化学物質を効果的に除去できることを実証した	
D19	物化	Zenobio, JE; Salawu, OA; Han, ZW; Adeleye, AS	Adsorption of per- and polyfluoroalkyl substances (PFAS) to containers	2022	J. Hazard. Mater. Adv. 2022 Aug:7:100130. doi: 10.1016/j.hazadv.2022.100130.	Mass transfer of per-and polyfluoroalkyl substances (PFAS) to container walls during sample collection and storage or experimentation is an important source of error in PFAS analysis. To minimize this error, high-density polyethylene (HDPE) and polypropylene containers are widely used for PFAS studies. However, there is sparse data to justify these container polymer choices. In this study, we investigated the adsorption of six common PFAS (in single-analyte solutions and in mixtures) to containers (made of HDPE, polypropylene, glass, polyethylene terephthalate (PET), and polystyrene) at 4 & DEG;C and 20 & DEG;C. All the containers adsorbed PFAS from the aqueous phase regardless of temperature. PFAS adsorption from single-analyte solutions ranged from 3.89 ng/cm2 (for hexafluoropropylene oxide dimer acid, GenX) to 30.34 ng/cm2 (for perfluorooctanesulfonamide, FOSA). In the mixtures, the highest PFAS adsorption (total concentration = 55.73 ng/cm2) occurred in the polypropylene container. The general trend of PFAS adsorption from the mixture was polypropylene > HDPE > PET > glass > polystyrene. In addition, adsorption to polypropylene containers made by three different manufacturers was substantially different for long-chain PFAS. PFAS adsorption to containers was influenced by PFAS chemistry, container hydrophobicity, and temperature. The result shows that container characterization for PFAS adsorption is an important step in PFAS studies.					1			C	-	分析化学上の問題を検討した論文。混合物からのPFAS吸着の一般的傾向は、ポリプロピレン＞HDPE＞PET＞ガラス＞ポリスチレンであった。	
D20	物化	Thomas, J; Serrato, A; Lin, W; Jager, W; Xu, YJ	Perfluorobutyric Acid and Its Monohydrate: A Chirped Pulse and Cavity Based Fourier Transform Microwave Spectroscopic Study	2014	Chem.-Eur. J. 2014 May:20(20):6148-6153. doi: 10.1002/chem.201304321.	Rotational spectra of perfluorobutyric acid (PFBA) and its monohydrate were studied with a broadband chirped pulse and a narrow-band cavity based Fourier transform microwave spectrometer, and high-level ab initio calculations. Extensive conformational searches were performed for both the acid and its monohydrate at the MP2/6-311++G(2d,p) level of theory. Two and three conformers were predicted to exist for PFBA and its monohydrate, respectively. One set of rotational transitions was observed and assigned for each, PFBA and its monohydrate. Based on the measured broadband spectra, we confidently conclude that only one dominant conformer exists in each case. The orientation of the hydroxyl group in PFBA was determined by using isotopic analysis. Comparison of the observed transition intensities and the calculated electric dipole moment components allowed us to identify the most stable monohydrate conformation, which takes on an insertion hydrogen-bonding topology. Comparisons to the shorter chain analogues, that is, trifluoroacetic acid, perfluoropropionic acid, and their monohydrates, are made to elucidate the general trend in their conformational preference and binding topologies.	1							D	-	一分子での安定コンフォメーションを研究したもの。	
D21	物化	Koyama, Y; Shimono, S; Kishimura, H; Takekiyo, T; Yoshimura, Y; Abe, H; Matsuishi, K	High-pressure crystal polymorphs in 1-butyl-3-methylimidazolium perfluorobutanesulfonate	2021	J. Mol. Liq. 2021 Aug:335:116415. doi: 10.1016/j.molliq.2021.116415.	The high-pressure (HP) crystal polymorph of a fluorinated ionic liquid (fIL) was determined using X-ray diffraction and Raman spectroscopy. The irreversible crystal polymorph of 1-butyl-3-methylimidazolium perfluorobutanesulfonate ([C(4)mim][PFBS]) was observed upon compression and decompression using X-ray diffraction. Conformational variance/invariance of [C(4)mim](+) and [PFBS](-) in the Raman spectra corresponded to the HP crystal polymorph. By the degrees of freedom of the conformations and their conformational flexibilities, the conformational variance was switched at the specific pressure for a volume contraction under HP, at which point the crystal system changed. The HP crystal polymorph was entirely different from the low-temperature crystal polymorph.				1				D	-	イオン液体を構成する化合物の結晶構造を決めただけ	
D22	物化	Dunn, M; Becanova, J; Snook, J; Ruyle, B; Lohmann, R	Calibration of Perfluorinated Alkyl Acid Uptake Rates by a Tube Passive Sampler in Water	2023	ACS ES T Water. 2023 Feb 10;3(2):332-341. doi: 10.1021/acsestwater.2c00384.	Per-and polyfluoroalkyl substances (PFAS) are a group of 4000+ man-made compounds of great concern due to their environmental ubiquity and adverse effects. Despite general interest, few reliable detection tools for integrative passive sampling of PFAS in water are available. A microporous polyethylene tube with a hydrophilic-lipophilic balance sorbent could serve as a flow-resistant passive sampler for PFAS. The tube's sampling rate, Rs, was predicted based on either partitioning and diffusion or solely diffusion. At 15 degrees C, the laboratory-measured Rs for perfluorohexanoic acid of 100 +/- 81 mL day-1 was better predicted by a partitioning and diffusion model (48 +/- 1.8 mL day-1) across 10-60 cm s-1 water flow speeds (15 +/- 4.2 mL day-1 diffusion only). For perfluorohexane sulfonate, Rs at 15 degrees C were similarly different (110 +/- 60 mL day-1 measured, 120 +/- 63 versus 12 +/- 3.4 mL day-1 in respective models). Rs values from field deployments were in between these estimates (46 +/- 40 mL day-1 for perfluorohexanoic acid). PFAS uptake was not different for previously biofouled membranes in the laboratory, suggesting the general applicability of the sampler in environmental conditions. This research demonstrates that the polyethylene tube's sampling rates are sensitive to the parameterization of the models used here and partitioning-derived values should be used.		1						C	-	親水性-親油性バランス吸着剤を用いた微多孔ポリエチレンチューブにより，PFASの耐流動性パッシブサンプラーとして機能することを検討した	
D23	物化	Zhang, J; Xu, GY; Song, AX; Wang, L; Lin, MQ; Dong, ZX; Yang, ZH	Faceted fatty acid vesicles formed from single-tailed perfluorinated surfactants	2015	Soft Matter 2015 ;11:7143-7150. doi: 10.1039/c5sm01494h	The aggregation behavior and rheological properties of two mixtures of perfluorononanoic acid (PFNA)/NaOH and perfluorodecanoic acid (PFDA)/NaOH were investigated in aqueous solutions. Interestingly, pH-sensitive polyhedral fatty acid vesicles were spontaneously formed in both systems, which were determined by freeze-fracture transmission electron microscopy (FF-TEM) measurements. Especially, a phase transition from faceted vesicles to the L-3 phase with the increase of pH was observed in the PFNA/NaOH system while it was not observed in the PFDA/NaOH system. Differential scanning calorimetry (DSC) and wide angle X-ray scattering (WAXS) measurements confirmed that the bilayers of the faceted vesicles were in the crystalline station indicating that the crystallization of fluorocarbon chains was the main driving force for their formation. Besides, the two systems of faceted perfluorofatty acid vesicles exhibit interesting rheological properties, for instance, they showed high viscoelasticity and shear-thinning behaviour, and the elastic modulus (G') and viscous modulus (G '') of PFDA/NaOH vesicles were much higher than those of PFNA/NaOH vesicles. Conversely, the solution of the L3 phase with fluid bilayers did not present viscoelastic properties. Therefore, the viscoelastic properties of vesicles resulted from the crystalline fluorinated alkyl chains with high rigidity at room temperature and the dense packing of vesicles. As far as we know, such faceted fatty acid vesicles formed from single-tailed perfluorinated surfactants have been rarely reported. Our work successfully constructs polyhedral fatty acid vesicles and proposes their formation mechanism, which should be a great advance in the fundamental research of fatty acid vesicles.			1					D	-	多面体脂肪酸ベシクルの構築に成功し、その形成メカニズムを提案するもの	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D24	物化	Torres, MF; de Rossi, RH; Fernandez, MA	Hydrolysis of p-nitrophenyl perfluorooctanoate in mixed surfactant systems	2014	RSC Adv. 2014;4(54):28606-28614. doi: 10.1039/c4ra02888k.	The kinetics of the hydrolysis reaction of p-nitrophenyl perfluorooctanoate were studied in the presence of different amphiphilic systems: two hydrocarbon surfactants (sodium dodecyl sulfate, SDS, and polyoxyethylene(23) lauryl ether, Brij-35), a perfluorinated detergent (perfluorononanoic acid, PFNA) and in mixtures of SDS-PFNA and Brij-35-PFNA. The study was performed at different compositions of the mixtures (characterized by the molar fraction of PFNA, alpha(PFNA)), and for each alpha(PFNA) the concentration was varied over a wide range. The kinetic probe p-nitrophenyl perfluorooctanoate showed a very strong interaction with the surfactants. In the presence of the mixed surfactants, the behaviour of the probe changed dramatically with the composition of the mixtures, which indicates that this substrate is very sensitive to the effect of the micellar media, being a very good molecule to study these types of surfactant systems. The use of the studied ester allowed us to confirm the presence of two different aggregates in the mixture Brij-35-PFNA as was previously observed with other techniques. The presence of hydrocarbon-rich micelles at low alpha(PFNA), as well as perfluorinated rich micelles at high alpha(PFNA) was also confirmed. The kinetic behaviour of p-nitrophenyl perfluorooctanoate in SDS-PFNA mixtures fully agreed with our previous description of the aggregates formed in this system. The presence of a practically pure PFNA micelle at high alpha(PFNA) could be also demonstrated from the kinetic results.			1					D	-	ペルフルオロオクタン酸p-ニトロフェニルの加水分解反応の速度論	
D25	物化	Manivel, A; Ilayaraja, N; Velayutham, D; Noel, A	Medium effects on the electro-deposition of MnO2 on glassy carbon electrode - A comparative study in alkane, perfluoro alkane carboxylic acids and methanesulphonic acid	2007	Electrochim. Acta. 2007 Nov:52(28):7841-7848. doi: 10.1016/j.electacta.2007.06.008.	Voltammetric studies of Mn(II) were carried out in acetic acid (AA), trifluoroacetic acid (TFA), butyric acid (BA), perfluorobutyric acid (PFBA) and methanesulphonic acid (MSA) media. Influence of anodic limit and the nature of acids were investigated. Oxidation of Mn(II) shows two anodic peaks in weak acids namely acetic acid and butyric acid media due to the formation of insoluble Mn(III) and Mn(IV) species. Reduction of these species were also observed as two peaks in the cathodic region. Formation and reduction of solid oxide phases are the dominant electrode processes in such weak acid media. In strong acids like MSA and TFA media sharp anodic and cathodic peaks were obtained due to the formation and reduction of stable soluble Mn(III) species. SEM studies reveal the formation of thicker oxide phases in weak acid media and much thinner oxide layers in strong acid media. gamma-MnO2 phase was formed from AA and TFA while epsilon-MnO2 phase was formed from BA and PFBA, suggesting a relationship between phase structure and anionic size.	1							D	-	的外れ．酢酸(AA)、トリフルオロ酢酸(TFA)、酪酸(BA)、パーフルオロ酪酸(PFBA)およびメタンスルホン酸(MSA)媒体中でMn(II)のポルタンメトリー研究	
D26	物化	Abe, H; Kishimura, H; Uruichi, M	A phase variety of fluorinated ionic liquids: Molecular conformational and crystal polymorph	2023	Spectroc. Acta Pt. A-Molec. Biomolec. Spectr. 2023 Feb:286:121948. doi: 10.1016/j.saa.2022.121948.	Crystal polymorphs of fluorinated ionic liquids (fILs) were examined at low-temperature (LT) by Raman spectroscopy. The fILs were 1-alkyl-3-methylimidazolium perfluorobutanesulfonate, [Cnmim][PFBS] (n = 4, 6, and 8). The cations and anion possess conformational degrees of freedom. Various LT phases were derived from the conformational polymorphs of the cations and the anion. Conformational flexibility depended on alkyl chain length. The crystal polymorphs in the fILs were sensitive to molecular conformations and flexibility.				1				D	-	イオン液体の論文．的外れ．	
D27	物化	Saeidi, N; Kopinke, FD; Georgi, A	What is specific in adsorption of perfluoroalkyl acids on carbon materials?	2021	Chemosphere. 2021 Jun:273:128520. doi: 10.1016/j.chemosphere.2020.128520.	Various activated carbon products show wide variability in adsorption performance towards perfluoroalkyl acids (PFAAs) and predictive tools are largely missing. In order to gain a better understanding on the adsorption mechanisms of PFAAs, perfluorooctanoic acid (PFOA) was compared with its fluorine-free analogon octanoic acid (OCA) as well as phenanthrene (nonionic) in terms of their response towards changes in carbon surface chemistry. For this approach, a commercial activated carbon felt (ACF) with high content of acidic surface groups was modified by amino-functionalisation as well as thermal defunctionalisation in H-2 (yielding DeCACF). While improvement by amino-functionalisation was moderate, defunctionalisation drastically enhanced adsorption of PFOA and other PFAAs. In comparison, OCA and phenanthrene were much less affected. Electrostatic interactions and charge compensation provided by positively charged surface sites (quantified by their anion exchange capacity) are obviously more crucial for PFAAs than for common organic acids (such as the tested OCA). A possible reason is their exceptionally strong acidity with pK(a) < 1. Nevertheless, at the best modified ACF material (DeCACF) the sorption coefficients (K-d) for PFOA and perfluorooctylsulfonic acid (PFOS) at environmentally relevant concentrations reach the range of 107 L/kg which is outstanding. DeCACF provides a surface with overall low polarity (low O-content), low density of acidic sites causing electrostatic repulsion, but nevertheless a sufficient density of charge-balancing sites for organic anions. The results of the present study contribute to an optimized selection of adsorbents for PFAA adsorption from water considering also various salt matrices and the presence of natural organic matter.								C	-	活性炭への吸着影響を調べたもの	
D28	物化	Karoyo, AH; Sidhu, P; Wilson, LD; Hazendonk, P	Characterization and Dynamic Properties for the Solid Inclusion Complexes of beta-Cyclodextrin and Perfluorobutyric Acid	2014	J. Phys. Chem. C. 2014 Jul:118(28):15460-15473. doi: 10.1021/jp502325e.	The structural characterization of solid- and solution-state inclusion complexes (ICs) of beta-cyclodextrin (beta-CD; host) with perfluorobutyric acid (PFBA; guest) is presented in this study. Complexes in the solid state were prepared at various host/guest mole ratios (i.e., 1:1 and 2:1) using a modified dissolution method. Thermal analyses and multinuclear C-13 NMR methods employing direct polarization (DP) and cross-polarization (CP) techniques with magic angle spinning (MAS) and high-power H-1/F-19 decoupling were used to characterize the solid-state host guest complexes. Unequivocal evidence of the formation of beta-CD/PFBA inclusion compounds was provided using F-19 -> C-13 CP/MAS NMR results. Powder X-ray diffraction reveals that PFBA forms a cage-type structure with beta-CD, in which the guest adopts gauche and near-linear conformations in the 1:1 and 2:1 complexes, respectively, according to Fourier transform infrared spectroscopy results. Interpretation of the NMR splitting patterns of PFBA spectrum in solution reveals that PFBA undergoes fast rotation of the CF3 group on a 3-fold axis, while the remainder of the chain experiences a significant C-C bond rotation; hence, it is not locked in a particular rotamer configuration. The distribution of the rotational and axial motions in the beta-CD/PFBA complexes in the solid state as revealed by NMR relaxation dynamic studies is a function of the host/guest mole ratios and is determined by the binding geometry of the guest.	1							D	-	CDへの包接について調べただけ．	
D29	物化	Li, M; Sun, FY; Shang, WT; Zhang, XL; Dong, WY; Liu, TZ; Pang, W	Theoretical studies of perfluorochemicals (PFCs) adsorption mechanism on the carbonaceous surface	2019	Chemosphere 2019 Nov:235:606-615. doi: 10.1016/j.chemosphere.2019.06.191	Understanding the mechanism by which perfluorochemicals (PFCs) adsorbed on carbonaceous surface is eventually important to the design and process optimization of effective PFCs removal technologies. In this study, the possible binding mechanism of six different PFCs onto carbonaceous surface was investigated by means of first principles quantum mechanical methods based on density functional theory (DFT) calculation and wave function analysis. The adsorption process fitted well with pseudo-second-order kinetic indicated that chemical bonding could not be underestimated. The results indicate that there were monolayer adsorption, electrostatic and hydrophobic interactions existed in PFCs adsorption process. DFT results suggested that the adsorption of PFCs on carbonaceous surface was one chemi-sorption process that accompanied by Van der Waals interactions. As there was different head functional groups in PFOS and PFOA, their adsorption capacity mainly controlled by the availability of active sites that was occupied by PFCs. The variation of chain length of PFBS and PFOS also take a certain responsible for different adsorption paths, due mainly to their hydrophobic effect. The obtained results from wave function and DFT analysis give in-depth understanding of PFCs adsorption on carbonaceous surface and help to their effectively removal.				1				C	-	PFAS除去技術を目指した炭素質表面への吸着挙動を調べたもの．	
D30	物化	Hernandez, I; Pathumakanthar, N; Wyatt, PB; Gillin, WP	Cooperative Infrared to Visible Up Conversion in Tb3+, Eu3+, and Yb3+ Containing Polymers	2010	Adv. Mater. 2010 Dec:22(47):5356-+. doi: 10.1002/adma.201002674.	CONTENTS Intense visible photoluminescence is observed in Yb0.7Tb0.3(PFBS)(3) (PBFS = perfluorobutane-sulfonate) coordination polymers upon IR excitation as a result of cooperative up-conversion (UC) processes. These occur when two individually excited Yb3+ ions simultaneously combine their energy into a high-energy excited state of Tb3+.				1				D	-	無関係	
D31	物化	Zhang, J; Liu, CT; Hu, XY; Lv, QC; Zhang, HS; Pi, BX; Yang, ZH; Lin, MQ	Supramolecular self-assembly of the gamma-cyclodextrin and perfluorononanoic acid system in aqueous solution	2021	Soft Matter. 2021 Feb:17(5):1428-1436. doi: 10.1039/d0sm01744b.	Recently, inclusion complexes formed from cyclodextrins (CDs) and surfactants have been found to play complex and important roles in supramolecular self-assembly. In this work, the self-assembly of perfluorononanoic acid (PFNA)/gamma-cyclodextrin (gamma-CD) in aqueous solution was investigated. The sole PFNA solution assembled into spherical uni-lamellar vesicles under certain concentrations as revealed by freeze-fracture transmission electron microscopy (FF-TEM) images. Interestingly, when gamma-CD was added into the PFNA solution, one novel kind of cyclodextrin-based hydrogel with a crystal-like structure was obtained. The morphology of the hydrogels was inerratic parallel hexahedron or regular hexahedron as revealed by optical microscopy and scanning electron microscopy (SEM) measurements. Furthermore, the hydrogels were transformed into crystalline precipitates, which were composed of highly uniform tetragonal sheets with excellent crystallinity and homogeneous size distribution just by changing the gamma-CD concentration. More amazingly, the crystal-like hydrogels were sensitive to shear and switched to solutions in their morphology with bar-like and rod-like aggregates and smaller square sheets under different shear rates, and the hydrogel-solution transition behavior was a reversable process. H-1 NMR, Fourier transform infrared (FT-IR) and wide-angle X-ray diffraction (WXRD) measurements were performed to lead us to propose the formation mechanism of the above aggregates. Hopefully, our studies will cast new light on the fundamental investigations into the self-assembly of supramolecular systems of fluorinated surfactants and CD molecules and provide a new idea for smart material design.			1					D	-	CDとの包接を論じているだけ	
D32	物化	Gonzalez-Perez, A; Ruso, JM; Blanco, E; Romero, MJ; Prieto, G; Sarmiento, F	Volumetric properties of sodium perfluoroalkylcarboxylates in aqueous solutions at different temperatures	2006	Colloid Surf. A-Physicochem. Eng. Asp. 2006 Nov:290(1-3):50-55. doi: 10.1016/j.colsurfa.2006.03.057.	Densities and sound velocities of sodium perfluorohexanoate and sodium perfluorononanoate for different concentrations above and below the critical micelle concentration (cmc) have been obtained at different temperatures. Apparent molar volumes and compressibilities of the surfactants in the monomeric and micellar form have been estimated. The relevant results were plotted as a function of the temperature and the alkyl chain length by using previous data reported for sodium heptanoate and sodium octanoate. The expected linear behaviour in function of temperature and also alkyl chain length have been found. In order to analyze the influence of the substitution of the hydrogen by fluorine in the alkyl chain of the surfactant, the data were compared with the hydrogenated counterpart.		1	1					D	-	分子凝集性に関わることを，温度と鎖長の関数で検討．まとはずれ．	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D33	物化	Yan, ZN; Wen, XL; Kang, YX; Zhang, SY; Wu, SY	Volumetric and conductometric studies on the interactions of dipeptides with potassium perfluoroalkanesulfonate in aqueous solution at different temperatures	2016	J. Chem. Thermodyn. 2016 Feb:93:172-178. doi: 10.1016/j.jct.2015.10.004	Density and conductivity data for potassium perfluoroalkanesulfonate ((potassium perfluorobutanesulfonate (PFBS) and potassium perfluorooctanesulfonate (PFOS)) + dipeptide + water) systems were determined at different temperatures. The standard partial molar voluine (V-2,V-phi (o)), standard partial molar volume of transfer for dipeptide from water to aqueous potassium perfluoroalkanesulfonate solutions (Delta V-t(o)), hydration number (N-H), partial molar expansibility (E-phi(o),) and Hepler's constant for the dipeptides have been calculated from density data. Electrical conductivity was used to estimate the limiting molar conductivity (Lambda(o)), Walden product (Lambda(o)eta) and energy of activation of the transfer process (Ea) of potassium perfluoroalkanesulfonate in aqueous dipeptide solutions. Effects of temperature and the hydrocarbon chain length of the dipeptides on the volumetric and conductometric properties were examined. The results have been interpreted in terms of solute-solvent interactions and structural changes in the mixed solutions.				1				D	-	生化学への応用を考えた研究で的外れ。	
D34	物化	Li, GF; Gao, M	Thermal properties of polycarbonate containing potassium perfluorobutane sulfonate	2016	ACSR ADV COMPUT 2016:49:501-505. doi: 10.2991/icmit-16.2016.91	Potassium perfluorobutane sulfonate (PPFBS) was used to impart flame retardancy to polycarbonate (PC). The thermal properties of of the PC/PPFBS composites were studied by limiting oxygen index (LOI), vertical burning test (UL-94), TG, and scanning electron microscopy (SEM). The results showed that PC/1wt.% PPFBS composites passed UL-94V-0 rating, and its LOI values were 30.6%. Compared with PC, for the PC/PPFBS composites, the thermal stability and the char yield are increased. Scanning electron microscopy revealed that the char properties had crucial effects on the flame retardancy.				1				D	-	的外れ。	
D35	物化	Thomas, J; Serrato, A; Xu, YJ; Jager, W; Lin, W	Rotational spectra of perfluorobutyric acid and its monohydrate	2013	Abstr. Pap. Am. Chem. Soc. 2013 Apr:245:402-PHYS.	The pure rotational spectrum of perfluorobutyric acid, CF3CF2 CF2COOH, has been studied by a pulsed nozzle, chirped-pulse Fourier transform microwave spectrometer in the frequency range of 8-14 GHz. A total of 103 transitions, including a-type, btype, and c-type transitions have been observed and analyzed. The rotational constants and the five quartic centrifugal distortion constants were determined for the first time. The rotational constants are A = 1398.6731(6) MHz, B = 624.6361(5) MHz, and C = 598.4248(5) MHz. The rotational spectrum of the perfluorobutyric acid monohydrate has also been measured. The structure of the hydrate has been calculated from ab initio calculations. The comparison of this project and the previously studied perfluoropropionic acid and its monohydrate will be presented. The effect of hydrogen bonding on the structure of the monohydrates will be discussed.	1							D	-	的外れ。	
D36	物化	Thomas, J; Serrato, A; Carrillo, M; Lin, W; Jaeger, W; Xu, YJ	Rotational spectroscopic and theoretical studies of the perfluorobutyric acid-formic acid complex	2017	Abstr. Pap. Am. Chem. Soc. 2017 Apr:253:521.	Perfluorinated carboxylic acids are a special class of compounds with considerable industrial applications. In this study, we applied chirped pulse and cavity-based Fourier transform microwave spectroscopy to investigate the structural and possible tunneling properties of the perfluorobutyric acid–formic acid complex, together with high level ab initio calculations. Only one clearly dominant conformer, featuring an eight-membered double hydrogen-bonded ring, was predicted for the hetero acid dimer and detected experimentally. The rotational constants calculated at the B3LYP-D3BJ/6-311++G(2d,p) level are in excellent agreement with the experimental ones, better than those from MP2 calculations. No tunneling splittings were detected in the experimental spectra. Detailed analyses of the non-covalent intermolecular interactions in the hetero acid dimer provide an explanation for the absence of double proton transfer, and also identify the presence of F···F attractive interactions.	1							D	-	的外れ。	
D37	物化	Bernazzani, L; Gianni, P; Mollica, V	Calorimetric Study of the Aggregation of Lithium Perfluorohexanoate on Poly(ethyleneglycol) Oligomers in Water	2010	J. Solut. Chem. 2010 Nov:39(11):1698-1709. doi: 10.1007/s10953-010-9606-x.	The interaction of lithium perfluorohexanoate (LiPFHex) with poly(ethylene glycol) (PEG) of different molecular weights (600 Daa parts per thousand currency sign MWa parts per thousand currency sign20000 Da) was investigated in aqueous solution at 25.00 A degrees C by isothermal titration calorimetry (ITC). The interaction with one of the PEG polymers (MW=8000 Da) was also followed at the same temperature by viscosity and conductivity measurements. The aggregation pattern of this surfactant on the PEG polymeric chain was very similar to that exhibited by the homologous salts of perfluoroheptanoate, perfluorooctanoate and perfluorononanoate ions. The interaction enthalpies with PEG of this class of surfactants are always endothermic and decrease steeply with the decreasing length of the fluorocarbon chain. Experimental data from calorimetry, viscosity and conductivity consistently indicate a very small tendency of PEG polymers to wrap around the small LiPFHex micellar aggregates. The PFHex ion appears to be the shortest member of the series able to interact with a polyoxyethylenic chain. The same CF2 contribution to the Gibbs energy of micellization or aggregation on the polymers was found within the series, indicating a common hydrophobic driving force for the two processes.		1	1					D	-	電気化学の論文。	
D38	物化	Newmark, RA	Vicinal fluorine-fluorine coupling constants in perfluoropropyl groups	2009	J. Fluor. Chem. 2009 Apr:130(4):389-393. doi: 10.1016/j.jfluchem.2009.01.005.	The geminal fluorines in XCF(2)-CF(2)Y groups are magnetically inequivalent. The fluorines comprise an AA'XX' spin which should show non-first-order NMR spectra, but usually appear deceptively simple with little indication of vicinal coupling. Detailed analysis of the spectra of perfluorobutyric acid (1) and 2,2,3,3,4,4,4-heptafluorobutanol (2) are reported. The (3)J(AX) and (3)J(AX') range between 4 and 9 Hz and are of opposite sign.	1							D	-	NMRを主眼とした論文	
D39	物化	Kaiser, MA; Larsen, BS; Kao, CPC; Buck, RC	Vapor pressures of perfluorooctanoic, -nonanoic, -decanoic, -undecanoic, and -dodecanoic acids	2005	J. Chem. Eng. Data. 2005 Nov:50(6):1841-1843. doi: 10.1021/je050070r.	A dynamic method was used to determine the vapor pressures of perfluorooctanoic, -nonanoic, -decanoic, -undecanoic, and -dodecanoic acids. Measurements were made over the temperature range from (59.25 to 190.80) degrees C for perfluorooctanoic acid, from (99.63 to 203.12) degrees C for perfluorononanoic acid, from (129.56 to 218.88) degrees C for perfluorodecanoic acid, from (112.04 to 237.65) degrees C for perfluoroundecanoic acid, and from (127.58 to 247.36) degrees C for perfluorododecanoic acid. Pressures ranged from (0.128 to 96.50) kPa for perfluorooctanoic acid, from (1.12 to 99.97) kPa for perfluorononanoic acid, from (3.129 to 99. 97) kPa for perfluorodecanoic acid, from (0.616 to 99.97) kPa for perfluoroundecanoic acid, and from (0.856 to 99.96) kPa for perfluorododecanoic acid. A sealed vial experiment demonstrated that perfluorooctanoic acid sublimes at room temperature.			1					C	-	各種PFASの蒸気圧を決定	
D40	物化	Zhang, Y; Yan, YC; Wang, Y; Li, YF; Wang, X; Zhang, HM; Liu, J; Wang, F	The synthesis and solution properties of hyperbranched polyglycerols modified with hexafluorobutyl acrylate	2013	Colloid Surf. A-Physicochem. Eng. Asp. 2013 Sep:436:563-569. doi: 10.1016/j.colsurfa.2013.07.020	A series of well-defined fluorinated hyperbranched block copolymers poly(glycerol)-b-poly(hexafluorobutyl acrylate) (PG-b-PHFBA) were prepared by atom transfer radical polymerization (ATRP) of 2,2,3,4,4,4-hexafluorobutyl acrylate (HFBA) in THF, using bromoester-terminated hyperbranched polyglycerol (PG-g-Br) as a macroinitiator. H-1 NMR, C-13 NMR, F-19 NMR, GPC, FT-IR were employed to characterized the molecular structure of PG-b-PHFBA. The surface properties and micellization behavior of the copolymers in ionic liquid 1-butyl-3-methylimidazolium tetrafluoroborate ([bmim][BF4]) was studied by surface tension measurements and dynamic light scattering (DLS). The results showed that the copolymers in ILs could depress surface tension in a manner analogous to aqueous solutions, and the gamma(CMC) and critical micelle concentration (CMC) of the multiarm copolymers decreased with the increase of the PHFBA arm length. The DLS results demonstrated that the copolymer formed unimolecular micelles in ILs at the lower concentration, and two kinds of aggregates with D-h, 0.7-3 nm and 100-500 nm were detected at higher concentrations.								D	-	超分子化学の論文	
D41	物化	Viada, BN; Juarez, AV; Gomez, EMP; Fernandez, MA; Yudi, LM	Determination of the critical micellar concentration of perfluorinated surfactants by cyclic voltammetry at liquid/liquid interfaces	2018	Electrochim. Acta 2018 Feb:263:499-507. doi: 10.1016/j.electacta.2017.11.053	Based on the hypothesis that cyclic voltammetry applied to the interface formed by two immiscible electrolyte solutions can be used for determining critical micellar concentrations (cmc) of charged surfactants provided they exhibit ion transfer currents, we have carried out the study of three perfluorinated acids (perfluorooctanoic acid, PFO, perfluorononanoic acid, PFN, and perfluorodecanoic acid, PFD), dissolved in the aqueous phase. Cyclic voltammetry at the water/1,2-dichloroethane interface as well as fluorescence and surface pressure measurements, have been employed for cmc determinations and comparison. From the variation of voltammetric parameters on surfactant concentration it was possible to determine the cmc for these surfactants, obtaining good agreements with other methodologies. Impedance spectroscopy experiments have been also carried out to characterize the properties of the interface, demonstrating that at high surfactant concentration values, a monolayer with different domains is formed.				1				C	-	CV測定でcmcを決定．過去のデータとよく合っている	
D42	物化	Sekine, M; Campbell, RA; Valkovska, DS; Day, JPR; Curwen, TD; Martin, LJ; Holt, SA; Eastoe, J; Bain, CD	Adsorption kinetics of ammonium perfluorononanoate at the air-water interface	2004	Phys. Chem. Chem. Phys. 2004;6(21):5061-5065. doi: 10.1039/b411044g.	The adsorption of the fluorocarbon surfactant, ammonium perfluorononanoate (APFN) has been studied in an overflowing cylinder (OFC). The equilibrium adsorption isotherm, determined by drop shape tensiometry, is well-described by the Volmer isotherm. The dynamic surface excess at the-expanding surface of the OFC was measured by neutron reflectometry (NR). The dynamic surface excess was in good agreement with the predictions of a diffusion-controlled adsorption model. Significant Marangoni effects were observed. The relationship between the mass transport equation in the OFC and the short and long-time asymptotes of the Ward-Tordai equation is noted.				1				D	-	動的表面過剰濃度を決めているだけ	
D43	物化	Liu, LB; Wu, LL; Zhang, R; Zhang, LH; Hou, JL; Sun, CH; Zhang, YS; Tang, YH; Zhang, HP	Density functional theory study of perfluorooctane sulfonate adsorption on fluorinated graphene	2021	Surf. Innov. 2021 Apr:9(2-3):149-155. doi: 10.1680/jsuin.20.00046.	Density functional theory calculations are carried out to explore the adsorption behaviour of perfluorooctane sulfonate (PFOS) on pristine and fluorinated graphene. Then, the effects of different degrees of fluorination of graphene on the adsorption of PFOS are systematically investigated by analysis of the adsorption energy (E-ads), electron transfer and partial density of states. Finally, the unique adsorption behaviour of PFOS on graphene and fluorinated graphene is demonstrated by a companion study of four other organic molecules, namely heptafluorobutyric acid, phenanthrene, phenol and perfluorooctanoate.								D	-	PFOSがグラフェンに吸着する機構をDFT計算で追ったもの。	
D44	物化	Lermontov, SA; Malkova, AN; Sipyagina, NA; Baranchikov, AE; Kopitsa, GP; Bespalov, AS	Hydrophobization of organic resorcinol-formaldehyde aerogels by fluoroacylation	2021	J. Fluor. Chem. 2021 Apr:244:109742. doi: 10.1016/j.jfluchem.2021.109742.	Resorcinol-formaldehyde aerogels (RF AGs) of two density values (0.15 and 0.64 g/cm(3)) were acylated by an excess of perfluoroalkane carboxylic anhydrides (RFCO)(2)O (R = CF3, C8F17). After acylation by perfluorononanoic acid anhydride the resulting fluorinated aerogels retained high specific surface area (270-345 m(2)/g) and acquired high hydrophobicity - water drop contact angle value reached 145 degrees. Besides, these samples demonstrated low water vapour and liquid water absorption.				1				D	-	レゾルシノール-ホルムアルデヒドエアロゲルをパーフルオロアルカンカルボン酸無水物でアシル化して，撥水性の高い表面を作った。	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D45	物化	Pereiro, AB; Tome, LC; Martinho, S; Rebelo, LPN; Marrucho, IM	Gas Permeation Properties of Fluorinated Ionic Liquids	2013	Ind. Eng. Chem. Res. 2013 Apr:52(14):4994-5001. doi: 10.1021/ie4002469.	Despite the increasing amount of research in the ionic liquids field, there are still quite unexplored themes. That is the case of the fluorinated ionic liquids (FILs) family, here defined as ionic liquids with fluorine tags longer than four carbon atoms. In this work, gas permeation properties of two fluorinated ionic liquids, tetrabutylammonium heptadecafluorooctanesulfonate and 1-ethyl-3-methylpyridinium perfluorobutanesulfonate, were studied. For that purpose, supported liquid membranes of the fluorinated ionic liquids were prepared using a polymeric porous membrane as supporting material, and their gas permeation properties for 10 different gases at 294 K were measured using a time-lag apparatus. The results show that the gas solubility of these FILs is of the same order of magnitude as gas solubilities for previously tested fluorinated ionic liquids and that solute size plays a more important role on gas diffusivity than viscosity. The perfluorocarbons and carbon dioxide separation performances were evaluated, and the results show that 1-ethyl-3-methylpyridinium perfluorobutanesulfonate is a better candidate than tetrabutylammonium heptadecafluorooctanesulfonate for the gas separation processes tested in this work.				1				D	-	フッ素系イオン液体のガス透過特性	
D46	物化	Baggioli, A; Sansotera, M; Navarrini, W	Thermodynamics of aqueous perfluorooctanoic acid (PFOA) and 4,8-dioxa-3H-perfluorononanoic acid (DONA) from DFT calculations: Insights into degradation initiation	2018	Chemosphere 2018 Feb:193:1063-1070. doi: 10.1016/j.chemosphere.2017.11.115	Modern fluorosurfactants introduced during and after perfluoroallcyl carboxylates/sulfonates phase-out present chemical features designed to facilitate abatement, hence reducing persistence. However, the implications of such features on environmental partitioning and stability are yet to be fully appreciated, partly due to experimental difficulties inherent to the handling of their (diluted) aqueous solutions. In this work, rigorous quantum chemistry calculations were carried out in order to provide theoretical insights into the thermodynamics of hydroperfluorosurfactants in aqueous medium. Estimates of acid dissociation constant (pKa), standard reduction potential (E), and bond dissociation enthalpy (BDE) and free energy (BDFE) were computed for perfluorooctanoic acid (PFOA), 4,8-dioxa-3H-perfluorononanoic acid (DONA) and their anionic forms via ensemble averaging at density functional theory level with implicit solvent models. A (pICa) in the neighborhood of zero and a E of about 2.2 V were obtained for PFOA. Predictions for the acidic function of DONA compare well with PFOA's, with a pKa of 0.8-1.5 and a E of 2.07-2.15 V. Deprotonation thus represents the dominant phenomenon at environmental conditions. Calculations indicate that H-abstraction of the aliphatic proton of DONA by a hydroxyl radical is the thermodynamically favored reaction path in oxidative media, whereas hydrolysis is not a realistic scenario due to the high dissociation constant. Short intramolecular interactions available to the peculiar hydrophobic tail of DONA were also reviewed, and the relevance of the full conformational space of the fluorinated side chain discussed.			1					D	-	水溶液中のPFOAとDONAの熱力学について考察	
D47	物化	Vieira, NSM; Bastos, JC; Hermida-Merino, C; Pastoriza-Gallego, MJ; Rebelo, LPN; Pineiro, MM; Araujo, JMM; Pereiro, AB	Aggregation and phase equilibria of fluorinated ionic liquids	2019	J. Mol. Liq. 2019 Jul:285:386-396. doi: 10.1016/j.molliq.2019.04.086	In this work a specific family of ionic liquids, denominated fluorinated ionic liquids, with fluorine tags equal or longer than four carbon atoms, are fully characterized in order to understand their solubility and self-aggregation in aqueous solutions. The numerous combinations between cations and anions make these compounds a feasible option for the replacement of traditional and toxic surfactants used in the industrial and biomedical field. In this work, the increment of both hydrogenated and fluorinated side chain lengths, the influence of the cation headgroup (imidazolium and cholinium) as well as the difference between perfluorobutanesulfonate and perfluoropentanoate anions were studied. The liquid-liquid phase equilibria of fluorinated ionic liquids based on the perfluorobutanesulfonate anion with water were carried out. The self-aggregation behaviour of the different fluorinated ionic liquids in aqueous solutions was also determined using conductimetric titration, surface tension measurements and transmission electron microscopy. Several thermodynamic and surface parameters were obtained and used to discuss the aggregation process. These novel characterized fluorinated ionic liquids demonstrate an improved surface activity and aggregation behaviour, driven essentially by the increment of both hydrogenated and fluorinated chain lengths.				1				D	-	イオン液体	
D48	物化	Schaefer, CE; Drennan, DM; Tran, DN; Garcia, R; Christie, E; Higgins, CP; Field, JA	Measurement of Aqueous Diffusivities for Perfluoroalkyl Acids	2019	J. Environ. Eng.-ASCE. 2019 Nov;145(11):6019006. doi: 10.1061/(ASCE)EE.1943-7870.0001585.	Aqueous diffusivities were experimentally determined for perfluoroalkyl acids (PFAAs) with perfluorinated carbon chain lengths ranging from 3 to 8, including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS). The capillary method was employed at room temperature. Measured aqueous diffusivities ranged from 2.5x10-5 cm2/s (perfluorobutanoic acid) to 0.45x10-5 cm2/s (perfluorohexane sulfonic acid). The experimental results were in good agreement with aqueous diffusivities determined from previously performed experiments that measured PFAA uptake into activated carbon. Although molecular simulations for PFOA and PFOS were in reasonable agreement with experimental measurements, the Wilke-Chang model was not able to accurately predict the values nor describe the trend for the PFAAs used in this study. The nonuniform trend in the PFAA diffusivities with respect to the molar volumes likely is reflective of unique molecular interactions associated with highly fluorinated compounds.	1							C	-	水中拡散率を実験的に調査	
D49	物化	Teixeira, FS; Vieira, NSM; Cortes, OA; Araujo, JMM; Marrucho, IM; Rebelo, LPN; Pereiro, AB	Phase equilibria and surfactant behavior of fluorinated ionic liquids with water	2015	J. Chem. Thermodyn. 2015 Mar:82:99-107. doi: 10.1016/j.jct.2014.10.021	This work studies the phase equilibria and surfactant behavior of fluorinated ionic liquids (FILs) containing fluorinated chains equal to four carbons with water. The knowledge about the phase behavior is crucial for the applications of these novel FILs with tuneable properties. The phase equilibria of the binary mixtures FILs with water were studied at atmospheric pressure in a temperature range from (298.15 to 353.15) K. In this study, FILs containing ammonium, pyrrolidinium and imidazolium cations and the perfluorobutanesulfonate anion were included. The Non-Random Two Liquid (NRTL) thermodynamic model was successfully applied to rationalize the phase behavior of the binary (water + FILs) mixtures. Furthermore, the critical micelle concentrations (CMCs) of these FILs, which present cations and/or anions with surfactant properties were also performed at T = 298.15 K by measurements of the ionic conductivity. Finally, the Dynamic Light Scattering (DLS) was used with aim to determine the size of the aggregates of these FILs in water.				1				D	-	イオン液体	
D50	物化	Luis, A; Shimizu, K; Araujo, JMM; Carvalho, PJ; Lopes-da-Silva, JA; Lopes, JNC; Rebelo, LPN; Coutinho, JAP; Freire, MG; Pereiro, AB	Influence of Nanosegregation on the Surface Tension of Fluorinated Ionic Liquids	2016	Langmuir. 2016 Jun:32(24):6130-6139. doi: 10.1021/acs.langmuir.6b00209.	We have investigated, both theoretically and experimentally, the balance between the presence of alkyl and perfluoroalkyl side chains on the surface organization and surface tension of fluorinated ionic liquids (FILs). A series of ionic liquids (ILs) composed of 1-alkyl-3-methylimidazolium cations ([C(n)C(1)im] with n = 2, 4, 6, 8, 10, or 12) combined with the perfluorobutanesulfonate anion was used. The surface tensions of the investigated liquid salts are considerably lower than those reported for non fluorinated ionic liquids. The most surprising and striking feature is the identification, for the first time, of a minimum at n = 8 in the surface tension versus the length of the IL cation alkyl side chain. Supported by molecular dynamics (MD) simulations, it was found that this trend is a result of the competition between the two nonpolar domains (perfluorinated and aliphatic) pointing toward the gas-liquid interface, a phenomenon which occurs in ILs with perfluorinated anions. Furthermore, these ILs present the lowest surface entropy reported to date.				1				D	-	イオン液体	
D51	物化	Florindo, C; Tome, LC; Marrucho, IM	Thermodynamic Study of Aggregation of Cholinium Perfluoroalkanoate Ionic Liquids	2016	J. Chem. Eng. Data. 2016 Dec:61(12):3979-3988. doi: 10.1021/acs.jced.6b00455.	To advance the ionic liquid (IL) platform to tailor fluorinated surfactant properties, the aim of this work is to evaluate the surfactant properties of cholinium-based salts bearing perfluoroalkanoate anions. Novel surfactant ILs containing the cholinium cation [Ch](+) combined with different perfluoroalkanoate anions, namely perfluoropentanoate [PFPent](-), perfluorohexanoate [PFHex](-), perfluoroheptanoate [PFHept](-), and perfluorooctanoate [PFOct](-), were synthesized. The critical micelle concentrations (CMCs) were determined using an ionic conductivity method, at different temperatures. Thermodynamic parameters of micellization were also evaluated. The results indicate that the CMC value decreases in a linear manner with the increment of the fluoroalkyl chain length in the anion. The evaluation of the thermodynamic parameters shows that the micellization is spontaneous and entropically driven and that the enthalpy of micellization is very small. It was also observed that the introduction of the cholinium cation in these surfactants allows for smaller CMC values when compared to that of other tetraalkylammonium-based surfactants with the same fluorinated anions, in short to more efficient and green surfactants. This result is probably due to counterion association and not to counterion binding to micelle surface.		1						D	-	イオン液体	
D52	物化	Jing, P; Rodgers, PJ; Amemiya, S	High Lipophilicity of Perfluoroalkyl Carboxylate and Sulfonate: Implications for Their Membrane Permeability	2009	J. Am. Chem. Soc. 2009 Feb:131(6):2290-2296. doi: 10.1021/ja807961s.	Here we report on remarkably high lipophilicity of perfluoroalkyl carboxylate and sulfonate. A lipophilic nature of this emerging class of organic pollutants has been hypothesized as an origin of their bioaccumulation and toxicity. Both carboxylate and sulfonate, however, are considered hydrophilic while perfluroalkyl groups are not only hydrophobic but also oleophobic. Partition coefficients of a homologous series of perfluoroalkyl and alkyl carboxylates between water and n-octanol were determined as a measure of their lipophilicity by ion-transfer cyclic voltammetry. Very similar lipophilicity of perfluoroalkyl and alkyl chains with the same length is demonstrated experimentally for the first time by fragment analysis of the partition coefficients. This finding is important for pharmaceutical and biomedical applications of perfluoroalkyl compounds. Interestingly, similar to 2 orders of magnitude higher lipophilicity of a perfluoroalkyl carboxylate or sulfonate in comparison to its alkyl counterpart is ascribed nearly exclusively to their oxoanion groups. The higher lipophilicity originates from a strong electron-withdrawing effect of the perfluoroalkyl group on the adjacent oxoanion group, which is weakly hydrated to decrease its hydrophilicity. In fact, the inductive effect is dramatically reduced for a fluorotelomer with an ethylene spacer between perfluorohexyl and carboxylate groups, which is only as lipophilic as its alkyl counterpart, nonanoate, and is 400 times less lipophilic than perfluorononanoate. The high lipophilicity of perfluoroalkyl carboxylate and sulfonate implies that their permeation across such a thin lipophilic membrane as a bilayer lipid membrane is limited by their transfer at a membrane/water interface. The limiting permeability is lower and less dependent on their lipophilicity than the permeability controlled by their diffusion in the membrane interior as assumed in the classical solubility-diffusion model.			1				1	A	-	PFASの長さによって親水・疎水の程度が異なることを示した	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D53	物化	Day, JPR; Campbell, RA; Russell, OP; Bain, CD	Adsorption kinetics in binary surfactant mixtures studied with external reflection FTIR spectroscopy	2007	J. Phys. Chem. C. 2007 Jun:111(25):8757-8774. doi: 10.1021/jp067051o.	The adsorption kinetics of mixtures of soluble surfactants at the air-water interface was studied on an overflowing cylinder. Vibrational spectra of the adsorbed monolayers were acquired by external reflection Fourier transform infrared spectroscopy, and target factor analysis was used to determine the compositions of mixed monolayers. Laser Doppler velocimetry was employed to measure the surface expansion rates, and hence the effective surface age, which was in the range 0.1-1 s. Three surfactant mixtures with different interactions were investigated. Blends of the cationic hydrocarbon surfactant hexadecyl trimethylammonium bromide (CTAB) and the nonionic hydrocarbon surfactant octaethylene glycol monodecyl ether (C10E8) were found to mix ideally in the monolayer over a wide range of subsurface compositions. Combinations of C10E8 and the anionic fluorosurfactant ammonium perfluorononanoate (APFN) exhibited nonideal mixing that could be described with regular solution theory. APFN adsorbed to the interface at a rate limited by monomer diffusion but the adsorption of C10E8 appeared to be under kinetic control. The adsorption behavior of the cationic-anionic mixture of CTAB and APFN was dominated by the interaction of the oppositely charged headgroups. Either side of equimolar bulk composition only the species in excess was found to adsorb, which is rationalized by the presence of aggregates in the bulk that act as a sink for free monomer. Prior evidence in the literature suggests these aggregates may be vesicles. At equimolar compositions both species were found to coadsorb; this unexpected result may be explained by adsorption of vesicles to the uncharged interface. A semiquantitative model based on the interaction between the electrical double layers of the oppositely charged monolayer and vesicle explains the absence of adsorption of vesicles away from equimolar compositions. The combination of the overflowing cylinder, to generate a steadily expanding surface with well-defined hydrodynamics, and FTIR spectroscopy, to quantify the composition of the adsorbed monolayer, can be used to study a broad range of mixed inonolayers at the air-water interface under nonequilibrium conditions.			1				1	A	-	気水界面への吸着をIRの外部反射法で測定し，多変量解析で調べたもの	
D54	物化	Shibata O, Moroi Y, Saito M, Matuura R.	Monolayer Properties of Long-Chain Alkylammonium Perfluorohexanoates on the Concentrated Sodium Chloride Solution	1996	J Colloid Interface Sci. 1996 Dec 1;184(1):175-80. doi: 10.1006/jcis.1996.0609.	Surface pressure (pi)- and surface potential (DeltaV)-area (A) isotherms were obtained for monolayers of alkylammonium perfluorohexanoates of four different alkyl chains (m) on water and 4.4 M NaCl solutions as a function of molecular area of various temperatures by the Langmuir and the ionizing electrode methods. As for octadecylammonium perfluorohexanoate (C18F11), the pi-A curves of these long-hydro-short-fluoro chain salt showed three phase transition points. Judging from the surface potential and the apparent molar quantity together with our previous data on the transitions, the first was assigned to the transition from the expanded (E) phase to the condensed (C-I) phase, the second from the C-I phase to another condensed (C-I') phase, and the third from the (C-I') phase to another condensed (C-II) phase. From the surface potential, the apparent molar entropy change, and the phase diagram, the orientation of long-hydro-short-fluoro chain salts in the monolayer state was discussed.		1						D	-	水面上の単分子膜をpi-A測定とポテンシャル測定したもの	
D55	物化	Zhu B, Zhang P, Wang L, Liu Z	NOTE	1997	J Colloid Interface Sci. 1997 Jan 15;185(2):551-3. doi: 10.1006/jcis.1996.4609.	Atomic force microscopy was used to investigate the mixed monolayer of FC- and HC-amphiphiles. Clear topographic images showing domain structure of the mixed monolayer and the data of the domain size have been provided. It is revealed that in the mixed monolayer the sodium octadecanesulfonate molecules construct the hexagonal domain dispersing in the continuous two-dimensional phase of perfluorononanoic acid. These results strongly support that, due to the mutual-phobicity between fluorocarbon chain and hydrocarbon chain, there exists phase separation in the mixed monolayer of fluorocarbon and hydrocarbon amphiphiles, albeit the pi-A curves would obey the simple additive rule.			1					C	-	単分子膜をFCとHCを混ぜて作った場合，ドメイン形成をAFMで長鎖.	
D56	物化	Markin VS, Volkova-Gugeshashvili MI, Volkov AG.	Adsorption at liquid interfaces: the generalized Langmuir isotherm and interfacial structure	2006	J Phys Chem B. 2006 Jun 15;110(23):11415-20. doi: 10.1021/jp061818v.	The thermodynamics of adsorption of amphiphilic surface-active compounds at the interface between two immiscible liquids is considered. At the interface, these molecules are supposed to replace a few of the adsorbed molecules of both solvents. Classical isotherms of adsorption (Frumkin, Langmuir, Henry) were based on the model of nonpenetrable interface, where an adsorbate can substitute only molecules of one solvent. However, at the interface between two immiscible electrolytes, like nonpolar oil-water interfaces, or liquid membrane amphiphilic molecules can substitute molecules of both solvents; therefore, classical isotherms are not applicable in these cases. The generalization of Langmuir and Frumkin isotherms for permeable and nonpermeable interfaces, known as the Markin-Volkov (MV) isotherm, gives the possibility to analyze adsorption and the interfacial structure in a general case. In the present paper, the adsorption isotherms of pentafluorobenzoic acid at the octane-water interface at various pH were measured by the drop-weight method. The thermodynamic parameters of pentafluorobenzoic acid (PFBA) adsorption at the octane-water interface were found. From the measurements of PFBA adsorption, the structure of the octane-water interface was determined. Substitution of one adsorbed octane molecule requires approximately three adsorbed PFBA molecules. This result shows that the orientation of solvent molecules at the interface is different from the bulk solution. Adsorbed octane molecules have a lateral orientation with respect to the interface. Gibbs free energy of adsorption equilibrium and thermodynamic parameters of PFBA adsorption show that the adsorption of PFBA at the octane-water interface is accompanied by a reduction in the attraction between adsorbed PFBA molecules as the pH decreases to the acidic region.	1							C	-	PFBAのオクタン-水界面での吸着の熱力学的パラメータを見出し、その測定からオクタン-水界面の構造を特定	
D57	物化	Yu C, Sang Y, Li Y, Xue X.	Theoretical Study on the Origin of Abnormal Regioselectivity in Ring-Opening Reaction of Hexafluoropropylene Oxide	2023	Molecules. 2023 Feb 9;28(4):1669. doi: 10.3390/molecules28041669.	hat nucleophiles preferentially attack at the less sterically hindered carbon of epoxides under neutral and basic conditions has been generally accepted as a fundamental rule for predicting the regioselectivity of this type of reaction. However, this rule does not hold for perfluorinated epoxides, such as hexafluoropropylene oxide (HFPO), in which nucleophiles were found to attack at the more hindered CF3 substituted β-C rather than the fluorine substituted α-C. In this contribution, we aim to shed light on the nature of this intriguing regioselectivity by density functional theory methods. Our calculations well reproduced the observed abnormal regioselectivities and revealed that the unusual regiochemical preference for the sterically hindered β-C of HFPO mainly arises from the lower destabilizing distortion energy needed to reach the corresponding ring-opening transition state. The higher distortion energy required for the attack of the less sterically hindered α-C results from a significant strengthening of the C(α)-O bond by the negative hyperconjugation between the lone pair of epoxide O atom and the antibonding C-F orbital.						1		D	-	有機化学反応機構に関する研究	
D58	分析	Barola, C; Moretti, S; Giusepponi, D; Paoletti, F; Saluti, G; Cruciani, G; Brambilla, G; Galarini, R	A liquid chromatography-high resolution mass spectrometry method for the determination of thirty-three per- and polyfluoroalkyl substances in animal liver	2020	J. Chromatogr. A. 2020 Sep:1628:461442. doi: 10.1016/j.chroma.2020.461442.	An analytical method for the quantification of thirty-three perfluoroalkyl and polyfluoroalkyl substances (PFASs) in animal liver was developed applying the isotopic dilution methodology with twenty-one labelled isotopologues of native compounds. The proposed protocol involved the determination of short and long aliphatic chain PFASs (C-4-C-18) extracting liver with acetonitrile followed by two clean-up steps. The instrumental analysis was performed with liquid chromatography coupled to high-resolution mass spectrometry. The acquisition method combined full MS/dd-MS2, t-SIM/dd-MS2 and SIM experiments with variable resolution in order to maximize in one chromatographic run accuracy, sensitivity and selectivity. An eight-level validation study was performed evaluating linearity, trueness, precision, quantification and detection limits. Trueness was from 94 to 126% with intra-laboratory reproducibility lower than 20%. Limits of quantification were in the range 2-100 pg g(-1), except for 2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)-propanoic acid, HFPO-DA (500 pg g(-1)). The analysis of a certified reference material (IRMM-427) and participation in a proficiency test scheme (FAPAS - 0687) confirmed these satisfactory performances. Finally, the application of the developed procedure to detect PFASs in sixteen liver samples of farm animals revealed that chicken was the less contaminated species.						1		-	-		
D59	分析	Zafeiraki, E; Costopoulou, D; Vassiliadou, I; Bakeas, E; Leondiadis, L	Determination of perfluorinated compounds (PFCs) in various foodstuff packaging materials used in the Greek market	2014	Chemosphere 2014 Jan:94:169-176. doi: 10.1016/j.chemosphere.2013.09.092	Perfluorinated compounds (PFCs) are used in food packaging materials as coatings/additives for oil and moisture resistance. In the current study, foodstuff-packaging materials collected from the Greek market, made of paper, paperboard or aluminum foil were analyzed for the determination of PFCs. For the analysis of the samples, pressurized liquid extraction (PLE), liquid chromatography-tandem mass spectrometry (LC-MS/MS) and isotope dilution method were applied to develop a specific and sensitive method of analysis for the quantification of 12 PFCs: perfluorobutanoic acid (PFBA), perfluoropentanoic acid (PFPeA), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA), perfluorododecanoic acid (PFDoA), perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS) and perfluorooctane sulfonate (PFOS) and the qualitative detection of 5 more: perfluorotridecanoic acid (PFTrDA), perfluorotetradecanoic acid (PFTeDA), perflyohexadecanoic acid (PFHxDA), perfluorooctadecanoic acid (PFODA) and perfluorodecane sulfonate (PFDS). No PFCs were quantified in aluminum foil wrappers, baking paper materials or beverage cups. PFTrDA, PFTeDA and PFHxDA were detected in fast food boxes. In the ice cream cup sample only PFHxA was found. On the other hand, several PFCs were quantified and detected in fast food wrappers, while the highest levels of PFCs were found in the microwave popcorn bag. PFOA and PFOS were not detected in any of the samples. Compared to other studies from different countries, very low concentrations of PFCs were detected in the packaging materials analyzed. Our results suggest that probably no serious danger for consumers' health can be associated with PFCs contamination of packaging materials used in Greece.	1	1	1	1				-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D60	分析	Zheng, PP; Liu, M; Yin, HW; Shen, L; Wang, YZ; Wu, Q	Analysis of 58 poly-/perfluoroalkyl substances and their occurrence in surface water in a high-technology industrial park	2020	Environ. Pollut. 2020 Dec:267:115381. doi: 10.1016/j.envpol.2020.115381.	Poly/perfluoroalkyl substances (PFASs) have some water solubility so that they are more liable to enter surface water. A comprehensive analysis method was established to analyze 17 classes of 58 PFASs in surface water by ultra-performance liquid chromatography-tandem mass spectrometry (UPLC-MS/MS) after automated solid phase extraction (SPE). The method showed acceptable recoveries and precision with recoveries of 60%-130% and RSD less than 30% with a few exceptions, and method detection limits (MDLs) of 0.004 ng/L-2.0 ng/L. It was investigated the surface water around Zhangjiang High-Technology Park in Shanghai. The concentration of Sigma PFASs ranged from 115 ng/L to 600 ng/L. The main pollutant was perfluoro-3-methylheptanoic acid (P3MHpA), which is isopropyl isomer of perfluorooctanoic acid (PFOA), accounting 41.6% of Sigma PFASs. It was detected in all samples and its level was far higher than that of PFOA with the maximum of 432 ng/L determined surrounding integrated circuits company. Short-chain perfluorocarboxylic acids (PFCAs) and PFOA were also major constituents accounting for 39.9% of Sigma PFASs. Perfluorosulfonic acid (PFSAs (C-4,C- 6,C- 8)) were detected in all samples, while most concentrations were below 10 ng/L. In addition, 1H,1H,2H,2H-perfluorooctane sulfonate (6:2) (6:2 FTS), 2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)-propanoic acid (HFPO-DA) and 9-chlorohexadecafluoro-3-oxanonane-sulfonate (9Cl-PF3ONS) were also detected in all samples at low level. Long chain PFCAs and PFSAs and other classes of PFASs were also detected with low levels and/or low frequencies. The level of PFASs shows an increasing trend in surface water in Shanghai. The whole risk is low for residents from water exposure, while it should cautious to the emission of P3MHpA from integrated circuits and its potential risk.					1			-	-		
D61	分析	Kourtchev, I; Hellebust, S; Heffernan, E; Wenger, J; Towers, S; Diapouli, E; Eleftheriadis, K	A new on-line SPE LC-HRMS method for the analysis of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) in PM2.5 and its application for screening atmospheric particulates from Dublin and Enniscorthy, Ireland	2022	Sci. Total Environ. 2022 Aug:835:155496. doi: 10.1016/j.scitotenv.2022.155496.	A sensitive analytical method has been developed and validated for the determination of 16 polyfluorinated alkyl substances (PFAS) in fine airborne particulate matter (PM2.5) using on-line solid phase extraction (SPE) coupled with liquid chromatography (LC) - negative electrospray ionisation high resolution mass spectrometry (-) ESI-HRMS. On-line SPE allows simultaneous sample clean-up from interfering matrices and lower limits of detection (LODs) by injecting a large volume of sample into the LC system without compromising chromatographic efficiency and resolution. The method provides LODs in the range 0.08-0.5 pg/mL of sample extract allowing detection of selected PFAS in aerosol particles at low fg/m(3) level and showed good tolerance to the considered PM matrix. The validated method was applied for analysis of PFAS in ambient PM2.5 samples collected at two urban locations in Ireland, i.e., Enniscorthy and Dublin. Several PFAS were observed above the detection limit, including perfluorobutyrate (PFBA), perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), perfluorobutanesulfonic acid (L-PFBS) and perfluorononanoic acid (PFNA), as well as fluorotelomer sulfonates: 4:2 FTS, 6:2 FTS and 8:2 FTS. The results indicate that some toxic PFAS, such as PFOS and PFOA, are still detected in the environment despite being phased out from production and subject to restricted use in the EU and USA for more than two decades. Observation of fluorotelomer sulfonates (4:2 FTS, 6:2 FTS and 8:2 FTS, which are used as alternatives for legacy PFOA and PFOS) in ambient PM2.5 samples raises a concern about their persistence in the atmosphere and impact on human health considering emerging evidence that they could have similar health endpoints as PFOA and PFOS. To our knowledge, this is the first study to identify PFAS in ambient PM2.5 at urban locations in Ireland and also the first study to detect 4:2 and 8:2 fluorotelomer sulfonates in atmospheric aerosol particles.	1		1	1				-	-		
D62	分析	Olomukoro, AA; Emmons, RV; Godage, NH; Cudjoe, E; Gionfriddo, E	Ion exchange solid phase microextraction coupled to liquid chromatography/laminar flow tandem mass spectrometry for the determination of perfluoroalkyl substances in water samples	2021	J. Chromatogr. A. 2021 Aug:1651:462335. doi: 10.1016/j.chroma.2021.462335.	Per- and polyfluoroalkyl substances (PFAS) are toxic and bioaccumulative compounds that are persistent in the environment due to their water and heat resistant properties. These compounds have been demonstrated to be ubiquitous in the environment, being found in water, soil, air and various biological matrices. The determination of PFAS at ultra-trace levels is thus critical to assess the extent of contamination in a particular matrix. In this work, solid phase microextraction (SPME) was evaluated as a pre-concentration technique to aid the quantitation of this class of pollutants below the EPA established advisory limits in drinking water at parts-per-trillion levels. Four model PFAS with varying physicochemical properties, namely hexafluoropropylene oxide dimer acid (GenX), perfluoro-1- butanesulfonate (PFBS), perfluoro-n-octanoic acid (PFOA) and perfluoro-1-octanesulfonate (PFOS) were studied as a proof of concept. Analysis was performed with the use of ultra-high pressure liquid chromatography-laminar flow tandem mass spectrometry (UHPLC-MS/MS). This study proposes the use of hydrophilic-lipophilic balance-weak anion-exchange/polyacrylonitrile (HLB-WAX/PAN) as a SPME coating, ideal for all model analytes. A sample volume of 1.5 mL was used for analysis, the optimized protocol including 20 min extraction, 20 min desorption and 6 min LC/MS analysis. This method achieved LOQs of 2.5 ng L-1 (PFOS) and 1 ng L-1 (GenX, PFBS and PFOA) with satisfactory precision and accuracy values evaluated over a period of 5 days.				1	1			-	-		
D63	分析	Frigerio, G; Cafagna, S; Polledri, E; Mercadante, R; Fustinoni, S	Development and validation of an LC-MS/MS method for the quantitation of 30 legacy and emerging per- and polyfluoroalkyl substances (PFASs) in human plasma, including HFPO-DA, DONA, and cC6O4	2022	Anal. Bioanal. Chem. 2022 Jan:414(3):1259-1278. doi: 10.1007/s00216-021-03762-1.	Per- and polyfluoroalkyl substances (PFASs) include persistent organic pollutants whose spread is still ubiquitous. Efforts to substitute substances of high concern with fluorinated alternatives, such as HFPO-DA (GenX), DONA (ADONA), and cC6O4, have been made. The aim of this work was to develop and validate an isotopic dilution liquid chromatography-tandem mass spectrometry (LC-MS/MS) method suitable to quantify 30 PFASs in human plasma. Analytes included legacy PFASs (PFOA, PFOS, and PFHxS), fluorinated alternatives (PFBA, PFBS, 6:2 FTSA, HFPO-DA, DONA, and cC6O4), and newly identified compounds (F-53B and PFECHS). The sample preparation was rapid and consisted of simple protein precipitation and centrifugation. Calibration standards and quality control solutions were prepared with a human pooled plasma containing relatively low background levels of the considered analytes. A complete validation was carried out: the lower limits of quantitation (LLOQs) ranged from 0.009 to 0.245 mu g/L; suitable linearity (determination coefficients, R-2 0.989-0.999), precision (2.0-19.5%, relative standard deviation), and accuracy (87.9-113.1% of theoretical) were obtained for considered concentration ranges. No significant variations of analyte responses were recorded under investigated storage conditions and during matrix effect tests. The external verification confirmed the accuracy of the method, although limited to 12 analytes. The method was also applied to 38 human plasma samples to confirm its applicability. The developed assay is suitable for large-scale analyses of a wide range of legacy and emerging PFASs in human plasma. To our knowledge, this is the first published method including cC6O4 for human biomonitoring.	1			1	1			-	-		
D64	分析	Yamashita, N; Kannan, K; Taniyasu, S; Horii, Y; Okazawa, T; Petrick, G; Gamo, T	Analysis of perfluorinated acids at parts-per-quadrillion levels in seawater using liquid chromatography-tandem mass spectrometry	2004	Environ. Sci. Technol. 2004 Nov:38(21):5522-5528. doi: 10.1021/es0492541.	Perfluorinated acids (PFAs) and their salts have emerged as an important class of global environmental contaminants. Determination of sub-parts-per-trillion or parts-per-quadrillion concentrations of perfluorinated acids in aqueous media has been impeded by relatively high background levels arising from procedural or instrumental blanks. To understand the role of the oceans in the transport and fate of perfluorinated acids, methods to determine ultratrace levels of these compounds in seawater are needed. In this study, sources of procedural and instrumental blank contamination by perfluorinated acids have been identified and eliminated, to reduce background levels in blanks and thereby improve limits of quantitation. The method developed in this study is capable of detecting perfluorooctanesulfonate (PFOS), perfluorohexanesulfonate (PFHS), perfluorobutanesulfonate (PFBS), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), and perfluorooctanesulfonamide (PFOSA) at low pg/L levels in oceanic waters. PFOA is the major perfluorinated compound detected in oceanic waters, followed by PFOS. Further studies are being conducted to elucidate the distribution and fate of perfluorinated acids in oceans.			1	1				-	-		
D65	分析	Genualdi, S; Beekman, J; Carlos, K; Fisher, CM; Young, W; DeJager, L; Begley, T	Analysis of per- and poly-fluoroalkyl substances (PFAS) in processed foods from FDA's Total Diet Study	2022	Anal. Bioanal. Chem. 2022 Jan:414(3):1189-1199. doi: 10.1007/s00216-021-03610-2.	Additional occurrence data are needed to better understand human exposure to per- and poly-fluoroalkyl substances (PFAS) from commercially available foods in the United States. The Food and Drug Administration's (FDA) Total Diet Study (TDS) collects foods that are both nationally and regionally distributed. In 2018, 172 processed foods were collected from grocery stores around Lenexa, KS, as part of the TDS national collection. A previously developed method for the analysis of PFAS in foods as part of the TDS regional collection was modified and optimized for these samples. This method was single lab validated using 5 different matrices and method detection limits were calculated. During the analysis of these samples, challenges arose with method blanks and further investigation into statistical methods to distinguish between blank and sample concentrations were done. The confirmation of two short chain PFAS, perfluorobutanoic acid (PFBA) and perfluoropentanoic acid (PFPeA), was not possible using triple quadrupole mass spectrometry and a confirmation method was developed using high-resolution mass spectrometry. This technique was also used to investigate potential detections and interferents that fell within the retention time criteria for positive detections. In the national collection, positive detections of perfluorooctanesulfonic acid (PFOS) and perfluorononanoic acid (PFNA) were found in frozen fish sticks/patties, PFOS and perfluorodecanoic acid (PFDA) in canned tuna, and PFOS in protein powder. Concentrations were all below 150 ppt, and no other detects were confirmed above the method detection limits in any other foods.	1		1					-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D66	分析	Liu, BL; Zhang, H; Xie, LW; Li, JY; Wang, XX; Zhao, L; Wang, YP; Yang, B	Spatial distribution and partition of perfluoroalkyl acids (PFAAs) in rivers of the Pearl River Delta, southern China	2015	Sci. Total Environ. 2015 Aug:524:1-7. doi: 10.1016/j.scitotenv.2015.04.004	This study investigated the occurrence of perfluoroalkyl acids (PFAAs) in surface water from 67 sampling sites along rivers of the Pearl River Delta in southern China. Sixteen PFAAs, including perfluoroalkyl carboxylic acids (PFCAs, C5-14, C-16 and C-18) and perfluoroalkyl sulfonic acids (PFSAs, C-4, C-6, C-8 and C-10) were determined by high performance liquid chromatography-negative electrospray ionization-tandem mass spectrometry (HPLC/ESI-MS/MS). Total PFAA concentrations (Sigma PFAAs) in the surface water ranged from 1.53 to 33.5 ng.L-1 with an average of 7.58 ng.L-1. Perfluorobutane sulfonic acid (PFBS), perfluorooctanoic acid (PFOA), and perfluorooctane sulfonic acid (PFOS) were the three most abundant PFAAs and on average accounted for 28%, 16% and 10% of Sigma PFAAs, respectively. Higher concentrations of S PFAAs were found in the samples collected from Jiangmen section of Xijiang River, Dongguan section of Dongjiang River and the Pearl River flowing the cities which had very well-developed manufacturing industries. PCA model was employed to quantitatively calculate the contributions of extracted sources. Factor 1 (72.48% of the total variance) had high loading for perfluorohexanoic acid (PFHxA), perfluoropentanoic acid (PFPeA), PFBS and PFOS. For factor 2 (10.93% of the total variance), perfluorononanoic acid (PFNA) and perfluoroundecanoic acid (PFUdA) got high loading. The sorption of PFCAs on suspended particulate matter (SPM) increased by approximately 0.1 log units for each additional CF2 moiety and that on sediment was approximately 0.8 log units lower than the SPM logK(d) values. In addition, the differences in the partition coefficients were influenced by the structure discrepancy of absorbents and influx of fresh river water. These data are essential for modeling the transport and environmental fate of PFAAs.		1	1	1				-	-		
D67	分析	Cheng, Z; Zhang, F; Chen, XP; Du, LL; Gao, CT; Tan, KJ	Highly sensitive and selective detection of perfluorooctane sulfonate based on the Janus Green B resonance light scattering method	2016	Anal. Methods. 2016 :8(45):8042-8048. doi: 10.1039/c6ay02739c.	A simple, highly sensitive and selective assay method has been developed for the determination of perfluorooctane sulfonate (PFOS), a kind of emerging persistent organic pollutant, which is bio-accumulative, resistant to degradation and toxic. It was found that PFOS can form complexes with protonated Janus Green B (JGB) through electrostatic interaction in pH 5.8 citric acid-sodium citrate (CA-NaCA) buffer medium resulting in a remarkable enhancement of the resonance light scattering (RLS) intensity of the system. The study shows that the maximum scattering wavelength is located at 319.0 nm and the enhanced RLS intensities are in proportion to the concentration of PFOS in the range of 0.05-9.0 mmol L-1 (R-2 = 0.9958), with a detection limit of 5.6 nmol L-1 (3 sigma). Under the same experimental conditions, various perfluorinated compounds (PFPrA, PFBA, PFPeA, PFHeA, PFHpA, PFOA, PFNA, and PFBS) and JGB interactions were studied and the scattering signal changes very little. Based on the above discussion, a simple, highly sensitive and selective resonance light scattering analysis method was established for the detection of PFOS. In this work, the optimum reaction conditions were investigated. The reaction mechanism between JGB and PFOS was also studied by the absorption spectrum, scanning electron microscopy (SEM), the combination ratio and so on. This method is successfully applied to the selective detection of PFOS in environmental water samples with RSD <= 2.7%.	1			1	1			-	-		
D68	分析	Zhao, XL; Li, JD; Shi, YL; Cai, YQ; Mou, SF; Jiang, GB	Determination of perfluorinated compounds in wastewater and river water samples by mixed hemimicelle-based solid-phase extraction before liquid chromatography-electrospray tandem mass spectrometry detection	2007	J. Chromatogr. A 2007 Jun:1154(1-2):52-59. doi: 10.1016/j.chroma.2007.03.093.	A comparative study on the use of cetyltrimethylammonium bromide (CTAB)-coated silica and sodium dodecyl sulphate (SDS)-coated alumina mixed hemimicelles-based solid-phase extraction (SPE) for the pre-concentration of six perfluorinated compounds (PFCs) in environmental water samples was presented. The six analytes heptafluorobutyric acid (HFBA), perfluoroheptanic acid (PFHeA), perfluorooctanic acid (PFOA), perfluorooctanic sulfonic (PFOS), perfluorononanic acid (PFNA) and perfluorodecanic acid (PFDeA) were quantitatively retained on both sorbent materials. The cationic surfactant (CTAB adsorbed onto silica) was more appropriate for SPE of PFCs. The main factors affecting adsolubilization of PFCs including the amount of surfactant, pH of solution, sample loading volume and desorption were investigated and optimized. Concentration factor of 500 were achieved by SPE of 500 mL of several environmental water samples. The method detection limits obtained for HFBA, PFHeA, PFOA, PFOS, PFNA and PFDeA were 0.10, 0.28, 0.07, 0.20, 0.10 and 0.05 ng/L, respectively. The relative standard deviation of recoveries ranged from 2 to 8%, which indicated good method precision.			1					-	-		
D69	分析	Lou, J; Bao, ZB; Wu, XJ; Yang, YW; Wu, WZ; Wang, SH; Ren, QL	Analysis of Perfluoro-carboxylic Acid Fluorides by Gas Chromatography/Mass Spectrometry	2013	Chin. J. Anal. Chem. 2013 Jul:41(7):1086-1090. doi: 10.3724/SP.J.1096.2013.21000.	The perfluoro. carboxylic acid fluorides prepared by electrochemical perfluorination (ECPF) method were analyzed by gas chromatography/mass spectrometry. Methanol was used to convert the perfluoro. carboxylic acid fluorides into the methyl esters at 60 degrees C. The effects of column length, polarity and film thickness on the separation efficiency were investigated. The KB-1MS capillary column (90 m x 0. 25 mm x 1. 0 mu m) was employed in the GC/MS analysis. The fragmentation patterns and mass spectrometric characteristics of perfluorinated alicyclic acid methyl esters, aliphatic carboxylic acid methyl esters and mono. unsaturated perfluorinated aliphatic carboxylic acid methyl esters were analyzed and deduced from known patterns of perfluoro-organic mass spectrometry. In this work, five perfluoro. carboxylic acid fluorides including two isomers were identified and the perfluorocyclohexylcarboxylic acid fluoride accounted for about 65% of the total perfluoro-carboxylic acid fluorides in the product.								-	-		
D70	分析	Liu, SQ; Junaid, M; Zhong, W; Zhu, YC; Xu, N	A sensitive method for simultaneous determination of 12 classes of per- and polyfluoroalkyl substances (PFASs) in groundwater by ultrahigh performance liquid chromatography coupled with quadrupole orbitrap high resolution mass spectrometry	2020	Chemosphere. 2020 Jul:251:126327. doi: 10.1016/j.chemosphere.2020.126327.	Per- and polyfluoroalkyl substances (PFASs) comprise a large group of chemicals with diverse physicochemical properties, which make their simultaneous determination a challenging task. A trace analytical method based on ultrahigh performance liquid chromatography-quadrupole Orbitrap high resolution mass spectrometry (UHPLC-Q-Orbitrap HRMS) was developed for simultaneous determination of 54 PFASs belonging to 12 classes in groundwater, including 24 perfluorocarbons and 30 precursors. This method provided good linearity of calibration standards (R-2 > 0.99), excellent method limits of quantification (MLOQs) (0.5-250 pg/L), satisfactory matrix spiking recoveries (63%-148%), high precision (intra-day relative standard deviations (RSDs) 1.4-11.4%, inter-day RSDs 1.6-12.9%, and inter-week RSDs 2.1-12.7%), and short runtime (13 min), suitable for high throughput studies. The newly established method was successfully applied to detect PFASs in the groundwater samples collected from Hebei Province, China. Twenty PFASs were detected with the total concentration of 0.3-32.9 ng/L, indicating the contamination level similar to that in drinking water. The dominant PFASs were perfluorobutanesulfonate (PFBS), perfluorobutanoic acid (PFBA), perfluoropentanoic acid (PFPeA) and perfluorooctanoic acid (PFOA). In addition, 6:2 fluorotelomer phosphate diester (6:2 diPAP) and 6:2 fluorotelomer sulfonate (6:2 FTS) were found as the major precursors. The total PFAS concentrations were lower than the cumulative permissible limit of 70 ng/L for PFOS and PFOA recommended by the United States Environmental Protection Agency (USEPA) for drinking water in 2016. In a nutshell, this study provided a fast and sensitive method based on HRMS for the simultaneous analysis of a wide range of PFASs, present at trace levels in groundwater samples.	1			1				-	-		
D71	分析	Liberatore, HK; Jackson, SR; Strynar, MJ; McCord, JP	Solvent Suitability for HFPO-DA (GenX Parent Acid) in Toxicological Studies	2020	Environ. Sci. Technol. Lett. 2020 Jul:7(7):477-481. doi: 10.1021/acs.estlett.0c00323.	Per- and polyfluorinated alkyl substances (PFAS) are of significant interest because of their prevalence and environmental persistence. In addition, for many PFAS, including fluorinated ethers such as hexafluoropropylene oxide dimer acid (HFPO-DA, or the parent acid of GenX), toxicological data are sparse. In general, in vitro testing frequently uses dimethyl sulfoxide (DMSO) as a carrier solvent due to its low toxicity, solubility across vast chemical space, and permeation across biological barriers. For PFAS, laboratory practice has assumed that the materials are stable across a wide range of solvents, pHs, and temperatures. In this study, HFPO-DA stability was evaluated with DMSO and other commonly used solvents to determine each solvent's suitability for use in toxicity assays. The formation of HFPO-DA's degradation product, heptafluoropropyl 1,2,2,2-tetrafluoroethyl ether (Fluoroether E-1), was monitored by headspace gas chromatography-mass spectrometry over time. These experiments revealed degradation of HFPO-DA to Fluoroether E-1 in DMSO and other aprotic, polar solvents, with half-lives on the order of hours (1, 1.25, and 5.2 h for DMSO, acetone, and acetonitrile, respectively). This rapid degradation suggests the need for caution when performing or using data from toxicity assessments on HFPO-DA and closely related PFAS.					1			-	-		
D72	分析	Mullin, L; Katz, DR; Riddell, N; Plumb, R; Burgess, JA; Yeung, LWY; Jogsten, IE	Analysis of hexafluoropropylene oxide-dimer acid (HFPO-DA) by liquid chromatography-mass spectrometry (LC-MS): Review of current approaches and environmental levels	2019	Trac-Trends Anal. Chem. 2019 Sep:118:828-839. doi: 10.1016/j.trac.2019.05.015	Emerging per- and polyfluorinated compounds (PFAS) compounds are of increasing interest for environmental monitoring, one being hexafluoropropylene oxide-dimer acid (HFPO-DA), commonly referred to as GenX. The following review describes existing liquid chromatography-mass spectrometry (LC-MS) methods used to analyse HFPO-DA, including sample preparation and method sensitivity relative to other PFAS. Analytical challenges are also described, in particular the significant formation of in-source fragmentation, dimer and dimer adducts which detract from [M-H](-) signal. Lastly, detected levels of HFPO-DA in environmental and biological samples are compared across the limited number of available field exposure studies, which found several mu g/L concentrations in water samples taken near fluorochemical plant discharges.					1			-	-		
D73	分析	Beser, MI; Pardo, O; Beltran, J; Yusa, V	Determination of per- and polyfluorinated substances in airborne particulate matter by microwave-assisted extraction and liquid chromatography-tandem mass spectrometry	2011	J. Chromatogr. A 2011 Jul:1218(30):4847-4855. doi: 10.1016/j.chroma.2011.04.082.	A sensitive and confirmatory analytical method has been developed for the determination of 12 ionic per- and polyfluorinated alkyl substances (PFAS) in fine airborne particulate matter (PM2.5) at trace levels. The proposed method includes extraction of PM2.5-bound PFAS by microwave-assisted extraction (MAE) followed by centrifugation and injection into the liquid chromatograph coupled to a triple quadrupole tandem mass spectrometry system (LC-MS/MS). The main parameters affecting the performance of MAE were optimised using statistical design of experiments (DoE). Recoveries ranged from 83 to 120% and the method quantification limit (MQL) was 1.4 pg m(-3), when air volumes of 720 m(3) were sampled. This method was successfully applied to 41 samples collected from five stations of the monitoring network of the Valencian Regional Government (Spain) during April-July 2010. Eight out of 12 PFCs investigated were quantified in at least one sample (PFBA, PFPeA, PFHxS, 6:2 FTS, PFOA, PFNA, PFOS and PFDA). The measured concentrations ranged from 1.4 to 34.3 pg m(-3).	1		1					-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D74	分析	Yeo, MK; Hwang, EH; Jeong, GH	Distribution characteristics of perfluorinated compounds in major river water and sediment	2012	Anal. Sci. Technol. 2012 Oct:25(5):313-323. doi: 10.5806/AST.2012.25.5.313.	We have developed analysis method of PFCs in river water and sediment, and determined seven species of PFCs such as PFBS, PFHxS, PFOS, PFHpA, PFOA, PFNA and PFDA. Water and sediment samples were collected from 21 and 13 different sites along the Nakdong, Seomjin and Nam River, respectively. The water samples were pretreated with HLB cartridge and sediment samples were concentrated after extracted by sonication, and the levels of PFCs were determined by LC-MS/MS. The coefficient of determination (R-2) values of calibration curves were higher than 0.99. The method detection limits ranged 0.09 similar to 0.63 ng/L in water and 0.013 similar to 0.020 ng/g in sediment. The recovery rates of PFCs was found to be 74 similar to 98% for water and 87 similar to 111% for sediment. PFOA was the major species in water samples and followed by PFHpA and PFOS. In sediment, PFOA, PFOS and PFDA showed similar levels. Both water and sediment samples collected from the Nakdong River showed the highest concentrations of PFCs among the three rivers.			1	1				-	-		
D75	分析	Lu, DN; Zhu, DZ; Gan, HH; Yao, ZY; Luo, JY; Yu, SR; Kurup, P	An ultra-sensitive molecularly imprinted polymer (MIP) and gold nanostars (AuNS) modified voltammetric sensor for facile detection of perfluorooctance sulfonate (PFOS) in drinking water	2022	Sens. Actuator B-Chem.2022 Feb;352(Pt 1):131055. doi: 10.1016/j.snb.2021.131055.	Perfluorooctance sulfonate (PFOS) is one of the most studied Per-and-polyfluoroalkyl substances (PFAS) due to its relatively high environmental ubiquity and toxicity. This study presented an ultra-sensitive voltammetric sensor for the detection of PFOS in tap water based on a glassy carbon electrode (GCE) modified with a thin coating of gold nanostar (AuNS) and electropolymerized molecularly imprinted polymer (MIP). The AuNS coating helps to enhance the voltammetric response of blank signal intensity regarding the Fe2+ oxidation of the selected ferrocenecarboxylic acid (FcCOOH) redox probe; meanwhile, the statistical optimization of the MIP layer offers a higher peak change. Analytical results indicated the sensor could detect PFOS with an LoD and LoQ of 0.015 and 0.041 nM (i.e., 7.5 and 20.5 ppt), respectively. Moreover, it showed comparable analytical performance in tap water with the U.S. Environmental Protection Agency (EPA) method (i.e., Method 537.1). Interfering effects of approximately 10% underestimation were observed when samples contained equimolar perfluorobutanoic Acid (PFBA) or perfluorobutanesulfonic acid (PFBS). Additionally, common interferents in drinking water sources, such as humic acid and chloride ion, showed minor influence in the voltammetric response in terms of accuracy and reproducibility.	1			1				-	-		
D76	分析	Enevoldsen, R; Juhler, RK	Perfluorinated compounds (PFCs) in groundwater and aqueous soil extracts: using inline SPE-LC-MS/MS for screening and sorption characterisation of perfluorooctane sulphonate and related compounds	2010	Anal. Bioanal. Chem. 2010 Oct:398(3):1161-1172. doi: 10.1007/s00216-010-4066-0.	Perfluorinated compounds (PFCs) have been recognised as emerging pollutants of global relevance. A fully automated method with inline solid-phase extraction coupled to electrospray ionisation liquid chromatography-tandem mass spectrometry (SPE-LC-MS/MS) is presented and used for characterisation of soil adsorption and desorption for six PFCs: perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluorobutane sulphonate (PFBS), and perfluorooctane sulphonate (PFOS). The method reduces sample turnaround time and solvent consumption and is suitable for low volume sampling. The only sample preparation necessary for water samples was sedimentation by centrifugation. The method has a total runtime of 21 min including inline sample cleanup (2 min for injection and SPE, 14 min for the chromatographic separation, 5 min for reconditioning). Negative AP-ESI with selective reaction monitoring (SRM) was used and the method was documented for quantification of the six environmentally important PFCs in subsoil matrix and related aqueous matrixes (groundwater and drainage water). Linearity was demonstrated in the range 5 to 2,500 ng/l and the LOD was between 2 and 8 ng/l in groundwater. Adsorption was characterised by linear Freundlich isotherms for all six compounds in two agricultural top soils (A horizon, sandy and clayey soil).Variability in sorption characteristics for soil types as well as compound properties were found, and correlation between the organic carbon normalised sorption coefficient (K (OC)) and PFC molecular weight was demonstrated. The K (d) values were in the range 0.1 to 33 (l/kg), and 0.3 to 65 (l/kg) for sorption and desorption respectively.			1	1				-	-		
D77	分析	Grokowsky, EJ; Borgerding, AJ	Selective Detection and Identification of Perfluorinated Alkyl Substances Compounds Using Low-Resolution Precursor Ion Mass Spectrometry	2023	Environ. Eng. Sci. 2023 Jun. doi: 10.1089/ees.2023.0059	Using a low-resolution triple quadrupole mass spectrometer, a nontargeted approach for detecting and identifying perfluorinated alkyl substances (PFAS) has been developed and applied. Because many PFAS will fragment to C2F5- at m/z 119, we used precursor ion scanning mode to detect multiple classes of PFAS in a sample without the need for target ions as required by purely selective methods such as multiple reaction monitoring (MRM). Precursor ion scanning offers a relatively simple way to detect and identify nontargeted PFAS that is potentially accessible to more laboratories than approaches using high-resolution mass spectrometry. Specifically, we have used the method to measure traditional classes of PFAS-like perfluorinated carboxylic acids, sulfonates and sulfonamides, as well as recently developed PFAS-like hexafluoropropylene oxide - dimer acid (HFPO-DA, GenX), and other recently discovered classes like hydrogenated perfluorocarboxylic acids (HPFCAs) and unsaturated PFAS (UPFAS). Using a triple quadrupole mass spectrometer with a single common fragment results in a smaller fraction of PFAS that will be detected compared to the high throughput techniques, and the low-resolution mass spectrometry limits the selectivity somewhat. In addition to PFAS, precursor ion scanning of m/z 119 also detected alkylbenzene sulfonates, a class of very common surfactants that also fragment to a product ion at the same nominal mass. The method detection limits were & SIM;30 ng/L for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), including a 10,000 x concentration by solid phase extraction. We demonstrated the effectiveness of this approach to identify several classes of recently discovered PFAS compounds in well water samples from French Island, WI, which had been previously identified as having significant PFAS contamination.				1				-	-		
D78	分析	Tian, Q; Sun, M	Analysis of GenX and Other Per- and Polyfluoroalkyl Substances in Environmental Water Samples	2019	SEP SCI TECHNOL-SER 2019:11:355-370. doi: 10.1016/B978-0-12-815730-5.00014-4	The presence of per- and polyfluoroalkyl substances (PFAS) in surface water, groundwater, and finished drinking water is receiving increased attention due to the toxicity and carcinogenicity of these compounds. While low toxicity thresholds of these compounds and the evolving regulations require sensitive analytical techniques capable of detecting PFAS concentrations in sub-ng/L levels, the ubiquitous presence of PFAS in lab supplies and instrument parts makes it crucial to prepare samples with minimize contamination. Meanwhile, as the fluorochemical manufacturers shift their products from legacy PFAS to alternative species, more emerging PFAS species have been identified in recent years. Routine PFAS quantification has been relying on liquid chromatography–mass spectrometry (LC/MS). Although LC/MS has been a useful tool for analyzing legacy PFAS, it is limited by the availability of the analytical standards or even structural information of the emerging PFAS species. As a result, nontargeted analysis using high-resolution mass spectrometry as well as different techniques for total PFAS analysis has been developed. With these tools, significant efforts have been made to identify and quantify infrequently reported PFAS species, and as a result, the occurrence of many novel species has been revealed. For example, per- and polyfluoroalkyl ether acids (PFEA) are a family of emerging PFAS that are discharged to the environmental as replacement products made by the fluorochemical manufacturers and as industrial byproducts. An important species in the PFEA family, the ammonium salt of hexafluoropropylene oxide dimer acid (with the trade name of “GenX”), has have been detected in waterbodies in multiple countries. The occurrence of GenX and other structurally related PFEA species in North Carolina is discussed as a case study to demonstrate how the analytical advances promoted the awareness and removal of these compounds from the environment.				1				-	-		
D79	分析	Islam, GJ; Arrigan, DWM	Voltammetric Selectivity in Detection of Ionized Perfluoroalkyl Substances at Micro-Interfaces between Immiscible Electrolyte Solutions	2022	ACS Sens. 2022 Oct:7(10):2960-2967. doi: 10.1021/acssensors.2c01100.	Widespread contamination by per- and polyfluoroalkyl substances (PFAS) and concern about their health impacts require the availability of rapid sensing approaches. In this research, four PFAS, perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluorohexanesulfonic acid (PFHxS), and perfluorooctanesulfonic acid (PFOS), were studied at micropipette-based interfaces between two immiscible electrolyte solutions (mu ITIES) to assess the potentiality for their detection by ion transfer voltammetry. All four PFAS substances were detected by ion transfer voltammetry at the mu ITIES, with half-wave transfer potentials (E-1/2 vs Ag/AgCl) for PFOS, PFHxS, PFBS, and PFOA of 0.34, 0.32, 0.2S, and 0.23 V, respectively. The selectivity of the mu ITIES for detection of PFAS mixtures was investigated. Among the six combinations of the four compounds, most combinations were detectable, except PFOA + PFBS and PFHxS + PFOS, because of unresolved ion transfer voltammograms. These findings provide a basis for the design of new PFAS sensing strategies based on ion transfer voltammetry.				1				-	-		
D80	分析	Berendsen, BJA; Lakraoui, F; Leenders, L; van Leeuwen, SPJ	The analysis of perfluoroalkyl substances at ppt level in milk and egg using UHPLC-MS/MS	2020	Food Addit. Contam. Part A-Chem. 2020 Oct:37(10):1707-1718. doi: 10.1080/19440049.2020.1794053.	Per- and poly-fluorinated substances (PFASs) are man-made chemicals that have been used for a variety of applications and can end up in the food chain. New opinions on the risk assessment were recently published by the European Food Safety Authority, emphasising the need for more sensitive methods. From this, minimum required LOQs for the analytical method for analysis of milk and egg have been calculated for perfluorooctanoic acid (PFOA) and GenX (hexafluoropropylene oxide dimer acid, HFPO-DA). A fully validated method is described for analysis of 13 PFASs, including PFOA and HFPO-DA, in milk and egg. All compounds, except perfluorodecane sulphonate (PFDS), can be quantitatively determined in these matrices with a trueness ranging from 87% to 119% and a relative within-laboratory reproducibility between 12% and 41%. Also the method proved suitable for confirmation of the identity of the individual PFASs. The LOQ for HFPO-DA in milk and egg is 0.05 ng g(-1), well below the calculated required LOQ. For PFOA in egg the determined LOQ is 0.025 ng g(-1), nicely below the required level of 0.03 ng g(-1). In milk the required LOQ was not achieved: 0.005 instead of 0.003 ng g(-1). However, on six out of eight days an LOQ of 0.0025 ng g(-1)was demonstrated. It is concluded that the required LOQs are achievable when instrument performance is optimal. The current method can be expanded with long chain PFASs by using a cellulose filter instead of the PTFE filter vials. The presented method was applied for a small-scale study in The Netherlands.				1				-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D81	分析	Li, JY; Cui, YH; Xie, SY; Wang, HY; Peng, DP; Huang, LL; Tao, YF; Pan, YH; Chen, DM; Yuan, ZH	Determination of Perfluorocarboxylic Acids and Perfluorosulfonic Acids in Aquatic Products by Quick, Easy, Cheap, Effective, Rugged, and Safe Sample Preparation with Liquid Chromatography-Tandem Mass Spectrometry	2018	Food Anal. Meth. 2018 Jun:11(6):1627-1635. doi: 10.1007/s12161-018-1146-9.	A method using liquid chromatography-tandem mass spectrometry (LC-MS/MS) with QuEChERS (quick, easy, cheap, effective, rugged, and safe) sample preparation was developed for the simultaneous determination of 12 perfluorocarboxylic acids (PFCAs) and 7 perfluorosulfonic acids (PFSAs) in the muscle of shrimp, shellfish, and fish. A modified QuEChERS procedure was applied to the extraction and concentration of perfluorinated compounds (PFCs) as well as for removal of interferences. The determination of the 19 PFCs was performed by LC-MS/MS in negative-ion detection mode. C-13-labeled PFCs, as a stable isotopic internal standard (except for L-PFBS, L-PFPeS, ipPFNS, and L-PFNS, for which no labeled analogs were available), was used for calibration. The limits of detection ranged from 0.01-1.0 mu g/kg. The recoveries of spiked sample at 0.02-8.0 mu g/kg ranged from 61 to 117% with relative standard deviations of less than 14%. The developed method was successfully utilized to monitor real samples, which demonstrated that it is a simple, fast, and robust method and could be used to monitor PFCAs and PFSAs in aquatic products. Most of the samples tested positive, mainly for perfluorooctane sulfonate acid (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanoic acid (PFBA), but other samples of the 14 studied PFCs were also present.	1			1				-	-		
D82	分析	Brase, RA; Spink, DC	Enhanced Sensitivity for the Analysis of Perfluoroethercarboxylic Acids Using LC-ESI-MS/MS: Effects of Probe Position, Mobile Phase Additive, and Capillary Voltage	2020	J. Am. Soc. Mass Spectrom. 2020 Oct:31(10):2124-2132. doi: 10.1021/jasms.0c00244.	Perfluoroethercarboxylic acids (PFECAs) have recently emerged as replacements for toxic per- and polyfluorinated alkyl substances (PFAS) including perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). Compared with other PFAS, many PFECAs including hexafluoropropylene oxide dimer acid (HFPO-DA, trade name GenX) exhibit poor sensitivity during analysis using liquid chromatography-electrospray ionization-tandem mass spectrometry (LC-ESI-MS/MS) and are therefore often difficult to quantify. This study examined changes in ESI probe position, mobile phase additive, and capillary voltage with the goal of enhancing PFECA sensitivity. In addition, the relative contributions of existing mechanistic theories for PFAS ionization during ESI are discussed. Results indicated that the LC-ESI-MS/MS sensitivity for 9 PFECAs can be improved significantly by altering the ESI probe position. At the optimal probe position, lowering the capillary voltage from 2.0 to 0.5 kV universally enhanced the LC-ESI-MS/MS sensitivity for PFAS analysis. For most analytes, the use of ammonium bicarbonate rather than ammonium acetate as a mobile phase additive also enhanced the analytical response. These effects have not been previously reported and suggest that many laboratories may be conducting analyses of PFECAs under suboptimal conditions. Using the strategies outlined in this study, PFECAs can be more easily incorporated into comprehensive methods for PFAS analysis. Here, we describe analytical parameters that enhance the sensitivity for some PFECAs by up to 36-fold while maintaining high sensitivity for legacy PFAS. This work not only highlights solutions to mitigate inadequate PFECA sensitivity but also provides insight into the mechanisms underlying PFAS ionization efficiency during LC-ESI-MS/MS.					1			-	-		
D83	分析	Glasscott, MW; Vannoy, KJ; Kazemi, R; Verber, MD; Dick, JE	mu-MIP: Molecularly Imprinted Polymer-Modified Microelectrodes for the Ultrasensitive Quantification of GenX (HFPO-DA) in River Water	2020	Environ. Sci. Technol. Lett. 2020 Jul:7(7):489-495. doi: 10.1021/acs.estlett.0c00341.	Per- and polyfluoroalkyl substances (PFAS) are emerging as a hazardous class of environmental micropollutant, and robust, sensitive, and inexpensive sensing modalities are needed to detect the earliest onset of contamination of surface water. Here, we present a molecularly imprinted polymer (MIP)-modified microelectrode (r = 6.25 mu m) sensor for the quantification of a pervasive environmental PFAS, GenX (HFPO-DA), in surface water obtained from the Haw River in North Carolina. A 20 nm film of o-phenylenediamine was electropolymerized in the presence of GenX to generate a templated polymer adjacent to the electrode surface with subsequent solvent extraction resulting in GenX-specific recognition sites. The oxidation of ferrocene methanol was observed as a function of GenX concentration, and the current decreased linearly with the concentration of GenX. A linear dynamic range of 1-5000 pM with a limit of detection of 250 fM and excellent selectivity against environmental interferents, such as humic acid and perfluorooctanesulfonate, was achieved. The use of oxygen reduction as an additional ambient detection mechanism and the amenability of microelectrodes to relatively resistive environmental matrices are demonstrated to extend the applicability of MIP-modified microelectrodes to environmental waterways as deployable sensors.					1			-	-		
D84	分析	Fernandez-Sanjuan, M; Meyer, J; Damasio, J; Faria, M; Barata, C; Lacorte, S	Screening of perfluorinated chemicals (PFCs) in various aquatic organisms	2010	Anal. Bioanal. Chem. 2010 Oct:398(3):1447-1456. doi: 10.1007/s00216-010-4024-x.	The aim of this study was to evaluate the occurrence of five perfluorinated chemicals (perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexane sulfonic acid (PFHxS), and perfluorobutane sulfonic acid) in aquatic organisms dwelling in either freshwater or marine ecosystems. Organisms selected were insect larvae, oysters, zebra mussels, sardines, and crabs, which are widespread in the environment and may represent potential bioindicators of exposure to PFCs. The study comprises the optimization of a solid-liquid extraction method and determination by high-performance liquid chromatography coupled to tandem mass spectrometry. Using spiked zebra mussels at 10 and 100 ng/g level, the method developed provided recoveries of 96% and 122%, and 82% to 116%, respectively, and a limit of detection between 0.07 and 0.22 ng/g ww. The method was highly sensitivity and robust to determine PFC compounds in a wide array of biological matrices, and no matrix interferents nor blank contamination was observed. Among organisms studied, none of the bivalves accumulated PFCs, and contrarily, insect larvae, followed by fish and crabs contained levels ranging from 0.23 to 144 ng/gww of PFOS, from 0.14 to 4.3 ng/gww of PFOA, and traces of PFNA and PFHxS. Assessment of the potential use of aquatic organisms for biomonitoring studies is further discussed.			1	1				-	-		
D85	分析	Cao, D; Wang, ZD; Han, CG; Cui, L; Hu, M; Wu, JJ; Liu, YX; Cai, YQ; Wang, HL; Kang, YH	Quantitative detection of trace perfluorinated compounds in environmental water samples by Matrix-assisted Laser Desorption/Ionization-Time of Flight Mass Spectrometry with 1,8-bis(tetramethylguanidino)-naphthalene as matrix	2011	Talanta. 2011 Jul:85(1):345-352. doi: 10.1016/j.talanta.2011.03.062.	Determination of perfluorinated compounds (PFCs) is very important because of their potential hazards to the environment and human health. In present work, 1,8-bis (tetramethylguanidino)-naphthalene (TMGN), a superbasic proton sponge, was firstly employed as the matrix for quantitative detection of acidic PFCs in environmental water samples by Matrix-assisted Laser Desorption/Ionization-Time of Flight Mass Spectrometry (MALDI-TOF-MS). Several acidic PFCs, such as perfluorooctanesulfonate (PFOS) and perfluorooctanoic acid (PFOA), were selected as model analytes for demonstrating the feasibility of the detection method. The results showed that deprotonated ions of these PFCs were detected without any other matrix ions interference. The achieved sensitivity with TMGN for PFOS detection was ten-fold higher than that with 1,8-bis (dimethyl-amino)-naphthalene (DMAN) which was used for the detection of fatty acid by MALDI-TOF-MS. The high sensitivity of this method made it feasible to monitor and quantify acidic PFCs in complicated environmental water samples. Furthermore, a novel combined strategy of solid phase extraction (SPE) followed by MALDI-TOF-MS detection was developed for quantifying PFCs in environmental water samples. The calibration curves with a wide linear dynamic range (0.1-10 ng L-1 for PFOS, PFHxS, and PFBS, and 0.5-50 ng L-1 for PFOA, PFNA, and PFDA.) were obtained. The limit of detection CLOD) for PFOS of this method was 0.015 ng L-1 (a signal-to-noise ratio of 3), which was lower than the LOD (0.036 ng L-1) obtained by high-pressure liquid chromatography/tandem mass spectrometry (LC-MS/MS) method. Moreover, the strategy was used to detect the selected PFCs in water samples collected from Xiaoqinghe river and Gaobeidian wastewater. The achieved concentrations of PFCs were closed to those obtained by LC-MS/MS method. It is indicated that the proposed MALDI-TOF-MS method with TMGN as the matrix is much reliable and can be used as an alternative method to detect trace PFCs in environmental water samples.			1	1				-	-		
D86	分析	Hopkins, ZR; Sun, M; DeWitt, JC; Knappe, DRU	Recently Detected Drinking Water Contaminants: GenX and Other Per- and Polyfluoroalkyl Ether Acids	2018	J. Am. Water Work Assoc. 2018 Jul:110(7):13-28. doi: 10.1002/awwa.1073.	For several decades, a common processing aid in the production of fluoropolymers was the ammonium salt of perfluorooctanoic acid (PFOA). Because PFOA is persistent, bioaccumulative, and toxic, its production and use are being phased out in the United States. In 2009, the US Environmental Protection Agency stipulated conditions for the manufacture and commercial use of GenX, a PFOA replacement. While GenX is produced for commercial purposes, the acid form of GenX is also generated as a byproduct during the production of fluoromonomers. The discovery of high concentrations of GenX and related perfluoroalkyl ether acids (PFEAs) in the Cape Fear River and in finished drinking water of more than 200,000 North Carolina residents required quick action by researchers, regulators, public health officials, commercial laboratories, drinking water providers, and consulting engineers. Information about sources and toxicity of GenX as well as an analytical method for the detection of GenX and eight related PFEAs is presented. GenX/PFEA occurrence in water and GenX/PFEA removal by different drinking water treatment processes are also discussed.					1			-	-		
D87	分析	Zafeiraki, E; Costopoulou, D; Vassiliadou, I; Leondiadis, L; Dassenakis, E; Traag, W; Hoogenboom, RLAP; van Leeuwen, SPJ	Determination of perfluoroalkylated substances (PFASs) in drinking water from the Netherlands and Greece	2015	Food Addit. Contam. Part A-Chem. 2015 Dec:32(12):2048-2057. doi: 10.1080/19440049.2015.1086823.	In the present study 11 perfluoroalkylated substances (PFASs) were analysed in drinking tap water samples from the Netherlands (n=37) and from Greece (n=43) by applying LC-MS/MS and isotope dilution. PFASs concentrations above the limit of quantification, LOQ (0.6ng/l) were detected in 20.9% of the samples from Greece. Total PFAS concentrations ranged between 8) were only rarely detected. In the drinking water samples from the eastern part of the Netherlands, where drinking water is sourced from groundwater reservoirs, no PFASs were detected. This demonstrates that exposure to PFASs through drinking water in the Netherlands is dependent on the source. Additionally, five samples of bottled water from each country were analysed in the current study, with all of them originating from ground wells. In these samples, all PFASs were below the LOQ.								-	-		
D88	分析	Cennamo, N; Arcadio, F; Perri, C; Zeni, L; Sequeira, F; Bilro, L; Nogueira, R; D'Agostino, G; Porto, G; Biasiolo, A	Water monitoring in smart cities exploiting plastic optical fibers and molecularly imprinted polymers. The case of PFBS detection	2019	2019 IEEE INTERNATIONAL SYMPOSIUM ON MEASUREMENTS & NETWORKING (M&N 2019)	The detection of perfluorobutanesulfonic acid (PFBS) in water is presented for the first time exploiting a low-cost optical chemical sensing strategy, based on plastic optical fibers and molecularly imprinted polymers (MIPs), able to detect pollutants in water. The sensor's response measured in this work for the detection of PFBS is similar to the one obtained with Perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA), already investigated. The detection limit of PFBS is considered of interest when compared to those obtained by using different expensive traditional approaches, e.g. high performance liquid chromatography-mass spectrometry (HPLC-MS). Moreover, the use of this sensing approach is a very attractive perspective for fast, in situ, and remote low-cost detection of pollutants in water for smart cities applications.				1				-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D89	分析	McCord, J; Newton, S; Strynar, M	Validation of quantitative measurements and semi-quantitative estimates of emerging perfluoroethercarboxylic acids (PFECAs) and hexfluoroprolyene oxide acids (HFPOAs)	2018	J. Chromatogr. A 2018 May:1551:52-58. doi: 10.1016/j.chroma.2018.03.047	Legacy perfluorinated compounds exhibit significant environmental persistence and bioaccumulation potential, which has spawned an ongoing effort to introduce replacement compounds with reduced toxicological risk profiles. Many of these emerging chemical species lack validated quantitative methods, and, frequently, appropriate analytical standards for accurate monitoring and identification. To fill this knowledge gap, a general method for the quantitative determination of perfluoroether carboxylic acids (PFECAs) by LC-MS/MS was single-lab validated on spike-recovery samples in surface, drinking, and wastewater for a variety of perfluorinated ether standards. Relative error measurements for spike-recovery samples in each matrix ranged from 0.36% to 25.9%, with an average error of 10% overall. Coefficient of variation (CV) for each compound ranged from 10 to 28% with an average of 17%. The quantitative methodology was applied during repeated weekly monitoring of the Cape Fear River during remediation of PFECA hexafluoropropyloxide dimer-acid (HFPO-DA), known by the brand name GenX. Semi-quantitative concentration estimates for emerging PFECA compounds lacking analytical standards was also carried out using surrogate calibration curves and mass labeled HFPO-DA as an internal standard. Estimates of the emerging compounds were possible using matched standards, but application of the estimation methodology to compounds with known concentration revealed that such estimates may possess up to an order of magnitude, or more, in uncertainty due to the difficulty of matching with an appropriate standard. Nevertheless, the estimation biases are primarily systematic (extraction efficiency and instrument response) rather than stochastic, enabling the collection of time-course data; both HFPO-DA and the emerging compounds were reduced in surface water and drinking water concentration of several orders of magnitude after removal of the source waste stream.					1			-	-		
D90	分析	Zhang, CH; McElroy, AC; Liberatore, HK; Alexander, NLM; Knappe, DRU	Stability of Per- and Polyfluoroalkyl Substances in Solvents Relevant to Environmental and Toxicological Analysis	2022	Environ. Sci. Technol. 2022 May:56(10):6103-6112. doi: 10.1021/acs.est.1c03979.	Per- and polyfluoroalkyl substances (PFASs) arewidely used anthropogenic chemicals. For environmental andtoxicological analysis, it is important to understand the stability ofPFASs, including novel per- and polyfluoroalkyl ether acids(PFEAs), in commonly used solvents. In this study, weinvestigated the effects of PFAS characteristics, solvent type,water-to-organic solvent ratio, and temperature on the stability of21 PFASs including 18 PFEAs. None of the studied PFASs showedmeasurable degradation in deionized water, methanol, or isopropylalcohol over 30 days; however, nine PFEAs degraded in the polaraprotic solvents acetonitrile, acetone, and dimethyl sulfoxide(DMSO). PFEA degradation followedfirst-order kinetics, andfirst-order rate constants increased with increasing temperature and with decreasing water-to-organic solvent ratio. Monoethers witha carboxylic acid functional group adjacent to a tertiary carbon (>CF-COOH) degraded more rapidly than multiethers in which thecarboxylic acid moiety was adjacent to repeating-CF2O-groups. In contrast, monoethers with a carboxylic acid moiety adjacent toa secondary carbon (-CF2-COOH) were stable in all tested solvents. Using high-resolution mass spectrometry, we determined thatPFEAs with a >CF-COOH group were stoichiometrically decarboxylated in aprotic solvents and formed products with a >CFHgroup; e.g., hexafluoropropylene oxide-dimer acid (HFPO-DA or GenX), HFPO-trimer acid, and HFPO-tetramer acid werestoichiometrically converted to Fluoroethers E-1, E-2, and E-3, respectively. PFEA degradation results highlight the importance ofsolvent choice when preparing dosing solutions and performing extractions for environmental and toxicological assessments ofPFEAs.					1			-	-		
D91	分析	Scordo, CVA; Checchini, L; Renai, L; Orlandini, S; Bruzzoniti, MC; Fibbi, D; Mandi, L; Ouazzani, N; Del Bubba, M	Optimization and validation of a method based on QuEChERS extraction and liquid chromatographic-tandem mass spectrometric analysis for the determination of perfluoroalkyl acids in strawberry and olive fruits, as model crops with different matrix characteristics	2020	J. Chromatogr. A. 2020 Jun:1621:461038. doi: 10.1016/j.chroma.2020.461038.	A QuEChERS method was optimized and validated for the LC-MS/MS analysis of perfluoro-n-pentanoic acid (PFPeA), perfluoro-1-butanesulfonic acid (PFBuS), perfluoro-n-hexanoic acid (PFHxA), perfluoro-n-heptanoic acid (PFHpA), perfluoro-1-hexanesulfonic acid (PFHxS), perfluoro-n-octanoic acid (PFOA), perfluoro-n-nonanoic acid (PFNA), perfluoro-1-octanesulfonic acid (PFOS) and perfluoro-n-decanoic acid (PFDA) in freeze-dried strawberry and olive, as model fruits characterized by very different chemical compositions. The method was evaluated for apparent recovery, intra-day and inter-day precision, matrix effect and recovery. The method optimized for strawberry provided for most compounds absolute values of matrix effect (vertical bar ME%vertical bar) <= 11%, except for PFHxA, which showed a signal suppression of 22%. The extraction efficiency was tested at the spike levels 500-5000 pg/g d.w. for PFPeA, PFBuS, and PFHxA, and 100-1000 pg/g d.w. for the other target analytes, evidencing as a whole recoveries in the range of 65-89%. For olive fruits, due to their high fat content, an ultrasound-assisted extraction was necessary to obtain an efficient sample disgregation so as to increase the extraction yield and its precision. Moreover, a d-SPE clean-up with GCB allowed to achieve vertical bar ME%vertical bar <= 8% (except for PFBuS, which showed a signal enhancement of 19%) and recoveries calculated at the aforementioned spike levels were in the range 75-97%. The two methods provided very good linearity (R-2 >= 0.9984) from 10,000 pg/g down to compound specific quantification limits, which were included in the ranges of 2.9-393 pg/g and 2.6-127 pg/g for strawberry and olive fruit, respectively. The methods were applied to the analysis of PFAAs in strawberry and olive fruits commercially available in two Italian supermarkets, as well as obtained under irrigation with various treated wastewaters (TWWs), evidencing in both cases a higher PFAAs occurrence in olives than in strawberry. However, PFAAs concentrations determined in the investigated fruit matrixes were quite low, being their sum 1.9 ng/g d.w. in the worst case (i.e. olive fruits grown under irrigation with TWWs).		1	1						-	-		
D92	分析	Nakata, H; Nakata, A; Okada, F; Ito, R; Inoue, K; Saito, K; Nakazawa, H	Development of online solid-phase extraction-HPLC/MS/MS method for the determination of perfluorochemicals in human plasma	2005	Bunseki Kagaku 2005 Sep:54(9):877-884. doi: 10.2116/bunsekikagaku.54.877.	A method for determining perfluorochemicals (PFCs) such as perfluorooctanesulfonic acid (PFOS), paerfluorooctane slufoneamide (PFOSA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA), in human plasma samples was developed by online solid-phase extraction-HPLC/MS/MS, only after deproteination with acetonitrile. The limits of detection of PFOS, PFOSA, PFOA, PFNA and PFDA in human plasma at a signal to noise (ratio of 3) were 0.08 similar to 0.14 ng/ml, and the limits of quantitation of PFOS, PFOSA, PFOA, PFNA and PFDA in human plasma were 0.50 ng/ml. The average recoveries of PFOS, PFOSA, PFOA, PFNA and PFDA ranged from 93.3 to 105% (RSD, 3.0 similar to 8.9%; n = 6). This method is more rapid and accurate, compared with the column-switching HPLC/MS method presented in previous reports(18)19)). The developed method can be applied to the determination of PFOS, PFOSA, PFOA, PFNA and PFDA in human plasma samples for monitoring human exposure.			1						-	-		
D93	分析	Forster, ALB; Zhang, Y; Westerman, DC; Richardson, SD	Improved total organic fluorine methods for more comprehensive measurement of PFAS in industrial wastewater, river water, and air	2023	Water Res. 2023 May:235:119859. doi: 10.1016/j.watres.2023.119859.	Per-and polyfluoroalkyl substances (PFAS) are high-profile environmental contaminants, many having long persistence in the environment and widespread presence in humans and wildlife. Following phase-out of per-fluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) in North America and restrictions in Europe, PFAS replacements are now widely found in the environment. While liquid chromatography (LC)-mass spec-trometry (MS) is typically used for measurement, much of the PFAS is missed. To more comprehensively capture organic fluorine, we developed sensitive and robust methods using activated carbon adsorption, solid phase extraction, and combustion ion chromatography (CIC) to measure total organic fluorine (TOF) in industrial wastewaters, river water, and air. Two extraction techniques, adsorbable organic fluorine (AOF) and extractable organic fluorine (EOF), were optimized and compared using 39 different PFAS, including replacements, such as GenX and perfluorobutanesulfonate. Our AOF method achieves 46-112% and 87% recovery for individual PFAS and PFAS mixtures, respectively, with 0.5 mu g/L limit of detection (LOD) for a 50 mL sample volume and a 0.3 mu g/ L LOD for a 500 mL sample volume . Our EOF method achieves 72-99% and 91% recovery for individual PFAS and PFAS mixtures, respectively, with 0.2 mu g/L LOD for a 500 mL sample volume and 0.1 mu g/L LOD for 1200 mL. In addition to 39 anionic PFAS, two zwitterionic PFAS and two neutral PFAS were evaluated using the optimized TOF methods. Substantially higher TOF values were measured in industrial wastewater, river water, and air samples compared to LC-MS/MS, demonstrating how TOF methods provided a more comprehensive measure-ment of the total PFAS present, capturing known and unknown organic fluorine.				1	1				-	-		
D94	分析	Zhang, TT; Zhao, HM; Lei, A; Quan, X	Electrochemical Biosensor for Detection of Perfluorooctane Sulfonate Based on Inhibition Biocatalysis of Enzymatic Fuel Cell	2014	Electrochemistry. 2014 Feb:82(2):94-99. doi: 10.5796/electrochemistry.82.94.	An electrochemical biosensor for sensitive detection of perfluorooctane sulfonate (PFOS) was developed based on the PFOS inhibition influence on the biocatalysis process of enzymatic biofuel cell (BFC). The one-compartment BFC was prepared used multi-walled carbon nanohorns (MWNHs) modified glassy carbon electrodes (GCE) as the substrates for both bioanode and biocathode, and glutamic dehydrogenase (GLDH) and bilirubin oxidase (BOD) acted as biocatalysts of bioanode and biocathode, respectively. The BFC generated an open circuit potential (V-oc) of 30.65 mV and a maximum power density of 27.5 mu W/cm(2). After interaction times of 20 min, a wide linear range from 5 to 500 nmol/L between Delta V-oc and PFOS concentration was achieved with good correlation R-2 = 0.976 and number of measurements is three times (n = 3), and the detection limit was 1.6 nmol/L. Furthermore, we choose 4 kinds of perfluorinated chemicals, whose structures are similar with PFOS, including perfluorooctanoic acid (PFOA), nonafluorobutanesulfonic acid potassium (PFBSK), perfluorooctanesulfonamide (PFOSA) and heptadecafluorononanoic acid (PFNA), and 2 kinds of chemicals (SMNBS and SDS), which co-exist with PFOS in micro-polluted water and could possibly disturb the PFOS detection. The electrochemical biosensor exhibited good selectivity for PFOS against these chemicals. High precision with relative standard deviation (RSD) (n = 3) from 3.6 to 7.7% for PFOS detection in real water samples was also demonstrated by the standard addition method. Results obtained in this study indicated that this electrochemical biosensor could be successfully used for selective detection of PFOS in real micro-polluted water.			1	1					-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D95	分析	Haljasorg, T; Saame, J; Kipper, K; Teearu, A; Herodes, K; Reinik, M; Leito, I	Alternative Eluent Composition for LC-MS Analysis of Perfluoroalkyl Acids in Raw Fish Samples	2014	J. Agric. Food Chem. 2014 Jun:62(23):5259-5268. doi: 10.1021/jf5007243.	A wide range of anthropogenic pollutants that possess serious environmental and health risks are known. One type of these harmful substances that have become a focus of interest during the past decade are perfluoroalkyl acids (PFAAs), which are extensively used in industry for different purposes. Due to the harmful effects that these compounds might cause in living organisms, EFSA and EU CONTAM panel have issued a monitoring program for PFAAs in foodstuffs. This has given rise to intense research dedicated to the analysis of PFAAs over the past few years. This work focuses on chromatographic analysis of three PFAAs in fish. The analytes, perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorooctanesulfonic acid (PFOS), are commonly associated with the production of fluoropolymers. Fluorinated alcohols are used as eluent components, and their possible advantages as eluent modifiers in LC-MS analysis of PFAAs, alternative retention mechanism and enhanced ionization efficiency, are examined. The analyzed fish samples originating from Estonian fresh and marine waters had low contents of PFAAs.								-	-		
D96	分析	Manivel, A; Velayutham, D; Noel, M	Voltammetric behavior of perfluorocarboxylic acids and their corresponding ethyl esters on glassy carbon electrode: surface effects	2010	Ionics. 2010 Mar:16(2):153-159. doi: 10.1007/s11581-009-0377-6.	Voltammetric responses of trifluoroacetic acid, perfluorobutyric acid, perfluorohexanoic acid, and perfluorooctanoic acid (PFOA) were studied in acetonitrile/tetra-n-butylammonium perchlorate medium on glassy carbon electrode. All the four acids gave two voltammetric waves. PFOA exhibits blocking effects. In the presence of excess water, the first cathodic peak current increases, and the second peak disappeared. Very small quantity of triethylamine (TEA; 1-2 mM) was found to be effective in suppressing the first cathodic peak. Both the peak current and peak potential values were sensitive to water and TEA content. The ester derivatives of all the four perfluorocarboxylic acids (PFCAs), however, gave well-defined cathodic reduction peak around -2.3 V. This peak appears to be the best choice for quantitative estimation of PFCAs.			1					-	-		
D97	分析	Nishikoori, H; Murakami, M; Sakai, H; Oguma, K; Takada, H; Takizawa, S	Estimation of contribution from non-point sources to perfluorinated surfactants in a river by using boron as a wastewater tracer	2011	Chemosphere. 2011 Aug:84(8):1125-1132. doi: 10.1016/j.chemosphere.2011.04.036.	The contribution of non-point sources to perfluorinated surfactants (PFSs) in a river was evaluated by estimating their fluxes and by using boron (B) as a tracer. The utility of PFSs/B as an indicator for evaluating the impact of non-point sources was demonstrated. River water samples were collected from the Iruma River, upstream of the intake of drinking water treatment plants in Tokyo, during dry weather and wet weather, and 13 PFSs, dissolved organic carbon (DOC), total nitrogen (TN), and B were analyzed. Perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), perfluoroheptanoate (PFHpA), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorodecanoate (PFDA), perfluoroundecanoate (PFUA), and perfluorododecanoate (PFDoDA) were detected on all sampling dates. The concentrations and fluxes of perfluorocarboxylates (PFCAs, e.g. PFOA and PFNA) were higher during wet weather, but those of perfluoroalkyl sulfonates (PFASs, e.g. PFHxS and PFOS) were not. The wet/dry ratios of PFSs/B (ratios of PFSs/B during wet weather to those during dry weather) agreed well with those of PFS fluxes (ratios of PFS fluxes during wet weather to those during dry weather), indicating that PFSs/B is useful for evaluating the contribution from non-point sources to PFSs in rivers. The wet/dry ratios of PFOA and PFNA were higher than those of other PFSs, DOC, and TN, showing that non-point sources contributed greatly to PFOA and PFNA in the water. This is the first study to use B as a wastewater tracer to estimate the contribution of non-point sources to PFSs in a river.				1				-	-		
D98	分析	Kirkwood, KI; Fleming, J; Nguyen, H; Reif, DM; Baker, ES; Belcher, SM	Utilizing Pine Needles to Temporally and Spatially Profile Per- and Polyfluoroalkyl Substances (PFAS)	2022	Environ. Sci. Technol. 2022 Mar:56(6):3441-3451. doi: 10.1021/acs.est.1c06483.	As concerns over exposure to per- and polyfluoroalkyl substances (PFAS) are continually increasing, novel methods to monitor their presence and modifications are greatly needed, as some have known toxic and bioaccumulative characteristics while most have unknown effects. This task however is not simple, as the Environmental Protection Agency (EPA) CompTox PFAS list contains more than 9000 substances as of September 2020 with additional substances added continually. Nontargeted analyses are therefore crucial to investigating the presence of this immense list of possible PFAS. Here, we utilized archived and field-sampled pine needles as widely available passive samplers and a novel nontargeted, multidimensional analytical method coupling liquid chromatography, ion mobility spectrometry, and mass spectrometry (LC-IMS-MS) to evaluate the temporal and spatial presence of numerous PFAS. Over 70 PFAS were detected in the pine needles from this study, including both traditionally monitored legacy perfluoroalkyl acids (PFAAs) and their emerging replacements such as chlorinated derivatives, ultrashort chain PFAAs, perfluoroalkyl ether acids including hexafluoropropylene oxide dimer acid (HFPO-DA, GenX) and Nafion byproduct 2, and a cyclic perfluorooctanesulfonic acid (PFOS) analog. Results from this study provide critical insight related to PFAS transport, contamination, and reduction efforts over the past six decades.					1			-	-		
D99	分析	Xu, C; Zhu, JJ; Li, Y; Yu, YJ; Duan, GL	Fluorous solid-phase extraction (F-SPE) as a pilot tool for quantitative determination of perfluorochemicals in water samples coupled with liquid chromatography-tandem mass spectrometry	2015	RSC Adv. 2015;5(17):13192-13199. doi: 10.1039/c4ra16040a.	As a large group of stable existing organofluorine compounds widely present in the environment, perfluorochemicals (PFCs) could pose potential adverse effects on human health. In this study, a selective and sensitive fluorous solid-phase extraction (F-SPE) method coupled with liquid chromatography-tandem mass spectrometry (LC-MS/MS) was developed and validated for quantitative analysis of PFCs. The novel fluorous solid-phase cartridges used in the present work were synthesized, which have a fluorous solid phase being typically silica gel with a fluorocarbon bonded phase (-SiMe2(CH2)(2)C8F17). As a result of the fluorous-fluorous interaction, F-SPE displayed excellent extraction efficiency for the PFCs, including perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA). The method contains 4 steps: preconditioning, sample loading, fluorophobic washing and fluorophilic elution. Meanwhile, the cartridges could be regenerated by thorough washing with tetrahydrofuran (THF) and reused multiple times. The analytes collected from F-SPE were redissolved and injected into the LC-MS/MS system for quantitation afterwards. The separation was performed in negative ion mode using multiple reaction monitoring mode on a Shiseido C-18 column (150 x 4.6 mm, 5.0 mu m) using methanol and buffer (2 mM ammonium acetate, 0.05% HAc) as mobile phases with a gradient of 80/20 (v/v). The four kinds of PFCs could be eluted within 13 min with analytical recoveries being in the range of 95.3-102.8%. The developed method was applied to determine the concentration of PFCs in tap/river/waste samples collected in Shanghai, China which indicates the prospective value of F-SPE for environmental monitoring and protection.								-	-		
D100	分析	Hill, NI; Becanova, J; Lohmann, R	A sensitive method for the detection of legacy and emerging per- and polyfluorinated alkyl substances (PFAS) in dairy milk	2022	Anal. Bioanal. Chem. 2022 Jan:414(3):1235-1243. doi: 10.1007/s00216-021-03575-2.	There is widespread contamination by per- and polyfluoroalkyl substances (PFAS) across the globe, with adverse effects on human and environmental health. For human exposure, drinking water and dietary exposure have been recognized as important PFAS exposure pathway for the general population. Several documented cases of dairy milk contamination by PFAS have raised concerns over this exposure pathway in general. A sensitive method for determination of 27 PFAS in milk was hence modified and applied on raw and processed milk samples from 13 farms across the United States (U.S.). A combination of acid and basic extraction method and ENVI-Carb clean-up achieved recoveries of targeted PFAS between 70 and 141%. The method detection limits (MDL) ranged from 0.8 to 22 ng/L (for 26 PFAS) and 144 ng/L for perfluorobutanoic acid (PFBA). The uniqueness of this method is considered in the targeted screening of a broad range of legacy PFAS, as well as perfluorinated sulfonamide species and fluorotelomer sulfonates. No legacy PFAS were detected in 13 milk samples from regions of concern given local use of biosolids or proximity to fire training areas. Overall, then, the uptake of perfluoroalkyl acids (PFAA) from dairy milk in the U.S. is considered low.	1							-	-		
D101	分析	Kazemi, R; Potts, EI; Dick, JE	Quantifying Interferent Effects on Molecularly Imprinted Polymer Sensors for Per- and Polyfluoroalkyl Substances (PFAS)	2020	Anal. Chem. 2020 Aug:92(15):10597-10605. doi: 10.1021/acs.analchem.0c01565.	Per- and polyfluoroalkyl substances (PFAS) are emerging as harmful environmental micropollutants. Generally, PFAS species are quantified by mass spectrometry, for which a collected sample is taken to a centralized facility. Robust techniques to quantify PFAS in the field are necessary to diagnose environmental contamination at the earliest onset of pollution. Here, we developed a molecularly imprinted polymer (MIP) electrode for the detection of perfluorooctanesulfonate (PFOS) and explored the MIP surface and the effects of interfering molecules. MIPs were formed by the anodic deposition of o-phenylenediamine (o-PD) in the presence of PFOS template molecules on a glassy carbon macroelectrode. The performance of the resulting MIP electrode was evaluated by the current obtained from the oxidation of ferrocene carboxylic acid as the electrochemical probe. The MIP electrode was able to detect PFOS with a detection limit of 0.05 nM, which is lower than the health advisory limit of 0.14 nM reported by the U.S. EPA. To better understand PFOS association into the MIP, a Langmuir binding model was developed based on the changes in electrochemical responses of the MIP. Fitting the model to the experimental data gave an association constant (K-A) of 4.95 x 10(12) over a PFOS concentration range of 0 to 0.05 nM. The binding isotherm of other commonly found substances in contaminated water sources such as chloride, humic acid, perfluorooctanoic acid (PFOA), and perfluorobutanesulfonate (PFBS) was also investigated. In the case of chloride and humic acid, the calculated K-A values of 9.05 x 10(7) and 6.01 x 10(5), respectively, indicate relatively weak adsorption of these species on the MIP. However, PFOA, which is the carboxylate analog of PFOS, revealed a very close K-A value (3.41 x 10(12)) to PFOS. A greater K-A value (1.43 x 10(13)) was obtained for PFBS, which possesses the same functional group and a smaller molecular size compared to PFOS. The presented platform emphasizes the necessity to develop new strategies to make MIP sensors more specific if practical applications are to be pursued.					1			-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D102	分析	Huber, S; Brox, J	An automated high-throughput SPE micro-elution method for perfluoroalkyl substances in human serum	2015	Anal. Bioanal. Chem. 2015 May:407(13):3751-3761. doi: 10.1007/s00216-015-8601-x.	An automated high-throughput solid phase extraction (SPE) micro-elution method for 8 perfluorosulfonic acids, 11 perfluorocarboxylic acids and fluorooctane sulfonamide in human serum was developed. Importance was attached to the application of small volumes of reagents and solvents in addition to low sample volumes (50 mu L) in order to save the highly valuable sample material for follow-up and other studies. Instrumental analysis was performed by ultra high pressure liquid chromatography coupled to triple quadrupole mass spectrometry (UHPLC-MS/MS). The recoveries of perfluoroalkyl substances (PFASs) were satisfactory and between 70 and 120 % for most of the compounds at the three investigated spike concentrations. Perfluorobutane sulfonate (PFBS) was slightly underestimated at high concentrations (20 ng/mL; 67 %), whereas perfluoropentanoate (PFPA), perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS) were overestimated with 134, 131 and 133 % respectively, at low spike concentrations (0.2 ng/mL). The precision of the method was below 20 % coefficient of variation (CV%) for all target compounds with the only exception of PFOS (22 %) at low spike concentrations. Method detection limits ranged from 0.006 to 0.34 ng/mL. High sensitivity, accuracy, repeatability and robustness have been demonstrated for an appropriate concentration range. The applicability for real samples was satisfactory demonstrated by analysis of 40 sera samples from the general population from Tromso, Norway.				1					-	-		
D103	分析	Huset, CA; Barry, KM	Quantitative determination of perfluoroalkyl substances (PFAS) in soil, water, and home garden produce	2018	MethodsX 2018:5:697-704. doi: 10.1016/j.mex.2018.06.017	This data article includes details on the simple and efficient analytical methods used to measure perfluoroalkyl substances (PFASs) in water, soil, and produce from home gardens in Minnesota. PFASs in water were analyzed via direct injection. PFASs were extracted from homogenized soil using sonication, and from produce using dispersive solid phase extraction. Isotope dilution was used for quantitation in all methods. The method performance parameters and quality control measures are described. The methods described are applicable for a PFAS ranging from C4-C8 and the produce method was used on a wide variety of produce. For further details and experimental findings, please refer to the article Occurrence of perfluoroalkyl substances (PFAS) in garden produce at homes with a history of PFAS-contaminated drinking water The key benefits of this method are: This method adapts dispersive solid phase extraction for the analysis of PFAS in produce. The method can be used to analyze PFAS ranging from 4 to 8 carbons in a variety of produce types.									-	-		
D104	分析	Mattila, JM; Li, EY; Offenberg, JH	Tubing material considerably affects measurement delays of gas-phase oxygenated per- and polyfluoroalkyl substances	2023	J. Air Waste Manage. Assoc. 2023 May:73(5):335-344. doi: 10.1080/10962247.2023.2174612.	Per- and polyfluoroalkyl substances (PFAS) are persistent environmental pollutants associated with negative health impacts. Assessments of tubing-related measurement bias for volatile PFAS are lacking, as gas-wall interactions with tubing can delay quantification of gas-phase analytes. We use online iodide chemical ionization mass spectrometry measurements to characterize tubing delays for three gas-phase oxygenated PFAS - 4:2 fluorotelomer alcohol (4:2 FTOH), perfluorobutanoic acid (PFBA), and hexafluoropropylene oxide dimer acid (HFPO-DA). Perfluoroalkoxy alkane and high-density polyethylene tubing yielded relatively short absorptive measurement delays, with no clear dependence on tubing temperature or sampled humidity. Sampling through stainless steel tubing led to prolonged measurement delays due to reversible adsorption of PFAS to the tubing surface, with strong dependence on tubing temperature and sample humidification. Silcosteel tubing afforded shorter measurement delays than stainless steel due to diminished surface adsorption of PFAS. Characterizing and mitigating these tubing delays is crucial for reliable quantification of airborne PFAS. Implications: Per- and polyfluoroalkyl substances (PFAS) are persistent environmental contaminants. Many PFAS are sufficiently volatile to exist as airborne pollutants. Measurements and quantification of airborne PFAS can be biased from material-dependent gas-wall interactions with sampling inlet tubing. Thus, characterizing these gas-wall interactions are crucial for reliably investigating emissions, environmental transport, and fates of airborne PFAS.	1				1				-	-		
D105	分析	Lindstrom, G; Karrman, A; van Bavel, B	Accuracy and precision in the determination of perfluorinated chemicals in human blood verified by interlaboratory comparisons	2009	J. Chromatogr. A 2009 Jan:1216(3):394-400. doi: 10.1016/j.chroma.2008.10.091.	Perfluorinated chemicals (PFCs) are analyzed in laboratories worldwide to determine human blood levels and exposure pathways. The development of the analytical technique has been rapid in the last 10 years, and prerequisites for accurate and precise determination of PFCs in human blood at low ng/g concentrations are today readily available. The main contributing factors are the improved LC-MS instrumentations, the increased availability of native and mass labeled PFC standards, and new column materials available for chromatographic separations. The results of the first international interlaboratory study (ILS) in 2005 on PFCs revealed relatively better analytical results for human blood analyses when compared to analyses of a number of environmental matrices. The representative accuracy for the analyses of PFCs in human matrixes reported in recent years was established in the second human serum ILS in 2006. Interlaboratory standard deviations for the two human serum samples one low level concentration and one medium level concentration were found to be 12% and 16% for PFOS, respectively, and 47% and 21% for PFOA, respectively. Reported detections for all PFCs followed a frequency of PFOS > PFOA > PFHxS > PFNA > PFDA >> PFDoA >> PFDS >> PFHxA. Due to the small number of reported values for the other perfluorosulfonates and perfluorocarboxylates, standard deviations were not established.		1	1						-	-		
D106	分析	He, XW; He, Y; Huang, S; Fang, ZF; Liu, JJ; Ma, M; Chen, B	Fluoro-functionalized paper-based solid-phase extraction for analysis of perfluorinated compounds by high-performance liquid chromatography coupled with electrospray ionization-tandem mass spectrometry	2019	J. Chromatogr. A 2019 Sep:1601:79-85. doi: 10.1016/j.chroma.2019.06.019	Fluoro-functionalized paper was prepared and applied in solid phase extraction (SPE) for the analysis of trace-level perfluorinated compounds (PFCs). The proposed fluoro-functionalized paper-based solid-phase extraction (Fp-SPE) exhibits significant advantages for sample preparation, such as the biodegradability of paper-based adsorbent, simple manipulation and low cost. Owing to the fluorous affinity, the Fp-SPE technique with high sensitivity and high selectivity is more suitable for the selective enrichment of fluorine-containing molecules from the background of non-fluorinated organic compounds in a real water sample. Combined with high-performance liquid chromatography coupled with electrospray ionization-tandem mass spectrometry analysis (HPLC-MS/MS), the linear range of the PFCs, including perfluorobutyric acid (PFBA), perfluorooctanic acid (PFOA), perfluorooctane sulfonic acid (PFOS), and perfluorodecanoic acid (PFDA), was 0.20-5.0 ng/L with the limits of detection (LOD) ranging from 0.04-0.05 ng/L and the limits of quantification (LOQ) ranging from 0.15-0.20 ng/L. The method was then applied to the analysis of tap water, river water and waste water samples. The results of the actual sample analysis are consistent with that by reverse phase SPE (RP-SPE).	1								-	-		
D107	分析	Hu, WY; Jones, PD; DeCoen, W; King, L; Fraker, P; Newsted, J; Giesy, JP	Alterations in cell membrane properties caused by perfluorinated compounds	2003	Comp. Biochem. Physiol. C-Toxicol. Pharmacol. 2003 May:135(1):77-88. doi: 10.1016/S1532-0456(03)00043-7.	The recent detection of perfluorinated compounds (PFCs) in wildlife from even remote locations has spurred interest in the environmental occurrence and effects of these chemicals. While the global distribution of PFCs is increasingly understood, there is still little information available on their effects on wildlife. The amphiphillic nature of PFCs suggests that their effects could be primarily on cell membranes. In this study we measured the effects of PFCs on membrane fluidity and mitochondrial membrane potential using flow cytometry and effects on membrane permeability using cell bioassay procedures (H4IIE, MCF-7, PLHC-1). Of the PFCs tested, only perfluorooctane sulfonic acid (PFOS) increased the permeability of cell membranes to the hydrophobic ligands used. Three PFCs were tested in the membrane fluidity assay: PFOS, perfluorohexane sulfonic acid (PFHS), and perfluorobutane sulfonic acid (PFBS). PFOS increased membrane fluidity in fish leukocytes in a dose-dependent fashion, while PFHS and PFBS had no effect in the concentration range tested. The lowest effective concentrations for the membrane fluidity effects of PFOS were 5-15 mg/l. Effects on mitochondrial membrane potential occurred in the same concentration range as effects on membrane fluidity. This suggests that PFOS effects membrane properties at concentrations below those associated with other adverse effects.				1					-	-		
D108	分析	Yang, J; Wang, L; Chen, C; Zhang, J; Sun, HW	Determination of three perfluoro sulfonated chemicals in bivalve shells using high performance liquid chromatography-tandem mass spectrometry with the pretreatment of mixed inorganic acid digestion coupled with solid-phase extraction	2010	Chin. J. Chromatogr. 2010 May:28(5):503-506. doi: 10.3724/SP.J.1123.2010.00503.	For the analysis of perfluorobutane sulfonate (PFBS) perfluorohexane sulfonate (PFHxS) and perfluorooctane sulfonate (PFOS) in shells, an extraction method of mixed inorganic acid digestion coupled with solid phase extraction (SPE) was established. The target compounds were determined by high performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS). The shell powder was at first digested with the mixture of nitric acid and hydrochloric acid, then the digestion solution was adjusted to pH 6 with sodium hydroxide and cleaned up with Oasis WAX SPE cartridge. The perfluoro sulfonated chemicals were quantified with HPLC-MS/MS using electrospray ionization in negative ion mode with internal standard method. The limits of detection (LODs) were of 0. 28 ng/g for PFBS 0. 42 ng/g for PFHxS and 0.43 ng/g for PFOS, and matrix recoveries of the perfluoro sulfonated chemicals were 94. 88% - 96. 24%. The analytical results for the shells of two bivalves from Bohai Bay showed this pretreatment method is suitable for the determination of perfluoro sulfonated acids (PFSAs) in shells. Concentrations of PFSAs in the shells ranged from < LOD - 0. 70 ng/g, which were an order of magnitude lower than those in the soft tissues of these bivalves.				1					-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D109	分析	Miralles-Marco, A; Wang, MM; Park, JS; Gatidou, G; Nika, MC; Bialorucki, S; Kalantzi, OI; Thomaidis, NS; Stasinakis, AS; Petreas, M	Exploring the integrity of targeted PFASs in extracted wastewater samples during transport and storage stages	2021	Chemosphere. 2021 Nov:282:131065. doi: 10.1016/j.chemosphere.2021.131065.	Little information exists on the effects of shipping and handling on per- and polyfluoroalkyl substances (PFASs) in environmental samples. Thus, we evaluated the integrity of dried wastewater extracts and the sensitivity of our high-resolution mass spectrometry (HRMS) instrument to perform such analyses by monitoring 13 representative PFASs in samples extracted, evaporated, and stored at room temperature up to one month. Relative to zero-day recoveries of six detected PFASs ranged between 94 and 124% (RSD <38%) for influents, between 88 and 126% (RSD <18%) for effluents after 28 days. Larger variabilities are tentatively associated with the lack of specific mass-labeled standards and the interactions between analytes and remaining matrix components over time. In a second stage, a mix of local and international dry-shipped wastewater samples were analyzed and the same PFASs were quantified. Up to six PFASs were identified, with median concentrations ranging from 1.3 (perfluoro butyl sulfonate (PFBS)) to 7.7 ng/L (perfluoro hexanoic acid (PFHxA)) and from 1.5 (PFBS) to 13.8 ng/L (PFHxA) in local influents and effluents respectively; and from 0.7 (perfluoro hexyl sulfonate (PFHxS)) to 52.8 ng/L (PFHxA) and from 0.5 (PFHxS) to 21.4 ng/L (PFHxA) in Greek influents and effluents, respectively. The importance of this study lies on the need to consider the wider recovery shifts and expanded variability ranges of PFASs derived from the transport and storage times of dried extracts, particularly when applied to HRMS and wide-scope screening approaches.		1		1				-	-		
D110	分析	Yeung, LWY; Miyake, Y; Taniyasu, S; Wang, Y; Yu, HX; So, MK; Jiang, GB; Wu, YN; Li, JG; Giesy, JP; Yamashita, N; Lam, PKS	Perfluorinated Compounds and Total and Extractable Organic Fluorine in Human Blood Samples from China	2008	Environ. Sci. Technol. 2008 Nov:42(21):8140-8145. doi: 10.1021/es800631n.	An improved extraction (ion pairing) and cleanup (ENVI-carb and solid phase extraction) method was developed for analysis of perfluorinated compounds (PFCs) in human whole blood samples from China. Ten PFCs including PFOS, PFHxS, PFOSA, PFDoDA, PFUnDA, PFDA, PFNA, PFOA, PFHpA, and PFHxA were detected in the blood samples (n = 30) from five cities (Jintan, Nanjing, Guiyang, Beijing, and Shenyang). PFOS was found to be the dominant PFC ranging from 0.446-83.1 ng/mL. Total fluorine (TF) and extractable organic fluorine (EOF) also were measured in the blood samples using combustion ion chromatography for fluorine. Analysis of known PFCs and extractable organic fluorine showed that known PFCs could account for >70% of EOF in samples from Beijing, Shenyang, and Guiyang, whereas known PFCs could only account for similar to 30% of EOF in samples from Jintan. Results of the present study indicated the presence of substantial amounts of unidentified organic fluorine in human blood samples from Jintan. Characterization and identification of these unidentified fluorinated compounds will be instructive.		1	1					-	-		
D111	分析	Bangma, J; McCord, J; Giffard, N; Buckman, K; Petali, J; Chen, CL; Amparo, D; Turpin, B; Morrison, G; Strynar, M	Analytical method interferences for perfluoropentanoic acid (PFPeA) and perfluorobutanoic acid (PFBA) in biological and environmental samples	2023	Chemosphere. 2023 Feb:315:137722. doi: 10.1016/j.chemosphere.2022.137722.	While high-resolution MS (HRMS) can be used for identification and quantification of novel per- and polyfluorinated alkyl substances (PFAS), low-resolution MS/MS is the more commonly used and affordable approach for routine PFAS monitoring. Of note, perfluoropentanoic acid (PFPeA) and perfluorobutanoic acid (PFBA), two of the smaller carboxylic acid containing-PFAS, have only one major MS/MS transition, preventing the use of qualitative transitions for verification on low-resolution instrumentation. Recently our lab has observed widespread chemical interference in the quantitative ion channel for PFPeA (263 -> 219) and PFBA (213 -> 169) in numerous matrices. PFPeA interference was investigated using HRMS and putatively assigned as a diprotic unsaturated fatty acid (263.1288 Da) in shellfish and a separate interferent (13C isotope of 262.1087 Da) in hot cocoa, which had been previously described by the FDA. PFBA interference caused by saturated oxo-fatty acids, previously demonstrated in tissue, was also observed in liquid condensate from a residential air conditioning unit. Therefore, in support of PFAS analysis on low-resolution instrumentation, authors recommend several adjustments to analytical methods including altering liquid chromatography (LC) conditions as well as using matched internal standards to investigate and expressly confirm PFBA and PFPeA detections in both biological and environmental samples.	1							-	-		
D112	分析	Folorunsho, O; Bogush, A; Kourtchev, I	A new on-line SPE LC-HRMS method for simultaneous analysis of selected emerging contaminants in surface waters	2023	Anal. Methods. 2023 Jan:15(3):284-296. doi: 10.1039/d2ay01574a.	In recent years emerging contaminants (ECs) have received significant attention due to their widespread detection in surface waters and concerns that these compounds can cause adverse ecological and/or human health effects. Therefore, accurate methods for determining and quantifying ECs in surface water are essential for estimating their environmental impact. This work describes the development, validation and application of a sensitive multiclass method for simultaneous determination of 22 per and polyfluorinated alkyl substances (PFASs), 3 pharmaceuticals, 15 pesticides, and 2 bisphenols in surface water using on-line solid phase extraction (SPE) coupled with ultra-performance liquid chromatography-high-resolution mass spectrometry (UPLC-HRMS). The method allows simultaneous sample clean-up from interfering matrices and lower limits of detection (LODs) by injecting a large sample volume into the LC system without compromising chromatographic efficiency and resolution. Linearity of response over several orders of magnitude was demonstrated for all tested compounds (R-2 > 0.99), with the LODs ranging from 0.8 and 33.7 pg mL(-1), allowing detection of ECs at trace levels in surface water. The method showed acceptable accuracy and precision (CV, % and RE below 20%) for all tested ECs. It also provided recoveries between 60% and 130% for all tested ECs. The validated method was successfully applied for analysis of surface water samples from three rivers (Cam, Ouse and Thames) in England. Several ECs, including perfluorooctanesulfonic acid (PFOS), perfluorobutanesulfonic acid (PFBS), perfluorohexanoic acid (PFHxA), perfluorohexane sulfonic acid (PFHxS), dimethyl-metatoluamide (DEET) and ibuprofen were observed in analysed surface water above the method's limit of quantitation (LOQ), with concentrations ranging between 3.5 and 460 pg mL(-1).		1		1				-	-		
D113	分析	Reagen, WK; Ellefson, ME; Kannan, K; Giesy, JP	Comparison of extraction and quantification methods of perfluorinated compounds in human plasma, serum, and whole blood	2008	Anal. Chim. Acta. 2008 Nov:628(2):214-221. doi: 10.1016/j.aca.2008.09.029.	Perfluorinated compounds are ubiquitous in the environment and have been reported to occur in human blood. Accurate risk assessments require accurate measurements of exposures, but identification and quantification of PFCs in biological matrices can be affected by both ion suppression and enhancement in liquid chromatography-tandem mass spectrometry techniques (LC/MS-MS). A study was conducted to quantify potential biases in LC/MS-MS quantification methods. Using isotopically labeled perfluorooctanoic acid ([C-13(2)]-PFOA), perfluorononanoic acid ([C-13(2)]-PFNA), and ammonium perfluorooctanesulfonate ([O-18(2)]-PFOS) spiked tissues, ion-pairing extraction, solid-phase extraction, and protein precipitation sample preparation techniques were compared. Analytical accuracy was assessed using both solvent calibration and matrix-matched calibration for quantification. Data accuracy and precision of 100 +/- 15% was demonstrated in both human sera and plasma for all three sample preparation techniques when matrix-matched calibration was used in quantification. In contrast, quantification of ion-pairing extraction data using solvent calibration in combination with a surrogate internal standard resulted in significant analytical biases for all target analytes. The accuracy of results, based on solvent calibration was highly variable and dependent on the serum and plasma matrices, the specific target analyte [C-13(2)]-PFOA, [C-13(2)]-PFNA,or [O-18(2)]-PFOS, the target analyte concentration, the LC/MS-MS instrumentation used in data generation, and the specific surrogate internal standard used in quantification. These results suggest that concentrations of PFCs reported for human blood using surrogate internal standards in combination with external solvent calibration can be inaccurate unless biases are accounted for in data quantification.			1					-	-		
D114	分析	Zacs, D; Fedorenko, D; Pasecnaja, E; Bartkevics, V	Application of nano-LC-nano-ESI-Orbitrap-MS for trace determination of four priority PFAS in food products considering recently established tolerable weekly intake (TWI) limits	2023	Anal. Chim. Acta. 2023 Apr:1251:341027. doi: 10.1016/j.aca.2023.341027.	An analytical method was developed and validated for the analysis of four priority perfluoroalkyl substances (PFAS), namely, perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), and perfluorooctanesulfonate (PFOS) in food products using nanoscale liquid chromatography (nano -LC) coupled with nanoscale electrospray ionization (nano-ESI) and Orbitrap mass spectrometry (Orbitrap-MS) detection. The efficiency of two different nano-LC setups for chromatographic separation of selected PFAS was evaluated. The optimal LC separation of analytes was achieved using a reversed phase C18 (RP-C18) nano bore column with an integrated emitter. The effect of matrix concentration factor on signal suppression/enhancement was evaluated for different matrices. The method validation indicated analyte recoveries in the range 83-118% and within-laboratory reproducibility from 7 to 18%, while reanalysis of the materials from proficiency tests (PTs) showed that the accuracy of the obtained concentrations ranged from 85 to 124% of the provided consensus values. The method limits of quantification (m-LOQs) were set as first validation levels ranging from 0.001 to 0.3 ng g-1 sample depending on the type of the food group. The observed method performance char-acteristics met the criteria stated in Commission Regulation (EU) 2022/1428, Commission Recommendation (EU) 2022/1431, as well as Guidance Document on Analytical Parameters for the Determination of Per-and Polyfluoroalkyl Substances (PFAS) in Food and Feed with regards to the compliance testing of PFAS maximum levels (MLs) and monitoring purposes. The elaborated method was applied for the analysis of selected priority PFAS in different food groups collected from the Latvian retail market.			1					-	-		
D115	分析	Gao, Y; Zhang, QH; Li, XM; Li, XQ; Li, HM	Simultaneous determination of legacy and emerging per- and polyfluoroalkyl substances in fish by QuEChERS coupled with ultrahigh performance liquid chromatography tandem mass spectrometry	2018	Anal. Methods. 2018 Dec:10(47):5715-5722. doi: 10.1039/c8ay01478g.	In this study, a Quick, Easy, Cheap, Effective, Rugged, and Safe (QuEChERS) method was developed for simultaneous determination of 30 legacy and emerging per- and polyfluoroalkyl substances (PFASs) in fish by UHPLC-MS/MS. Primary and secondary amine (PSA), octadecylsilane (C18), Florisil and Envi-carb were applied in this method. The method detection limits (MDLs) ranged from 2 to 10 pg g(-1) except for PFBA (60 pg g(-1)). Recoveries obtained with fortified samples were in the range of 84.6% to 107%. The intra-day RSDs and inter-day RSDs ranged from 0.25% to 9.95% and 0.30% to 12.3%, respectively. Matrix effect (ME) factors were in the range of 0.79 to 1.31. ME factors increased with the increase of acetonitrile proportions in the mobile phase. The developed method was applied for PFAS detection in 40 marine fish samples. 16 PFASs were detected with Sigma(PFAS) concentrations in the range of 120 to 4488 pg g(-1). Perfluorooctanoic acid (PFOA) was the predominant PFAS followed by perfluorooctanesulfonate (PFOS). The newly emerging 6:2 chlorinated polyfluoroalkyl ether sulfonate (6:2Cl-PFAES) was detected in 85% of the samples, which warranted further investigation. The developed method was time-saving, efficient and accurate for determination of legacy and emerging PFASs in fish.	1							-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D116	分析	Yao, Y; Deng, JW; Yang, YY; Fang, L; Zhou, HY; Liu, HT; Wang, XW; Luan, TG	Determination of Perfluorinated Compounds in Water by Electrospray Ionization Mass Spectrometry Combined with Hollow Fiber Membrane Extraction	2015	Chin. J. Anal. Chem. 2015 JUL:43(7):1053-1057.	In this study, hollow fiber membrane extraction combined with ambient ionization mass spectrometry (AMS) was developed for the simultaneous determination of 7 perfluorinated compounds (PFCs) in aqueous solution, including perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorooctane sulfonate acid (PFOS), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUdA), and perfluorododecanoic acid (PFDoA). PFCs were detected in negative ion mode using selective reaction monitoring (SRM) mode. The extraction time and the pH value of extraction solution were optimized. C-13(4)-PFOS and C-13(4)-PFOA were used as internal standards for quantitative analysis. The method showed good linearity with correlation coefficient values (r(2)) greater than 0.991 for the seven target PFCs. With the exception of PFHpA, the limit of detection (LOD) for other six PFCs was within ranges from 0.8 to 2.7 ng/L while the limit of quantitative (LOQ) was from 2.7 ng/L to 8.9 ng/L. The enrichment factor of five PFCs was more than two hundred. The developed method was applied to detect the seven PFCs in tap water and Pearl River water, and they were all not detected. The recoveries were within the ranges of 88.5%-108.3% and 94.2%-116.7% when 40 ng/L and 400 ng/L PFCs were spiked into tap water, respectively. In terms of the Pearl River water, the recoveries were within the ranges of 75.0%-102.6% and 81.2%-97.6% when 40 ng/L and 400 ng/L PFCs were spiked, respectively.			1					-	-		
D117	分析	Nakayama, SF; Isobe, T; Iwai-Shimada, M; Kobayashi, Y; Nishihama, Y; Taniguchi, Y; Sekiyama, M; Michikawa, T; Yamazaki, S; Nitta, H; Oda, M; Mitsubuchi, H; Sanefuji, M; Ohga, S; Mise, N; Ikegami, A; Suga, R; Shimono, M	Poly- and perfluoroalkyl substances in maternal serum: Method development and application in Pilot Study of the Japan Environment and Children's Study	2020	J. Chromatogr. A. 2020 May:1618:460933. doi: 10.1016/j.chroma.2020.460933.	Poly- and perfluoroalkyl substances (PFAS) have been investigated in a number of cohort studies due to concern over their adverse health effects. The aim of this study was to develop a reliable, high throughput and cost-effective analytical method for a broad range of PFAS in human serum. Protein precipitation, automatic solid phase extraction (SPE) pre-treatment and column-switching LC-MS/MS were employed. The optimised and validated method was then used to analyse the levels of 28 PFAS in 339 maternal serum samples from Pilot Study of the Japan Environment and Children's Study. Perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluoroundecanoic acid (PFUnA) and perfluorooctane sulphonic acid (PFOS) were detected in all 339 samples at median (range) concentrations of 1.9 (0.46-15), 1.5 (0.32-10), 1.3 (0.25-4.5) and 3.7 (0.43-15) ng/ml, respectively. These levels are comparable to those reported in previous studies using samples collected from various parts of the world. With a few exceptions, the remainder of the PFAS examined had lower detection rates but were found at concentrations similar to those reported in previous studies. The sensitivity and throughput ability of the method developed here are sufficient for its application in a large-scale biomonitoring study.			1					-	-		
D118	分析	Pan, YY; Shi, YL; Cai, YQ	Determination of Perfluorinated Compounds in Human Blood Samples by High Performance Liquid Chromatography-Electrospray Tandem Mass Spectrometry	2008	Chin. J. Anal. Chem. 2008 Oct:36(10):1321-1326. doi: 10.1016/S1872-2040(08)60072-9.	A sensitive method was established for the separation and determination of nine perfluorinated compounds (PFCs) in blood samples. Perfluorohexane sulfonate (PFHxS), perfluorohetanoic acid (PFHpA), perfluorooctanoate (PFOA), perfluorooctane sulfonat (PFOS), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecnaoic acid (PFUnDA), perfluorododecanoic acid (PFDoDA) and perfluorotetradodecanoic acid(PFTA) were detected by high performance liquid chromatography/electrospray tandem mass spectrometry (HPLC ESI MS/MS) with C-18 reversed phase column in 15 min, using C-13(4) labeled PFOS (MPFOS) as the internal standard. PFCs in the blood samples were further extracted with solid phase extraction cartridges after traditional MTBE extraction before injection. Four kinds of cartridges were tested, including RP, P, C-18 and HLB, then HLB cartridge was selected as the efficient adsorbent. A comparative study of two C-18 columns, Acclaim 120 (50 mm x 4.6 min, 3 mu m) and Acclaim 120 (250 mm x 4.6 mm, 5 mu m) column, were also performed. Both columns provided similar sensitivities, with the detection limits of 0.03 -0.8 mu g/L for real blood samples. The relative standard deviation of recoveries ranged from 3% to 11%. Finally, Acclaim 120 (250 mm x 4.6 mm, 5 mu m) column was chosen for its superiority of column capacity. With the optimal conditions, the recoveries of PFCs in blood samples ranged from 74.2% to 118.1%, with the exception of PFTA, which was only about 60%			1					-	-		
D119	分析	Genualdi, S; Young, W; Peprah, E; Srigley, C; Fisher, CM; Ng, B; deJager, L	Analyte and matrix method extension of per- and polyfluoroalkyl substances in food and feed	2023	Anal Bioanal Chem. 2023 Aug 2. doi: 10.1007/s00216-023-04833-1.	The development and expansion of analytical methods for per- and polyfluoroalkyl substances (PFAS) in food are essential for the continued monitoring of the United States (US) food supply and assessments of dietary exposure. In March 2022, the European Union Reference Laboratory for Halogenated Persistent Organic Pollutants in Feed and Food (EURL POPs) released a guidance document covering priority PFAS of interest, including analytical method parameters and limits of quantification (LOQs). As a result, the Food and Drug Administration (FDA) began method extension work to incorporate ten new additional analytes to method C-010.02 including long-chain perfluorosulfonic acids, fluorotelomer sulfonates, and perfluorooctane sulfonamide. Four long-chain carboxylic acids were also validated across all foods, which were previously added to C-010.02 but only validated in seafood. In December 2022, the European Union published Commission Regulation 2022/2388, establishing maximum levels for perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS) in certain foodstuffs, primarily fish, molluscs, crustaceans, and eggs. As a result, the FDA method was evaluated for performance in reaching LOQs defined in Commission Regulation (EU) 2022/1431. The FDA method was found to be able to reach all required LOQs for analytes in matrices with established maximum levels. Currently, method detection limits (MDLs), which are used by the FDA as the lower limit for reporting PFAS in surveillance samples, were in the same range as defined indicative levels. With further method modifications, required LOQs could be met in fruits, vegetables, and milk. Reaching the lower targeted LOQs for these food matrices will require moving the method to an instrument that can provide increased signal:noise gains at the lower limits of quantification.			1					-	-		
D120	分析	Zhang, P; Shi, YL; Cai, YQ; Mon, SF	Determination of perfluorinated compounds in water samples by high performance liquid chromatography-electrospray tandem mass spectrometry	2007	Chin. J. Anal. Chem. 2007 JUL:35(7):969-972.	A rapid and simple method was proposed for separation and determination of five perfluorinated compounds, perfluoroheptanic acid (PFHeA), perfluorooctanic acid (PFOA), perfluorooctanic sucfonic acid (PFOS), perfluorononanic acid (PFNA) and perfluorodecanoic acid (PFDeA) by using high performance liquid chromatography/electrospray tandem mass spectrometry (LC/ESI-MS/MS) with a C-18 reversed-phase column and CH3OH/NH4Ac eluent in 10 min. 500 mL sample liquor was concentrated by off-line RP cartridge, then washed with 2 mL methanol. The extractant solution was finally added with water to 5 mL before 50 mu L injection. Transitions of 363/319, 412. 9/368. 9, 498. 9/80, 462. 9/419 and 512. 8/469 were selected to qualification and quantification of PFHeA, PFOA, PFOS, PFNA and PFDeA. Linear calibrations were acquired in the range of 0. 5 - 20 ng/L with correlation coefficients more than 0. 9944. The detection limits (S/N = 3) for these five PFCs were 0. 10, 0. 15, 0. 11, 0. 11 and 0. 18 ng/L respectively. This method was applied to detect PFCs in environmental water samples. The recoveries were in the range of 52. 6% - 117. 5%.			1					-	-		
D121	分析	Dasu, K; Nakayama, SF; Yoshikane, M; Mills, MA; Wright, JM; Ehrlich, S	An ultra-sensitive method for the analysis of perfluorinated alkyl acids in drinking water using a column switching high-performance liquid chromatography tandem mass spectrometry	2017	J. Chromatogr. A 2017 Apr:1494:46-54. doi: 10.1016/j.chroma.2017.03.006	In epidemiological research, it has become increasingly important to assess subjects' exposure to different classes of chemicals in multiple environmental media. It is a common practice to aliquot limited volumes of samples into smaller quantities for specific trace level chemical analyses. A novel method was developed for the determination of 14 perfluorinated alkyl acids (PFAAs) in small volumes (10 mL) of drinking water using off-line solid phase extraction (SPE) pre-treatment followed by on-line pre-concentration on a WAX column before analysis on column-switching high performance liquid chromatography tandem mass spectrometry (HPLC-MS/MS). In general, large volumes (100-1000 mL) have been used for the analysis of PFAAs in drinking water. The current method requires approximately 10 mL of drinking water concentrated by using an SPE cartridge and eluted with methanol. A large volume injection of the extract was introduced on to a column-switching HPLC-MS/MS using a mix-mode SPE column for the trace level analysis of PFAAs in water. The recoveries for most of the analytes in the fortified laboratory blanks ranged from 73 +/- 14% to 128 +/- 5%. The lowest concentration minimum reporting levels (LCMRL) for the 14 PFAAs ranged from 0.59 to 3.4 ng/L. The optimized method was applied to a pilot-scale analysis of a subset of drinking water samples from an epidemiological study. These samples were collected directly from the taps in the households of Ohio and Northern Kentucky, United States and the sources of drinking water samples are both surface water and ground water, and supplied by different water distribution facilities. Only five PFAAs, perfluoro-1-butanesulfonic acid (PFBS), perfluoro-1- -hexanesulfonic acid (PFHxS), perfluoro-1-octanesulfonic acid (PFOS), perfiuoro-n-heptanoic acid (PFHpA) and perfluoron-octanoic acid (PFOA) are detected above the LCMRL values. The median concentrations of these five PFAAs detected in the samples was <4.1 ng/L with PFOS at 7.6 ng/L and PFOA at 10 ng/L. Concentrations of perfluoro-1-decanesulfonic acid, PFDS and other perfluoroalkyl carboxylic acids were below the LCMRL values.				1				-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D122	分析	Wang, P; Challis, JK; Luong, KH; Vera, TC; Wong, CS	Calibration of organic-diffusive gradients in thin films (o-DGT) passive samplers for perfluorinated alkyl acids in water	2021	Chemosphere. 2021 Jan:263:128325. doi: 10.1016/j.chemosphere.2020.128325.	The application of the organic-diffusive gradients in thin films (o-DGT) passive sampling technique for the monitoring of per- and polyfluoroalkyl substances (PFAS) in the environment is still limited. Six common PFAS with different chain lengths were evaluated in water by o-DGT. Measured diffusion coefficients (D) in agarose and polyacrylamide diffusive gels ranged from 4.55-8.63 x 10(-6) cm(2) s(-1) and 3.85-7.00 x 10(-6) cm(2) s(-1) at 23 degrees C, respectively. Experimental sampling rates (Rs) for both agarose- and polyacrylamide-WAX sampler configurations were within 22% relative error of D-based Rs for four of the PFAS. Larger differences for perfluorobutanesulfonic acid (PFBS) and perfluoroundecanoic acid (PFUnDA) ranged from 36% to 56%. In general, in-situ Rs can be predicted using measured D-values for perfluorinated alkyl acids. The mass accumulation of six PFAS in two o-DGT configurations was linear over 21 days (R-2 >= 0.97). Diffusion and uptake of o-DGT depended on the gel type and specific PFAS. Field demonstrations of o-DGT with WAX and HLB binding gels and polyacrylamide diffusive gels (not prone to biodegradation) found 0.3-19.5 ng L-1 of PFAS in rivers near industrial areas around Guangzhou and Foshan, China, with no apparent differences between the two co-deployed samplers. This study demonstrates that the configurations of o-DGT tested provide a cost-effective monitoring tool for measuring perfluorinated alkyl acids in aquatic systems, in particular the four PFAS for which reasonable correlations were observed.				1					-	-		
D123	分析	Washington, JW; Ellington, JJ; Jenkins, TM; Evans, JJ	Analysis of perfluorinated carboxylic acids in soils: Detection and quantitation issues at low concentrations	2007	J. Chromatogr. A 2007 Jun:1154(1-2):111-120. doi: 10.1016/j.chroma.2007.03.107.	Methods were developed for the extraction from soil, identification, confirmation and quantitation by LC/MS/MS of trace levels of perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA). Whereas PFOA, PFNA and PFDA all can be quantitated using the method of standard additions, PFOA also can be quantitated less laboriously using C-13(4)-PFOA as a matrix internal standard. The impact of extract matrices on signal varied between soils and temporally during analytical runs rendering C-13(4)-PFOA unsuitable as a matrix internal standard for quantitating perfluorinated carboxylic acids (PFCAs) other than PFOA, which co-elutes with C-13(4)-PFOA. In fact, for soil extracts, quantitation of PFCAs based on external calibrations proved about as accurate as use of matrix internal standards for target analytes that do not co-elute with the matrix internal standard. Also, C-13(4)-PFOA should be used carefully as a matrix internal standard for trace levels of PFOA because some C-13(4)-PFOA standards contain trace impurities of unlabelled PFOA. When the presence of PFCAs in soil extracts is being determined by LC/MS/MS, detection limits are best defined by statistical methods that quantify the significance of contrast between analytical signal and background noise using multiple analyses. Further, when developing a calibration of low concentrations using weighted regression, the central tendency of the calibration line is best fitted using graphical depictions of error. As the MDL for the transition-product quantitation ion is approached in LC/NIS/MS, relatively weak signals of transition-product confirmation ions can be used as a rejection criterion by looking for anomalously high values of the ratio of the confirmation to the quantitation ion.									-	-		
D124	分析	Han, YL; Pulikkal, VF; Sun, M	Comprehensive Validation of the Adsorbable Organic Fluorine Analysis and Performance Comparison of Current Methods for Total Per- and Polyfluoroalkyl Substances in Water Samples	2021	ACS ES&T Wat. 2021 Jun:1(6):1474-1482. doi: 10.1021/acsestwater.1c00047.	Per- and polyfluoroalkyl substances (PFASs) are widely detected in the environment, while a large number of them cannot be identified and/or quantified by current analytical methods. As a surrogate total PFAS analysis, the adsorbable organic fluorine (AOF) method was improved and validated in this study. The improved method has limits of detection and quantification of 300 and 400 ng/L, respectively, more sensitive than the previously reported AOF methods. AOF recovery for 29 individual PFASs ranged 53-113%, while three short-chain PFASs yielded lower recovery (19-39%) due to low adsorption efficiency. Recovery for PFAS mixtures in different environmental water matrices was 64-84%, and was negligibly impacted by the presence of fluoride, dissolved organic matter, or other matrix constituents. The validated method was applied to different environmental water samples, and AOF data were compared to results from other total PFAS analyses, including total fluorine, extractable organic fluorine, total oxidizable precursors, and summed individual PFASs. The fluorine contents from targeted PFAS analysis only contributed 0.4-29% of AOF concentrations in all except two samples, indicating the significance of AOF for estimating unknown PFAS concentrations, screening PFAS contamination, and assessing PFAS exposure.			1					-	-		
D125	分析	Camdzic, D; Dickman, RA; Aga, DS	Total and class-specific analysis of per- and polyfluoroalkyl substances in environmental samples using nuclear magnetic resonance spectroscopy	2021	J. Hazard. Mater. Lett. 2021 Nov:2:100023. doi: 10.1016/j.hazl.2021.100023.	This study reveals unique information that fluorine nuclear magnetic resonance (19F-NMR) spectroscopy provides in the analysis of per- and polyfluoroalkyl substances (PFASs). Our results demonstrate that the intensity of the terminal -CF3 signal can be used to determine the total PFASs regardless of headgroup. Characteristic chemical shifts of different classes of PFASs can also be observed, and are useful for differentiating between classes of PFAS. The NMR spectra of PFASs with ether linkages (e.g. GenX) show characteristic reference signals for both -CF2 and -CF3 signals that are useful for detection. Notably, 19F-NMR can differentiate between PFASs, non-PFAS, and F- ions, eliminating the need for sample clean-up even for complex samples. To illustrate this, the 19F-NMR spectra of perfluorooctane sulfonic acid (PFOS) in biosolids extract and in clean solvent spiked with PFOS standard were compared, and showed a difference of < 0.3 % in their signal intensities. The lack of matrix effect is contrary to the suppression or enhancement observed in PFAS analysis by liquid chromatography with mass spectrometry, the most commonly used method for quantifying PFASs. This paper presents 19F-NMR reference spectra for 34 PFASs and discusses the complementarity of this method with other approaches for the total and class-specific analysis of PFASs.					1				-	-		
D126	分析	Chan, WN; Harrison, RG	Separation of perfluoroalkyl substances by ion chromatography with a resorcinarene stationary phase	2023	Sep. Sci. Plus. 2023 Mar;6(3):. doi: 10.1002/sscp.202200136.	Perfluoroalkyl substances pose a worldwide environmental health risk. It is important to develop new detection and quantification methods for perfluoroalkyl substances. Currently, liquid chromatography-tandem mass spectrometry is the proposed method to analyze perfluoroalkyl substances. Ion chromatography, with its ability to use water samples as they are collected, could be a promising technique to detect anionic perfluoroalkyl substances in water. A new cationic stationary phase, composed of a resorcinarene bound to arginine, was synthesized and used to separate perfluoroalkyl substances by ion chromatography. The new packing material under the right gradient conditions separates perfluoroalkyl substances such as perfluorobutanoic acid, perfluorobutanesulfonic acid, perfluoropentanoic acid, perfluorohexanoic acid, perfluorohexanesulfonic acid, and perfluorooctanoic acid. Unlike the case with common anions, it was found that decreasing the NaOH concentration in the eluent resulted in better perfluoroalkyl substances separation. The detection limits of the perfluoroalkyl substances were from 0.44 to 4.0 mg/L and the limits of quantification were from 1.5 to 13 mg/L. The retention times of the perfluoroalkyl substances were dependent on the number of CF2 groups and whether their acid group was sulfonate or carboxylate. Also, the detection of perfluoroalkyl substances in tap and lake water was accomplished.	1	1	1	1					-	-		
D127	分析	Katsumata, T; Nakata, A; Iwasaki, Y; Ito, R; Saito, K; Nakazawa, H	Determination of perfluorochemicals in house-dust by LC/MS/MS after supercritical fluid extraction	2006	Bunseki Kagaku 2006 Dec:55(12):955-961. doi: 10.2116/bunsekikagaku.55.955.	The purpose of this study is to find the exposure sources of perfluorochemicals (PFCs). We have developed a method for measuring 4 PFCs (perfluorooctanesulfonate; PFOS, perfluorooctanoic acid; PFOA, perfluorononanoic acid; PFNA and perfluorohexanesulfonate; PFHxS) in house dust using supercritical fluid extraction (SFE) and based on high-performance liquid chromatography/tandem mass spectrometry. The mean extracted recovery assessed at two different concentrations (50 and 250 ng/g in house dust) was more than 97.9%. The assay was linear over the range 2.5 similar to 500 ng/g. The method detection limits were assessed as being 0.58 ng/g to 0.72 ng/g. We determined the concentrations of PFCs in 20 house-dust samples for investigating of the exposure source. The compounds were detected in all dust samples and the ranges were 7.0 similar to 41 ng/g for PFOS, 18 similar to 89 ng/g for PFOA and 5.5 similar to 69 ng/g for PFNA. PFHxS was determined in 8 samples (2.5 similar to 5.5 ng/g). Based on our experiments, house-dust might be one of the human exposure sources for PFCs. The developed method can be applied to the determination of PFCs in house dust samples for monitoring human exposure sources.			1					-	-		
D128	分析	Harrington, LM	Analysis of perfluoroalkyl and polyfluoroalkyl substances in serum and plasma by solvent precipitation-isotope dilution-direct injection-LC/MS/MS	2017	Anal. Methods. 2017 Jan:9(3):473-481. doi: 10.1039/c6ay02809h.	A validated liquid chromatography tandem mass spectrometry (LC/MS/MS) method is presented for the analysis of per- and polyfluoroalkyl substances (PFAS) in serum and plasma. The method employs stableisotope labeled internal standard (IS) and surrogate recover standard (SRS) spiked serum or plasma samples that are mixed and precipitated with acetonitrile. Quantitation is performed with stable-isotope IS solvent (50 : 50 acetonitrile : water) calibration using one direct injection (DI) chromatographic analysis of precipitated sample supernate. The analytical method includes fifteen stable isotope labeled ISs, four SRSs ([1,2,3,4-C-13(4)]PFOA, [1,2-C-13(2)]PFUnA, [1,2,3,4-C-13(4)]PFOS, [2,3,4-C-13(3)]PFBA), and sixteen target analytes perfluoroalkyl carboxylic acids (PFCAs) (C4-C12), perfluoroalkyl sulfonic acids (PFSAs) (C4, C6, C8), N-ethyl perfluorooctane sulfonamido acetate (EtFOSAA), N-methyl perfluorooctane sulfonamido acetate (MeFOSAA), perfluorooctane sulfonamide (FOSA), and perfluorobutane sulfonamide (FBSA). Mean recoveries of control human plasma fortified with method target analytes over the range 2.5-175 ng mL(-1) (10-700 ng mL(-1) PFOS) are 83.7-103% with relative standard deviations (RSDs) of <= 14% (PFBA = 19%). Mean recoveries and RSDs of control human plasma fortified with mixed branched and linear isomer PFOA and PFHS (2.5 & 10.0 ng mL(-1)), and PFOS (10 & 40 ng mL(-1)) were 83.2% (RSD +/- 7.7%), 101% (RSD +/- 4.9%), and 101% (RSD +/- 6.5%) respectively. Mean recoveries of control bovine serum fortified with the method target analytes over the lower concentration range 0.250-175 ng mL(-1) (1-700 ng mL(-1) PFOS) are 82.8-103% with RSDs <= 15% (MeFOSAA = 16%, EtFOSAA = 17%). Mean recoveries and RSDs for 736 American Red Cross (ARC) study plasma samples fortified with SRSs at 1 ng mL(-1) were 89.0% (+/- 7.3% RSD) for [1,2,3,4-C-13(4)]PFOA, 91.8% (+/- 10% RSD) for [1,2-C-13(2)]PFUnA, and 89.4% (+/- 7.9% RSD) for [1,2,3,4-C-13(4)]PFOS.	1								-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D129	分析	Groffen, T; Bervoets, L; Jeong, Y; Willems, T; Eens, M; Prinsen, E	A rapid method for the detection and quantification of legacy and emerging per- and polyfluoroalkyl substances (PFAS) in bird feathers using UPLC-MS/MS	2021	J. Chromatogr. B. 2021 May:1172:122653. doi: 10.1016/j.jchromb.2021.122653.	The bioaccumulation and toxicity of per- and polyfluoroalkyl substances (PFAS) have raised scientific and public concern in recent decades, leading to regulatory measures for some PFAS (e.g. perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA)). In addition, the discovery of new PFAS alternatives in the environment has led to growing concern about the presence of numerous other PFAS that are used unrestricted. Feathers have been successfully applied as non-destructive indicators for various contaminants, mostly metals and persistent organic pollutants (POPs), whereas their suitability as an indicator for PFAS is still discussed. Previous studies on PFAS in feathers have focused primarily on perfluoroalkyl sulfonic acids (PFSAs) and perfluoroalkyl carboxylic acids (PFCAs); analytical methods for other groups of PFAS or PFAS alternatives in feathers are still lacking. Hence, this study aimed to develop a rapid, sensitive and reliable analytical method for determining a broad range of PFAS (N = 32) in feathers, using liquid chromatography-tandem mass spectrometry (LC-MS/MS). An extraction duration of 24 h was found to be sufficient to extract the majority of PFAS from the feathers. The extraction recovery of the internal standards ranged on average from 68% (PFBA) to 97% (PFOS). The spike recovery was within an acceptable range of at least 70% for most of the target analytes and the precision was often > 80%. A further extract clean-up using weak anion exchange (WAX) solid phase extraction (SPE), was proven unnecessary, as it resulted in a similar or lower spike recovery, and, as a consequence, a lower precision and higher quantification limit. The analytical method allows detection of low PFAS concentrations in a low quantity of matrix (i.e. small feathers). The developed LC-MS/MS method was validated and shown to be a fast, sensitive and reliable method for determining a broad range of legacy and emerging PFAS in feathers.	1							-	-		
D130	分析	Lien, GW; Wen, TW; Hsieh, WS; Wu, KY; Chen, CY; Chen, PC	Analysis of perfluorinated chemicals in umbilical cord blood by ultra-high performance liquid chromatography/tandem mass spectrometry	2011	J. Chromatogr. B 2011 Mar:879(9-10):641-646. doi: 10.1016/j.jchromb.2011.01.037.	Perfluorinated compounds (PFCs) can cross the placental barrier and enter fetal circulation. This study aimed at developing a fast and sensitive ultra-high performance liquid chromatography/tandem mass spectrometry method for the determination of twelve perfluorinated compounds in cord blood. Samples were processed with protein precipitation using formic acid and methanol, mixed with stable isotope labeled standard, followed by sonication and centrifugation, and were analyzed using a Waters ACQUITS' UPLC coupled with a Waters Quattro Premier XE triple-quadrupole mass spectrometer. The instrument was operated in selected reaction monitoring (SRM) with negative electrospray ionization. Using BEN C-18 column (2.1 mm x 50 mm, 1.7 mu m) with 10-mM N-methylmorpholine/methanol gradient elution provided a fast chromatographic separation (5.5 min) and sharp peaks. Intra- and inter-day calibration bias was less than 7% and intra- and inter-day calibration of relative standard deviations were within 0.02-8.22% for all the analytes and concentrations. The recoveries of PFCs spiked into bovine serum ranged from 85 to 104% with relative standard deviations from 0.02 to 6.37%. The limits of quantitation (LOQs), defined as a signal-to-noise ratio of ten, ranged from 0.15 to 3.1 ng/mL for the twelve PFCs. Perfluorooctanoic acid (PFOA), perfluorooctyl sulfonate (PFOS), perfluoroundecanoic acid (PFUA) and perfluorononanoic acid (PFNA) were detected in up to 68% of umbilical cord plasma (n = 444) in Taiwan Birth Panel Study and the health effect of these chemicals on children developmental deserves further investigation.			1					-	-		
D131	分析	Gobelius, L; Persson, C; Wiberg, K; Ahrens, L	Calibration and application of passive sampling for per- and polyfluoroalkyl substances in a drinking water treatment plant	2019	J. Hazard. Mater. 2019 Jan:362:230-237. doi: 10.1016/j.jhazmat.2018.09.005	The aim of this study was to calibrate and apply polar organic chemical integrative samplers (POCIS) to examine 26 per- and polyfluoroalkyl substances (PFASs) in a drinking water treatment plant (DWTP). As a first step, the sampling rates (R-s) of 14 PFASs were determined in a laboratory calibration study for POCIS-WAX (weak-anion exchange) and POCIS-HLB (hydrophilic-lipophilic balance) (each with a surface area per mass of sorbent ratio of 227 cm(2) g(-1)). While most PFASs were still in the linear uptake phase during the 28-day calibration study, R-s ranged from 0.003 to 0.10 L d(-1) for POCIS-WAX and 0.00052 to 0.13 for POCIS-HLB. It is important to note that POCIS-WAX had higher R-s, for short-chain perfluoroalkyl carboxylates (PFCAs) with a perfluorocarbon chain length of C3-C6 and perfluorobutane sulfonate (PFBS) compared with POCIS-HLB. Furthermore, R-s was significantly positively correlated with the sorbent-water partition coefficient (K-pw) for POCIS-WAX and POCIS-HLB ($p < 0.0001$). Use of POCIS-WAX and POCIS-HLB in the DWTP showed good agreement with composite water sampling. No removal of PFASs was observed in the full-scale DWTP. Overall, this is the first study of PFAS monitoring in a DWTP using two types of POCIS. The results demonstrate high suitability for future applications.				1				-	-		
D132	分析	Shang, J; Gao, K; Chi, BW; Piao, YS; Ma, QY; Lu, LP; Wang, JW	Automated and fast online method for simultaneously determining a broad spectrum of per- and polyfluoroalkyl substances in a small volume of cerebrospinal fluid	2023	Anal. Bioanal. Chem. 2023 Mar:415(6):1221-1233. doi: 10.1007/s00216-022-04507-4.	Per- and polyfluoroalkyl substances (PFASs) are potentially neurotoxic compounds. Levels of PFASs in cerebrospinal fluid (CSF) could directly reflect their potential harm to the central nervous system. Because of the variety of PFASs and the rarity of CSF, there is an urgent need to establish a rapid online method to detect a broad spectrum of PFASs accurately and simultaneously by consuming a small amount of CSF. In this study, we developed a fast and automated method to analyze 52 PFASs in human CSF samples using online TurboFlow ultra-high-performance liquid chromatography-tandem mass spectrometry. Our method offered excellent matrix-matched standard curve linearity (correlation coefficient > 0.99), good limits of quantitation (MLOQs) (0.01 to 0.08 ng mL(-1)), satisfactory accuracy (recoveries of 74.6%-119.1%) and precision (relative standard deviations of 1.4%-13.2%), small sample amount consumption (50 mu L), and fast analysis time (18 min per sample) without complex sample pretreatment procedures. These are advantageous for the high throughput screening of PFASs in environmental epidemiology studies. Repeated freeze-thaw experiments showed that it was better to perform the analytical process soon as possible after sample collection. The established method was used to analyze PFASs in 60 people. Short-chain PFASs, perfluorobutanoic acid (PFBA), perfluoropentanoic acid (PFPeA), and novel PFASs [sodium 2-(N-ethylperfluorooctane-1-sulfonamido)ethyl phosphate (SAmPAP), perfluoroethylcyclohexanesulfonate (PFECHS), and perfluoro-3, 7-dimethyloctanoic acid (P37DMOA)] were reported in CSF for the first time. PFBA and PFPeA were detected in all samples with mean concentrations of 0.24 and 0.22 ng mL(-1), respectively. We also calculated the blood-brain barrier transmission efficiency of PFASs (R-PFAS), and the mean R-PFBA value was above 1, which indicated that PFBA might transfer from serum to CSF.	1							-	-		
D133	分析	Iwasaki, Y; Terayama, E; Kato, A; Ito, R; Saito, K; Makino, T; Nakazawa, H	Quantitative analysis of perfluorinated chemicals in media for in vitro fertilization and related samples	2012	Chemosphere. 2012 Jul:88(4):445-449. doi: 10.1016/j.chemosphere.2012.02.068.	The actual standard in vitro fertilization (IVF) protocol recommends an overnight gamete co-incubation. All of the culture media used for human IVF are supplemented with serum or albumin. In the present study, we determined the concentrations of perfluorinated chemicals (PFCs) in IVF media (IVFM) and related samples by liquid chromatography with tandem mass spectrometry (LC/MS/MS). The results indicated that the concentrations of PFOS and PFOA in the protein source were higher than those in the IVFM samples. Compared with human plasma concentrations of PFCs, PFCs in all of the IVFM samples, such as PFBS, PFHxS and PFOA, were either not detected or present at only trace levels, even when protein source was added. LC/MS/MS could be used to determine PFCs in IVFM samples in future studies of the effects of PFC exposure on intrauterine insemination.				1				-	-		
D134	分析	Yeung, LWY; Miyake, B; Li, P; Taniyasu, S; Kannan, K; Guruge, KS; Lam, PKS; Yamashita, N	Comparison of total fluorine, extractable organic fluorine and perfluorinated compounds in the blood of wild and pefluorooctanoate (PFOA)-exposed rats: Evidence for the presence of other organofluorine compounds	2009	Anal. Chim. Acta. 2009 Mar:635(1):108-114. doi: 10.1016/j.aca.2009.01.004.	The widespread occurrence and environmental persistence of perfluorinated compounds (PFCs) received worldwide attention recently. Exhaustive analysis of all fluorinated compounds in an environmental sample can be daunting because of the constraints in the availability of analytical standards and extraction methods. Combustion ion chromatographic technique for trace fluorine analysis was used to assess the concentrations of known PFCs (e.g., PFOS, PFOA) and total fluorine (TF) in the blood of wild rats collected from Japan. The technique was further validated using tissues from PFOA-exposed rats. Six PFCs (PFOS, PFOSA, PFUnDA, PFDA, PFNA, and PFOA) were detected in all of the wild rat blood samples. Concentrations of extractable organic fluorine (EOF) in fraction 1 (Fr1; MTBE extraction) of wild rats ranged 60.9-134 ng F mL(-1), while those in fraction 2 (Fr2; hexane) were below LOQ (32 ng FmL-1); TF concentrations in the blood of wild rats ranged from 59.9-192 ng F mL(-1). The contribution of known PFCs in EOF-Fr1 (MTBE) varied from 9% to 89% (56% on average), and known PFC concentrations in TF content were less than 25%. In contrast, TF concentrations in the blood of PFOA-exposed rats ranged from 46900 to 111000 ng F mL(-1), with PFOA contributing over 90% of TF. A comparison of results from the samples analyzed in this study and the literature revealed three distinct groups with PFOA/known PFC and TF levels (i.e., wild rats and general population, occupationally exposed workers, and PFOA-exposed laboratory rats). The mass balance analysis of the different forms of fluorine in blood suggested the presence of other forms of organic fluorine in addition to known PFCs.			1					-	-		
D135	分析	Nakata, A; Saito, K; Iwasaki, Y; Ito, R; Kishi, R; Nakazawa, H	Determination of Perfluorinated Compounds in Human Milk and Evaluation of Their Transition from Maternal Plasma	2009	Bunseki Kagaku 2009 Aug:58(8):653-659. doi: 10.2116/bunsekikagaku.58.653.	In this study, we focused our attention on breast fluid as specific perfluorinated compounds (PFCs) as an exposure source to infants, and developed a highly sensitive and accurate analytical method using high-performance liquid chromatography/tandem mass spectrometry (LC/MS/MS). For sample pretreatment, samples were determined using weak anion exchange (WAX) and solid phase extraction (SPE). The average recoveries of the analytes were in the range 94.3 similar to 109.0% (RSD <10.3%), and the limits of quantitation (LOQ) were determined to be 0.012 ng/mL for PFOA and 0.004 ng/mL for PFOS, PFHxS and PFNA, respectively. Relatively high levels of PFCs were detected from human milk, which ranged over 0.046 similar to 0.098 ng/mL for PFOS and over 0.016 similar to 0.270 ng/mL for PFOA. In addition, human milk and maternal plasma collected from the same donor were analyzed. As a result, the concentration of PFCs in human milk and maternal plasma showed significant correlations for HOS ($r = 0.78$) and PFOA ($r = 0.82$).			1					-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D136	分析	Jiao, Z; Li, JW; Mo, LJ; Liang, JM; Fan, HB	A molecularly imprinted chitosan doped with carbon quantum dots for fluorometric determination of perfluorooctane sulfonate	2018	Microchim. Acta. 2018 Oct;185(10):. doi: 10.1007/s00604-018-2996-y.	A molecularly imprinted polymer (MIP) was fabricated for selective recognition of the highly persistent pollutant perfluorooctane sulfonate (PFOS). The MIP was prepared from chitosan and doped with fluorescent carbon quantum dots (CQDs). It was characterized by fluorescence spectrophotometry, scanning electron microscopy, and Fourier transform infrared spectroscopy. The fluorescence of the CQDs, best measured at excitation/emission wavelengths of 350/460nm, is enhanced by PFOS, and the effect is much stronger for the MIP than for the nonimprinted polymer (NIP). The imprinting factor is 2.75. The method has good specificity over sodium dodecyl sulfate (SDS), perfluorooctanoic acid (PFOA), sodium dodecyl sulfonate (SDS'), sodium dodecyl benzene sulfonate (SDBS), perfluorooctanesulfonyl fluoride (POSF), perfluorobutane sulfonate (PFBS) and 1-octanesulfonic acid sodium (OSA). Fluorescence increases linearly in the 20-200pgL(-1) POSF concentration range in aqueous solution. The method was applied to the determination of PFOS in spiked serum and urine samples. The limits of detection are 66 and 85pgL(-1) for serum and urine samples respectively. The recoveries ranged from to 81-98%, with relative standard deviations in the range of 1.8-8.2%. Compared with LC-MS/MS, this assay is more convenient since the material can be prepared flexibly and the method can be applied on-site.				1					-	-		
D137	分析	Lajin, B; Goessler, W	Fluorinated carboxylic acids as ion repelling agents in reversed-phase chromatography	2020	J. Chromatogr. A. 2020 Nov:1631:461575. doi: 10.1016/j.chroma.2020.461575.	Fluorinated carboxylic acids have been in use as ion-pairing reagents for over three decades. It has been observed that ion-pairing reagents not only increase the retention of oppositely charged analytes on reversed-phase HPLC columns but also decrease the retention of similarly charged analytes; these latter effects, however, have not been thoroughly investigated for the fluorinated carboxylic acids, and the application of these reagents has been rather restricted to their ion-pairing capacity to separate basic analytes. In the present study, we report a systematic investigation about the effects of three fluorinated carboxylic acids (trifluoroacetic acid (TFA), pentafluoropropionic acid (PFPA), and heptafluorobutyric acid (HFBA)) on the retention and selectivity of the separation of halogenated carboxylic acids and sulfonic acids by reversed-phase chromatography with an inductively coupled plasma mass spectrometry detector (ICPMS). Several eluents were tested and compared at different concentrations (0-100 mM) and pH values, including sulfate, nitrate, phosphate, oxalate, TFA, PFPA, and HFBA. The fluorinated carboxylic acids resulted in a consistent decrease in the retention factors (up to ca. 9-fold with HFBA) in a concentration dependent manner, which plateaued at around 50 mM. Significant improvement of the peak symmetry of the chromatographed acids was also observed. We highlight the advantages of incorporating the fluorinated carboxylic acids in modifying the selectivity and retention of organic acids in reversed phase chromatography in general, and particularly when employing chromatographic detectors with limited compatibility with organic mobile phases such as the ICPMS.									-	-		
D138	分析	Cao, D; Hu, M; Han, CG; Yu, JY; Cui, L; Liu, YX; Wang, HL; Cai, YQ; Kang, YH; Zhou, YQ	Proton sponge-functionalized silica as high performance adsorbents for solid-phase extraction of trace perfluoroalkyl sulfonates in the environmental water samples and their direct analysis by MALDI-TOF-MS	2012	Analyst. 2012 :137(9):2218-2225. doi: 10.1039/c2an16190g.	1,8-Bis(dimethylamino)naphthalene (DMAN), a classical 'proton sponge', was functionalized on silica particles as a novel solid-phase extraction (SPE) adsorbent (DMAN@silica) for extracting perfluoroalkyl sulfonates (PFSs). High reproducibility and excellent extraction capability for PFSs were obtained in a wide pH range (3.0 similar to 8.5). The adsorbed PFSs on DMAN@silica sorbents could be efficiently eluted by 1,8-bis(tetramethylguanidino)naphthalene (TMGN) solution which is a proton sponge with higher proton affinity than DMAN. The elution could be directly analyzed by MALDIT-OF-MS using TMGN as matrix. Clear mass spectra for the PFSs were obtained due to no matrix ions interference observed. Furthermore, a novel strategy based on the DMAN@silica-SPE enrichment, followed by MALDI-TOF-MS analysis, was proposed and applied for PFSs quantification in environmental water samples. The calibration curves of each of the target analytes showed a wide linear dynamic range of response (0.1-10 ng L-1 for perfluorooctane sulfonate (PFOS), perfluorohexyl sulfonate (PFHxS) and perfluorobutylsulfonate (PFBS)), which were over 2 orders of magnitude. The detection limits for PFOS, PFHxS, and PFBS were 0.021, 0.016, and 0.013 ng L-1, respectively (S/N = 3). Recoveries of PFOS, PFHxS, and PFBS are in the ranges of 92-104%, 95-102%, and 98-109% for spiked river water samples. These results indicated that the prepared DMAN@silica adsorbents could efficiently enrich PFSs and that the proposed method is reliable.				1					-	-		
D139	分析	Henderson, WM; Weber, EJ; Duirk, SE; Washington, JW; Smith, MA	Quantification of fluorotelomer-based chemicals in mammalian matrices by monitoring perfluoroalkyl chain fragments with GC/MS	2007	J. Chromatogr. B 2007 Feb:846(1-2):155-161. doi: 10.1016/j.jchromb.2006.08.042.	Perfluorocarboxylic acids (PFCAs), namely perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA), have been identified as persistent, bioaccumulative and potentially toxic compounds. The structural analog, 8-2 fluorotelomer alcohol (8-2 frOH) is considered the probable precursor of these stable metabolites. Because simultaneous quantification is needed for volatile and non-volatile perfluorinated chemicals (PFCs) in complex matrices, a GC/MS method was developed and tested based on selected ion monitoring of perfluorinated alkyl parent chain fragment ions. Although the method requires a derivatization step, combined GC/MS analysis of PFCA-me's and FTOHs increases analytical efficiency and decreases sample analysis time. The method instrument detection limits are between 7.1 and 24.5 ng/mL extract (MTBE), and the method quantification limits are below 50 ng/mL serum or ng/g liver for all PFCs investigated. Recoveries from mouse serum and liver homogenates, which were spiked with FTOHs and PFCAs at levels of 25 and 200 ng/mL or ng/g, ranged from 81 to 101%. Finally, the utility of the method was demonstrated by dosing male CD-1 mice with 30 mg/kg-BW of 8-2 FTOH and quantifying PFCs 6 h post-treatment. The advantages of this method are (1) the simultaneous detection of both volatile and non-volatile fluorotelomer-based chemicals in complex matrices, such as mammalian tissues, (2) as a confirmatory method to LC-MS/MS, and (3) as an alternative method of analysis for laboratories without access to LC-MS/MS.			1						-	-		
D140	分析	Mejia-Urueta, R; Mestre-Quintero, K; Vivas-Reyes, R	DFT-GIAO Calculation of Properties of F-19 NMR and Stability Study of Environmentally Relevant Perfluoroalkylsulfonamides (PFASAmide)	2011	J. Braz. Chem. Soc. 2011;22(12):2268-2274. doi: 10.1590/S0103-50532011001200005	Perfluorinated organic compounds (POCs), such as perfluorooctanesulfonate (PFOS) and perfluoroalkylsulfonamide (PFASA) are compounds that have recently attracted considerable attention worldwide because of its high persistence and wide distribution in the environment. Among the spectroscopic methods used to study the PFASA, F-19 nuclear magnetic resonance (NMR F-19) is very effective, due to its ability to determine concentrations of PFASA in biological samples and measure pollution in water samples. For this reason, a theoretical study of the properties of F-19 NMR was performed. In this study we have determined the shielding constant (sigma) for different fluorine nucleus of the 18 molecules under study, using density functional theory (DFT) and GIAO method with the B3PW91/6-31+G(d,p) level of calculation. The sigma calculations were made at vacuum and in presence of a solvent. The values of chemical shifts (delta), were also calculated in a different level of theory. The best results were obtained with the level of calculation DFT-GIAO/B3PW91/6-31+ G(d, p) by considering the solvent such as dimethylsulfoxide (DMSO), chloroform (CHCl3), acetone (CH3COCH3) and methanol (CH3OH). The results were interpreted in terms of calculated hardness at DFT/B3PW91/6-31+ G(d, p) level. The behaviour of the hardness was higher in the molecules of four carbons PFASA than eight carbons. This explain theoretically resistance of four carbons PFAS to be transformed into perfluorobutanesulfonate (PFBS).				1					-	-		
D141	分析	Petrick, LM; Wolff, MS; Barupal, D; Teitelbaum, SL	Comparison of untargeted and targeted perfluoroalkyl acids measured in adolescent girls	2022	Chemosphere. 2022 Mar:290:133303. doi: 10.1016/j.chemosphere.2021.133303.	Quantitative biomonitoring (e.g., targeted analysis) has served as the gold standard for environmental exposure biomonitoring for several decades. Recent advancements to broaden exposomic research brought new semi-quantitative untargeted assays that capture a wide range of endogenous metabolites and exogenous exposures in a single assay for discovery, though usually at the expense of absolute quantitation. The high-resolution mass spectrometers (HRMS) typically used in untargeted workflows are sensitive and robust, but there do not yet exist comprehensive comparisons between environmental chemicals at population exposure levels measured using targeted and untargeted assays. Using liquid chromatography (LC)-HRMS, we measured per-and polyfluoroalkyl substances (PFAS) including perfluorohexane sulfonate (PFHxS), n-perfluorooctanoic acid (PFOA), n-per-fluorooctanesulfonic acid (PFOS), and perfluorononanoic acid (PFNA) in plasma of 180 girls from New York City, and compared them to previously obtained targeted measures using correlation and rank order methods. We showed high agreement between the methods with Spearman Rhos ranging from 0.69 to 0.92 and weighted Kappa's from 0.62 to 0.82 for tertiles among the PFAS. This finding demonstrates that semi-quantitative data from untargeted assays designed for exposomics can be reliably used to estimate environmental exposures occurring in the general population, providing an economic alternative to targeted assays. We also describe an approach that can be used to compare relative quantitation measurements from an untargeted assay to tradi-tional targeted measures to establish fit-for-purpose usability and validation. These results suggest that envi-ronmental exposure measures from untargeted assays can serve as reliable inputs into statistical analysis for discovery and for determining their resultant biological impacts. Future efforts to develop new statistical ap-proaches for standardization and merging with targeted measures-toward harmonization-will further enhance the utility of untargeted assays in environmental epidemiology.			1						-	-		

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D142	分析	Zhong, ZX; Li, GK; Guo, LC; Yao, J; Liu, Z; Deng, JC	Solid-phase extraction based on amino-functionalized graphene oxide nanocomposites for analysis of short-chain perfluorinated alkyl acids in human serum by ion chromatography mass spectrometry	2018	Biomed. Chromatogr. 2018 JUL;32(7):e4223. doi: 10.1002/bmc.4223.	A highly sensitive method was developed for the analysis of short-chain perfluorinated alkyl acids (PFAAs) in serum samples using solid-phase extraction (SPE) coupled with ion chromatography-electrospray ionization-mass spectrometry. The synthesized amino-functionalized graphene oxide nanocomposites were used as an SPE sorbent for the enrichment of trace analytes and purification of samples. They exhibited high selectivity to polar compounds. The suppressor was employed to remove counterions and reduce background signals of mobile phase. These two crucial steps could effectively eliminate matrix effects and enhance analytical sensitivity. The lowest limits of quantification were 2.0gL(-1) for perfluorobutanoic acid and perfluorovaleric acid, 1.0gL(-1) for perfluorocaproic acid and 0.50gL(-1) for perfluorobutane sulfonic acid, respectively. The procedure was successfully applied for determination of trace PFAAs in 25 serum samples. Mean recoveries ranged from 86.3 to 101.4% with relative standard deviations of 1.6-6.8%. The method allowed an excellent separation and quantification of short-chain PFAAs that were difficult to analyze by conventional chromatography.	1	1		1				-	-		
D143	分析	Oro-Nolla, B; Dulsat-Masvidal, M; Bertolero, A; Lopez-Antia, A; Lacorte, S	Target and untargeted screening of perfluoroalkyl substances in biota using liquid chromatography coupled to quadrupole time of flight mass spectrometry	2023	J. Chromatogr. A. 2023 Jul:1701:464066. doi: 10.1016/j.chroma.2023.464066.	Perfluoroalkyl substances (PFAS) are known to bioaccumulate and trigger adverse effects in marine birds. This study develops an extraction and analytical methodology for the target/untargeted analysis of PFAS in eggs of Yellow-legged gull (Larus michahellis) and Audouin's gull (Larus audouinii) and blood of Greater flamingo (Phoenicopterus roseus), which are used as bioindicators of organic chemical pollution. Samples were extracted by ultrasonication with acetonitrile and cleaned-up with activated carbon, and analysis was performed by ultra-high-performance liquid chromatography coupled to a quadrupole-time of flight mass spectrometer (UHPLC-Q-TOF) with negative electrospray ionization. Data-independent acquisition (DIA) was performed through full-scan acquisition to obtain MS1 at 6 eV and MS2 at 30 eV. In a first step, quantitative analysis of 25 PFAS was performed using 9 mass-labelled internal standard PFAS and quality parameters of the method developed are provided. Then, an untargeted screening workflow is proposed using the high-resolution PFAS library database from NORMAN to identify new chemicals through accu-rate mass measurement of MS1 and MS2 signals. The method permitted to detect several PFAS at concen-trations ranging from 0.45 to 55.2 ng/g wet weight in gull eggs and from 0.75 to 125 ng/mL wet weight in flamingos' blood, with PFOS, PFOA, PFNA , PFUdA , PFTrDA , PFDoA , PFHxS and PFHpA the main com-pounds detected. In addition, perfluoro-p-ethylcyclohexylsulfonic acid (PFECHS, CAS number 646-83-3) and 2-(perfluorohexyl)ethanol (6:2 FTOH, CAS number 647-42-7) were tentatively identified. The devel-oped UHPLC-Q-TOF target/untargeted analytical approach increases the scope of PFAS analysis, enabling a better assessment on contaminant exposure and promoting the use of bird species as bioindicators of chemical pollution.			1					-	-		
D144	分析	Sznajder-Katarzynska, K; Surma, M; Wiczkowski, W; Pisku, M	Determination of perfluoroalkyl substances (PFASs) in fats and oils by QuEChERS/micro-HPLC-MS/MS	2020	Food Res. Int. 2020 Nov:137:109583. doi: 10.1016/j.foodres.2020.109583.	Per- and polyfluoroalkyl substances (PFASs) are man-made chemicals that have been identified as global lutants. Their widespread occurrence, including in food, is a potential concern for consumers. This work on the application of a simple and reliable analytical method for the simultaneous determination of fluoroalkyl acids in highly complex fatty matrices (fats and oils). The perfluoroalkyl substances were extracted by the QuEChERS method, based on the dispersive-Solid Phase Extraction using styrene-divinylbenzene sorbent, and quantitatively analysed by micro-high performance liquid chromatography tandem mass metry. Recoveries ranged from 72 to 104% with an acceptable relative standard deviation below 10%. quantification were within the range 0.002-0.075 ng/g depending on the perfluoroalkyl compound. The predominant compound in fat and oil food samples was perfluorooctanoic acid (PFOA) with a detection quency of 100%, and the highest levels were found for perfluorobutanoic acid (PFBA). The estimated exposure PFOA, which was 46% and 19% of the existing TWI for the EU and Polish population, respectively, is relatively high and indicates a potential risk to human health.	1							-	-		
D145	分析	Wang, XL; Zhang, QC; Zhao, ZY; Song, WG; Cheng, L; Yang, JH; Chen, SS; Guan, SH; Song, W; Rao, QX; Zhao, ZH	A multi-plug filtration (m-PFC) cleanup method based on carboxylic multi-walled carbon nanotubes for the detection of 14 perfluorinated compounds and dietary risk assessment of chicken, beef, and mutton collected from Shanghai markets	2021	Food Control. 2021 Dec:130:108330. doi: 10.1016/j.foodcont.2021.108330.	Dietary intake is a major pathway of human exposure to perfluorinated compounds (PFCs). Livestock and poultry meats (chicken, beef, mutton) account for a significant proportion of dietary consumption in China, and thus it is crucial to investigate the levels and composition profiles of PFCs in consumer meats to assess and mitigate potential health risks. However, rapid and simple analytical methods for such investigations are lacking. This study addresses this shortcoming by developing a rapid filtration clean-up method using carboxylic multi-walled carbon nanotubes (CMWCNTs) for the detection of 14 PFCs. Good linearities (R2 > 0.99) were obtained for all 14 PFCs in chicken, beef, and mutton. Recoveries ranged from 65 to 145% (except perfluorotetradecanoic acid, PFTeDA) with relative standard deviations (RSDs) lower than 16%. Method limits of detection (LODs) were between 0.12 and 0.83 ng g- 1d.w. Subsequently, this method was applied for the analysis of 46 livestock and poultry meat samples collected from markets in Shanghai. PFCs were detected in all samples with total concentrations of 1.61-4.27 ng g-1 wet weight (w.w) in chicken, 1.51-5.56 ng g-1 w.w in beef and 1.61-8.15 ng g-1 w.w in mutton. Perfluorooctanoic acid (PFOA) and perfluorobutanoic acid (PFBA) were the predominant compounds in these samples and accounted for over 92% of sigma PFCs. For regulated compounds such as PFOA, risk quotients (RQs) were determined to be much lower than 1. This suggests that chicken, beef, and mutton from Shanghai market pose very low PFC exposure risk to residents. However, high detection frequency of the unregulated PFBA demands further investigation of short-chain PFCs in consumer meats.	1							-	-		
D146	分析	Llorca, M; Farre, M; Pico, Y; Barcelo, D	Development and validation of a pressurized liquid extraction liquid chromatography-tandem mass spectrometry method for perfluorinated compounds determination in fish	2009	J. Chromatogr. A 2009 Oct:1216(43):7195-7204. doi: 10.1016/j.chroma.2009.06.062.	This paper describes the development and validation of an analytical methodology to determine eight perfluorinated compounds (PFCs) in edible fish using pressurized liquid extraction (PLE) with water and solid-phase extraction (SPE) with an ion-exchanger as extraction and pre-concentration procedures, followed by liquid chromatography-cluadi-upole-linear-ion trap mass spectrometry (LC-QqLIT-MS). The rapidity and effectiveness of the proposed extraction Procedure were compared with those most commonly used to isolate PFCs from fish (ion-pairing and alkaline digestion). The average recoveries of the different fish samples, spiked with the eight PFCs at three levels (the LOQ, 10 and 100 mu g kg(-1) of each PFC), were always higher than 85% with relative standard deviation (RSD) lower than 17%. A good linearity was established for the eight PFCs in the range from 0.003-0.05 to 100 mu g kg(-1), with r>0.9994. The limits of quantification (LOQs) were between 0.003 and 0.05 mu g kg(-1), which are well below those previously reported for this type of samples. Compared with previous methods, sample preparation time and/or LOQs are reduced. The method demonstrated its successful application for the analysis of different parts of several fish species. Most of the samples tested positive, mainly for perfluoropentanoic acid (PFPA), perfluorobutane sulfonate (PFBS) and perfluorooctanoic acid (PFOA) but other of the eight Studied PFCs were also present.				1				-	-		
D147	分析	Li, YL; Gao, K; Duo, B; Zhang, GS; Cong, ZY; Gao, Y; Fu, JJ; Zhang, AQ; Jiang, GB	Analysis of a broad range of perfluoroalkyl acids in accipiter feathers: method optimization and their occurrence in Nam Co Basin, Tibetan Plateau	2018	Environ. Geochem. Health. 2018 Oct:40(5):1877-1886. doi: 10.1007/s10653-017-9948-z.	Perfluoroalkyl acids (PFAAs) are ubiquitous in the environment. They are prone to accumulate in organisms and have raised public attention in recent decades. Feather samples have been successfully applied as nondestructive indicators for several contaminants. However, a sophisticated analytical method for determining PFAAs in feathers is still lacking. In the present study, a series of conditions, such as the use of the solid-phase extraction cartridge type and extraction/digestion methods, were optimized for the analysis of 13 PFAAs in feathers. According to the spiked recoveries, a weak-anion exchange cartridge was chosen and the methanol was selected as the extraction solvent. In the present study, an optimized pretreatment procedure combined with high-performance liquid chromatography-electrospray ionization-tandem mass spectrometric (HPLC-ESI-MS/MS) method was established for the determination of PFAAs in feathers. The recoveries and method detection limits of the PFAAs ranged from 71 to 120% and 0.16 to 0.54 ng/g, respectively. Finally, 13 PFAAs in four accipiter feather samples from Nam Co Basin, Tibetan Plateau, were analyzed, indicating that PFOS was the predominant PFAA in accipiter feathers, with an average of 4.67 ng/g, followed by the short-chain PFAAs, PFBS and PFBA, with averages of 1.91 and 1.39 ng/g, respectively. These results partly indicated the current situation of PFAA pollution in the Nam Co Basin, especially the existence of short-chain PFAAs in this region.	1			1				-	-		
D148	分析	Li, F; Zhang, CJ; Chen, J; Qu, Y; Zhou, Q	Determination and Elimination of Matrix Effect in Analysis of Perfluorinated Acids Using High Performance Liquid Chromatography-Negative Electrospray Tandem Mass Spectrometry	2009	2009 3RD INTERNATIONAL CONFERENCE ON BIOINFORMATICS AND BIOMEDICAL ENGINEERING, VOLS 1-11. 2009, 5378-5381	Matrix effects, ionization enhancement or suppression, are always possible with the electrospray ionization technique and can significantly hamper the analysis of PFAs in complex environmental matrixes. The objective of this study is to determine and eliminate the matrix effects in analysis of sewage using high performance liquid chromatography-negative electrospray tandem mass spectrometry (HPLC-negative ESI-MS/MS). Standard addition, which involves spiking successive known quantities of a standard into the sample extracts and reanalyzing, are used for determination of the matrix effects, while correction using isotopically labeled internal standards and clean-up of sample extracts using dispersive carbon sorbent are used for elimination of matrix effects. The results indicate that ultra-short- (C2-3) and long-chain PFCAs (>C10) suffer ionization suppression, while medium-chain PFCAs (C4-10) and PFBS experience ionization enhancement; however, PFHxS and PFOS do not suffer significant matrix effects. Although internal standards, MPFOA and MPFOS, can effectively negate matrix effects for medium-chain PFCAs (C7-10), they are not suitable for some short- (C10 PFCAs), which are eluted significantly earlier or later than their retention times, respectively. However, matrix effects of all analytes are significantly naegated by dispersive carbon sorbent because it can effectively remove the co-eluting interference compounds from SPE elution but not affect PFAs.				1				-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D149	分析	Rahman, MF; Anderson, WB; Peldszus, S; Huck, PM	Ion-Exchange Treatment of Perfluorinated Carboxylic Acids in Water: Comparison of Polystyrenic and Polyacrylic Resin Structures and Impact of Sulfate on Their Performance	2022	ACS ES T Water. 2022 Jul 8;2(7):1195-1205. doi: 10.1021/acsestwater.1c00501.	The removal of three perfluorinated carboxylic acids (PFCAs)-PFHpA, PFOA, and PFNA-in ultrapure and river water was evaluated using two anion-exchange resins-previously unreported macroporous polystyrenic A-500P and a more widely studied macroporous polyacrylic A-860. Both resins had similar properties, allowing direct comparison of PFCA removal performance between the two resin structures/matrices. This study also presents a new gas chromatography-mass spectrometry (GC/MS) method developed for PFCA analysis in water. In ultrapure water, A-500P exhibited higher removal capacity and faster removal compared to A-860, suggesting greater effectiveness of the polystyrenic structure compared to the polyacrylic structure. In the Grand River water, the target PFCAs were well removed by A-500P but not A-860. However, both resins achieved similarly high overall reductions of dissolved organic carbon (similar to 75%), suggesting, later confirmed in ultrapure water experiments, that inorganic anions (sulfate particularly) were competitors for the A-860 resin. The uncharged styrene and acrylic beads (base materials) of the two tested resins remove PFOA, implying that the dominant removal mechanism involves charge interactions between the negatively and the positively charged anion-exchange functional groups.			1					-	-		
D150	分析	Running, L; Atilla-Gokcumen, GE; Aga, DS	Development of a Liquid Chromatography-Mass Spectrometry-Based In Vitro Assay to Assess Changes in Steroid Hormones Due to Exposure to Per- and Polyfluoroalkyl Substances	2022	Chem. Res. Toxicol. 2022 Jul:35(7):1277-1288. doi: 10.1021/acs.chemrestox.2c00116.	Per- and poly-fluorinated substances (PFASs) are organic pollutants that have been linked to numerous health effects, including diabetes, cancers, and dysregulation of the endocrine system. This study aims to develop a liquid chromatography with tandem mass spectrometry (LC-MS/MS) assay to measure changes in 17 hormones in H295R cell line (a steroid producing adrenocortical cells) upon exposure to PFASs. Due to the challenges in the analysis of steroid hormones using electrospray ionization MS, a chemical derivatization method was employed to achieve 0.07-2 mu g/L detection limits in LC-MS/MS. Furthermore, a 10-fold concentration factor through solid-phase extraction (SPE) allows for consistent sub-parts per billion detections. Optimization of the derivatization conditions showed doubly-derivatized products in some hormone analytes, including progesterone, corticosterone, and cortisol, and gave improved ionization efficiency up to 20-fold higher signal than the singly-derivatized product. The use of SPE for sample cleanup to analyze hormones from cellular media using weak anion exchange sorbent yielded 80-100% recovery for the 17 targeted hormones. The method was validated by exposing H295R cells to two known endocrine disruptors, forskolin and prochloraz, which showed expected changes in hormones. An initial exposure of H295R cells with various PFAS standards and their mixtures at 1 mu M showed significant increases in progestogens with some PFAS treatments, which include PFBS, PFHxA, PFOS, PFDA, and PFDS. In addition, modest changes in hormone levels were observed in cells treated with other sulfonated or carboxylated headgroup PFASs. This sensitive LC-MS/MS method for hormone analysis in H295R cells will allow for the investigations of the alterations in the hormone production caused by exposure to various environmental insults in cell-based assays and other in vitro models.		1		1				-	-		
D151	分析	Muschket, M; Keltsch, N; Paschke, H; Reemtsma, T; Berger, U	Determination of transformation products of per- and polyfluoroalkyl substances at trace levels in agricultural plants	2020	J. Chromatogr. A. 2020 Aug:1625:461271. doi: 10.1016/j.chroma.2020.461271.	Per- and polyfluoroalkyl substances (PFASs) are ubiquitous in the environment. However, only a limited number of predominantly persistent perfluoroalkyl acids (PFAAs) have been analyzed in edible plants so far. We present a generic trace analytical method that allows for quantification of 16 intermediate fluorotelomer alcohol (FTOH)- or perfluoroalkane sulfonamidoethanol (FASE)-based transformation products as well as 18 PFAAs in plants. Additionally, 36 suspected intermediate PFAS transformation products were qualitatively analyzed. The ultrasound-assisted solid-liquid extraction of wheat and maize grain, maize leaves, Jerusalem artichoke and ryegrass (1-5 g plant sample intake) was followed by a clean-up with dispersive solid-phase extraction using graphitized carbon adsorbent (5-10 mg per sample) and chemical analysis by reversed phase liquid chromatography-tandem mass spectrometry. The method was based on matrix matched and extracted calibration and displayed good precision with relative standard deviations in triplicate analyses typically below 15% for all quantified analytes and matrices. An average deviation of 12% between quantified concentrations obtained by matrix matched and extracted calibration and a method based on isotopically labelled internal standards underlines the good trueness of the method. The method quantification limits for the majority of analytes in all plant samples were in the low ng/kg concentration range on a dry weight basis. Plant matrices were analyzed from crops grown on agricultural fields that have been contaminated with PFASs. FTOH- and/or FASE-based intermediate transformation products were detected in all samples with N-ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA) and perfluorooctane sulfonamide (FOSA) as the prevailing compounds in concentrations up to several hundred ng/kg in maize leaves. The 9:3 Acid (a transformation product of 10:2 FTOH) was tentatively identified. In accordance with these findings, the final degradation products perfluorooctane sulfonic acid (PFOS) and perfluorodecanoic acid (PFDA) were frequently detected. For perfluoroalkyl carboxylic acids (PFCAs), according to earlier findings, short chain homologues generally displayed the highest levels (up to 98 pg/kg for perfluorobutanoic acid (PFBA) in maize leaves). However, maize grain was an exception showing the highest concentrations for long chain PFCAs, whereas PFBA was not detected. The uptake of high levels of PFASs into plants is of concern since these may be used as animal feed or represent a direct exposure medium for humans.	1							-	-		
D152	分析	Scott, BF; Moody, CA; Spencer, C; Small, JM; Muir, DCG; Mabury, SA	Analysis for perfluorocarboxylic acids/anions in surface waters and precipitation using GC-MS and analysis of PFOA from large-volume samples	2006	Environ. Sci. Technol. 2006 Oct:40(20):6405-6410. doi: 10.1021/es061131o.	The presence of perfluorocarboxylates (PFCAs) in the environment is of increasing concern, following the discovery of perfluoroalkyl acids (PFAs) in wildlife and human samples. Here we report a method for the determination of (C-2-C-9) PFCAs by preparing the 2,4-difluoroanilides of the acids and analyzing by using GC-MS. Detector response was linear over the range 0.1-1000 pg of each perfluoroalkyl anilide. A complete suite of PFCAs can be analyzed in an individual sample with the PFCAs detected at levels similar to or lower than those determined by other methods. For a comparison between the present method and the more common LC-MS/MS method, 10 replicates of a sewage treatment plant discharge were analyzed for perfluorooctanoic acid (PFOA) using both methods. Results were nearly identical with low standard deviation (GC-MS 30.9 +/- 1.88 ng/L; while the LC-MS/ MS 34.7 +/- 3.05 ng/L). PFCA concentrations for water samples collected from depth profiles in mid-Lake Ontario were analyzed by GC-MS with most PFCAs (C-2-C-8) present above the detection limit (0.5 ng/L). Major PFCAs were trifluoroacetate (TFA) (100 ng/L) and perfluorobutanoate (PFBA) (> 5 ng/L). Results for PFOA (2.5 ng/L) were in good agreement with recent analyses by LC-MS/ MS. PFCAs were also detected in the precipitation samples at concentrations lower than those of the samples from the lake profiles or sewage treatment plants (STPs) effluent. Since PFOA levels may be less than the lower detection limit (< 0.5 ng/L) in 1 L samples, a method for large volumes using XAD-7 resin was developed that allows detection to 0.01 ng/L. This method was applied to Lake Superior samples which produced good agreement for C-6-C-9 PFCAs between regular analysis (GC-MS) and the XAD-7 followed by GC-MS analysis.	1							-	-		
D153	分析	Kaupmees, S; Rebane, R	Analysis and validation of perfluorinated compounds in water, sediment and fish with LC-ESI-MS/MS	2017	Int. J. Environ. Anal. Chem. 2017;97(8):695-709. doi: 10.1080/03067319.2017.1356922.	The analysis of perfluorinated compounds (PFCs) in environmental matrices is challenging, as the concentrations are generally low, but the risk of contamination is high. Sample preparation is a critical step and it is necessary to minimise the possibility of contamination. In this study, we successfully applied and validated a modified ion pair extraction method to quantify PFCs in sediment and fish samples. A large volume injection method was validated and used to quantify PFCs in different water matrices. Isotope internal standard of every analyte was applied to correct matrix effects. The recoveries of the analytes were 92-106% for water matrix, 93-119% for fish matrix and 86-103% for soil matrix whereas the achieved limit of quantitation values were 1.3-14.9ng/L for water, 0.19-0.28g/kg for fish and 0.14-0.41 for soil samples. Thirty-one surface water, 8 stormwater and 41 sediment samples collected all over Estonia were analysed and 4 (out of 8 analysed) PFCs were found in quantitative amount. The most frequently detected analyte perfluorobutanoic acid (PFBA) was found in 26% of the water samples with a maximum concentration of 137ng/L.	1							-	-		
D154	分析	Woudneh, MB; Chandramouli, B; Hamilton, C; Grace, R	Effect of Sample Storage on the Quantitative Determination of 29 PFAS: Observation of Analyte Interconversions during Storage	2019	Environ. Sci. Technol. 2019 Nov:53(21):12576-12585. doi: 10.1021/acs.est.9b03859.	In this study, we measured the effects of sample type and storage temperature on the stability of 29 per- and polyfluorinated alkyl substances (PFAS) in water. Spiked bottled water, surface water, and two types of effluent samples were stored in HDPE containers at +20, 4, and -20 degrees C over a period of up to 180 days. The analytes studied included C-4 through C-14 perfluorinated carboxylates (PFCAs); C-4 through C-10 and C-12 perfluorinated sulfonates (PFSAs); 4:2, 6:2, and 8:2 fluorotelomer sulfonates (FTS); three perfluorooctane sulfonamides (PFOSA, N-MeFOSA, and N-EtFOSA); two perfluorooctane sulfonamide ethanols (N-MeFOSE and N-EtFOSE); and two perfluorooctane sulfonamide acetic acids (N-MeFOSAA and EtFOSAA). Overall, 10 analytes, PFOA, PFNA, 8:2 FTS, PFOSA, N-MeFOSA, NEtFOSA, N-MeFOSAA, N-EtFOSAA, N-MeFOSE, and N-EtFOSE, showed increasing or decreasing concentration trends under at least one of the experimental conditions investigated. Increases in concentrations of N-MeFOSAA and N-EtFOSAA in surface water and effluent samples at +20 and 4 degrees C correlated with the decreases in the concentrations of N-MeFOSE and N-EtFOSE, respectively, suggesting analyte interconversion during sample storage. This is the first time such analyte conversion is reported in samples under storage, and this work demonstrates the importance of assessing stability of PFAS in environmentally relevant matrices. The significance of this study extends beyond sample storage for analysis, as toxicological and exposure studies conducted at room temperature also need to consider the significance of analyte degradation through the exposure process.			1					-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D155	分析	Cody, R; Maleknia, SD	Coated glass capillaries as SPME devices for DART mass spectrometry	2020	Rapid Commun. Mass Spectrom. 2020 DEC 15;34(23):e8946. doi: 10.1002/rcm.8946.	Rationale Solid-phase microextraction (SPME) provides high-throughput sample cleanup and pre-concentration. Here we demonstrate coated glass capillaries (CGCs) as SPME devices for specific applications in direct analysis in real time (DART) mass spectrometry, referred to as CGC-DART, for rapid screening of environmental contaminants at low parts-per-trillion detection limits and with accurate identification of analytes. Methods The extraction is performed in a one-step process in minutes by dipping the CGC in solutions containing the analytes, and then placing the CGC in a DART source for analysis. CGCs are disposable and relatively inexpensive in comparison with SPME devices, and can be prepared with hydrophobic, hydrophilic or mixed-mode materials similar to SPME. CGCs were prepared by adsorption coating with incubation of capillaries in saturated solutions of octadecylamine or covalent activation of silanes. Results Quantitation is shown with perfluorooctanoic acid (PFOA) at 1 ppt to 100 ppb, with the lowest detection at 500 parts-per quadrillion (ppq) in tap water. One-step extraction of contaminated groundwater from Northern Queensland, Australia, revealed perfluorooctane sulfonate (PFOS) and perfluorohexanesulfonamide as well as C4-C8 perfluoroalkyl carboxylic acids. A soil sample taken near a former military air base (New Hampshire, USA) revealed the presence of perfluorononanoic acid (PFNA) at 1 ppb and traces of perfluoroheptanoic acid. Conclusions CGC-DART enabled one-step extraction of PFASs in minutes with mL sample volumes at low concentrations as shown for the standards and contaminated soil and water samples. DART-MS combined with Kendrick mass defect analysis enabled accurate identification of PFASs without chromatography steps, as fluorinated compounds are mass deficient and easily distinguished over background signal.			1					-	-		
D156	分析	Theurillat, X; Mujahid, C; Eriksen, B; Griffin, A; Savage, A; Delatour, T; Mottier, P	An LC-MS/MS method for the quantitative determination of 57 per- and polyfluoroalkyl substances at ng/kg levels in different food matrices	2023	Food Addit. Contam. Part A-Chem. 2023 Jul:40(7):862-877. doi: 10.1080/19440049.2023.2226771.	To enable the monitoring of a wide scope of per- and polyfluoroalkyl substances (PFAS) in the ng/kg level in foodstuffs, an LC-MS/MS method comprising 57 analytes was developed and validated in seven different matrices (milk powder, milk-based infant formula, meat-based baby food puree, fish and fish oil, fresh egg, and soluble coffee). The analytical approach was based on an acetonitrile:water extraction followed by solid phase extraction clean-up with subsequent quantification of the extracted analytes either by isotope dilution (55 compounds) or by standard addition (2 compounds) mass spectrometry. The validation criteria followed the guidance document for the analysis of PFAS issued by the European Union Reference Laboratory for Halogenated Persistent Organic Pollutants. The lowest limits of quantification (LOQs) for the four recently regulated compounds (L-PFOS, PFOA, PFNA, L-PFHxS) were set at 0.010 & mu;g/kg in baby and infant foods (as sold) but also in dairy ingredients. Exception was for PFOA in milk powder due to too large variability in the repeatability. Applicability of the method was further demonstrated in 37 commodity check matrices. Overall validation data demonstrated the robustness of the method for most of the compounds and the LOQs achieved were low enough to ensure compliance with Commission Regulation EU 2022/2388 but also to support future collection of occurrence data in ng/kg level in food.			1					-	-		
D157	分析	Edmiston, PL; Hill, N; Hershberger, R; Hartmann, H; Carter, E; Divine, C	Laboratory validation of an integrative passive sampler for per- and polyfluoroalkyl substances in water	2023	Environ. Sci.-Wat. Res. Technol. 2023 Jun:9(7):1849-1861. doi: 10.1039/d3ew00047h.	A passive sampler for per- and polyfluoroalkyl substances (PFAS) in water has been developed which uses a porous organosilica adsorbent. Some performance characteristics, which remained incompletely answered after prior lab- and field-based testing, were assessed. The integrated response mode of the sampler was verified in bench-scale experiments where the aqueous phase concentration was varied 50-fold in the flow across passive samplers. It was found that the passive samplers were able to accumulate analytes and provide an accurate time-averaged concentration in situations where the PFAS concentration changed significantly over time. The integrated response is facilitated by an average 40-fold slower back diffusion rate compared to PFAS adsorption rates, attributed to in-particle diffusion. The maximum deployment time was assessed using a multi-month laboratory-based sampling event. It was found that the integrated response was maintained over 90 days except for perfluorobutanoic acid (PFBA) and perfluorodecanoic acid (PFDA) where adsorption reached equilibrium after 45 and 60 days of total sampling time, respectively. The mechanism of PFAS adsorption was explored using a column breakthrough curve in combination with previously reported adsorption isotherm data. The use of isotopic dilution for PFAS measurement was studied by measuring the adsorption, recovery, and stability of mass labeled surrogates in laboratory analysis. Surrogates were quantitatively bound and determined to be stable for at least 4 weeks in the adsorbed state. Sampling rates for EPA Method 1633 compounds N-methyl perfluorooctanesulfonamidoacetic acid and N-methyl perfluorooctanesulfonamide were also measured, expanding the existing sampling rate database to a total of 21 PFAS species.	1							-	-		
D158	分析	Fang, Z; Li, Y; Li, YY; Yang, DX; Zhang, H; Jones, KC; Gu, C; Luo, J	Development and Applications of Novel DGT Passive Samplers for Measuring 12 Per- and Polyfluoroalkyl Substances in Natural Waters and Wastewaters	2021	Environ. Sci. Technol. 2021 Jul:55(14):9548-9556. doi: 10.1021/acs.est.0c08092.	Extensive and long-term use of per- and polyfluoroalkyl substances (PFASs) has caused their widespread distribution in aquatic systems. A new diffusive gradients in thin-films (DGT) passive sampling method based on weak anion exchanger (WAX) binding layer is developed here for monitoring five perfluoroalkyl carboxylic acids (PFCAs), five perfluoroalkanesulfonic acids (PFSAs) and two PFASs (6:2 FTSA and GenX) in waters. Performance of WAX-DGTs was independent of environmental conditions, namely pH (3.03-8.96), ionic strength (1-500 mM), and DOM content (4-30 mg L-1). Diffusion coefficients (D) of the 12 PFASs in the diffusive gels were measured, 9 for the first time. Linear correlations between D and perfluoroalkyl chain lengths (CF2) were established to obtain D for congener chemicals with the similar functional group and structure. The binding capacity of the WAX-DGT sampler was at least 440 mu g PFASs per sampler, sufficient for applications in waters across a wide range of conditions and PFASs concentrations. Successful applications of WAX based DGT samplers in a wastewater treatment plant (P) and three rivers has demonstrated that DGT is a powerful tool for monitoring, surveillance and research of these 12 PFASs in aquatic systems, and can be extended to wider suites of PFs in future.					1			-	-		
D159	分析	Skaggs, CS; Logue, BA	Ultratrace analysis of per- and polyfluoroalkyl substances in drinking water using ice concentration linked with extractive stirrer and high performance liquid chromatography-tandem mass spectrometry	2021	J. Chromatogr. A. 2021 Dec:1659:462493. doi: 10.1016/j.chroma.2021.462493.	Detection of drinking water contaminants is vital to the protection of human health. One group of contaminants that have recently generated serious concerns over health risks are per- and polyfluoroalkyl substances (PFAS). These compounds are very bio-persistent, leading to their detection in all types of water sources, including drinking water. While analysis of drinking water for PFAS is important, it is currently arduous to detect ultratrace levels of these contaminants. Specifically, current ultratrace PFAS analysis methods are difficult, costly, require large sample volumes, and consume relatively large volumes of organic solvent. In the present work, an analytical method using Ice Concentration Linked with Extractive Stirrer (ICECLES) and high performance liquid chromatography-tandem quadrupole mass spectrometry (HPLC-MS/MS), was developed and validated to provide simple and ultratrace analysis of drinking water for 14 PFAS. The method featured a relatively low sample volume requirement (10 mL), automated extraction, minimal matrix effects, and minimal organic solvent use (i.e., the method requires only 50 mu L of methanol per sample). The method produced a wide linear range of 0.5 to 500 ng/L, ultratrace limits of detection (0.05 to 0.3 ng/L), and good accuracy and precision (i.e., 87 to 108% accuracy and = 19% relative standard deviation as a measure of precision). This method was tested on drinking water samples from across the United States and detected at least one PFAS compound in 52 of the 53 drinking water samples tested. Perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA), and perfluoroheptanoic acid (PFHpA) were detected in 89, 96, and 77% of the samples tested with maximum concentrations of 268 ng/L for PFHxA, 213 ng/L for PFOA, and 75.7 ng/L for PFHpA. Additionally, perfluorononanoic acid, perfluorodecanoic acid, and perfluoroheptanoic acid were each detected in at least one drinking water sample at concentrations > 20 ng/L. The availability of the method presented here allows ultratrace detection of PFAS while circumventing many of the disadvantages of current methods.		1	1					-	-		
D160	分析	Rawn, DFK; Menard, C; Feng, SY	Method development and evaluation for the determination of perfluoroalkyl and polyfluoroalkyl substances in multiple food matrices	2022	Food Addit. Contam. Part A-Chem. 2022 Apr:39(4):752-776. doi: 10.1080/19440049.2021.2020913.	A method for the determination of 21 perfluorinated and 10 polyfluorinated alkyl substances (PFAS) was developed for application in different food matrices. Acetonitrile was used as the extraction solvent with solid phase extraction weak anion-exchange (SPE-WAX) clean up, with LC-MS/MS analysis using both surrogate and performance standards to correct for losses during sample preparation and matrix effects. The method has been evaluated in four different matrices (fish, pizza, chicken nuggets and spinach). Originally, the focus was to develop a method for foods commonly thought to be a source of PFASs (e.g. fish). It was expanded to include foods where PFAS exposure would be possible through their presence in grease-proof food packaging (e.g. pizza, chicken nuggets). Vegetables (lettuce) and fruit (tomato) have recently been considered as part of proficiency testing programmes, so the inclusion of some testing in a vegetable matrix (i.e. spinach) was also added to the testing. Limits of quantification ranged from 0.018 ng g(-1) (L-PFDS) to 5.28 ng g(-1) (FHEA), although method quantification limits for PFBA (12.4 ng g(-1)), 6:2 PAP (8.96 ng g(-1)) and 8:2 PAP (3.49 ng g(-1)) were elevated above instrumental limits owing to their consistent detection in reagent blank samples. PFAS analyses were strongly impacted by matrix, therefore the use of isotopically labelled internal standards was critical to the development of accurate results. The accuracy of the method using numerous proficiency testing schemes or interlaboratory comparison studies has shown the developed method to be successful with z-scores for all concerned analytes in all test matrices remaining within +/- 2.0, with the exception of PFBA in wheat flour which was -2.4.	1							-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D161	分析	Jacob, P; Barzen-Hanson, KA; Helbling, DE	Target and Nontarget Analysis of Per- and Polyfluoralkyl Substances in Wastewater from Electronics Fabrication Facilities	2021	Environ. Sci. Technol. 2021 Feb:55(4):2346-2356. doi: 10.1021/acs.est.0c06690.	The goals of this study were to improve our understanding of the types of per- and polyfluoroalkyl substances (PFASs) that occur in wastewater from electronics fabrication facilities (labs) and to assess the relative concentrations of PFAS species. We collected wastewater samples from three fabs in the United States, analyzed the samples by means of high-resolution mass spectrometry, and implemented complementary target and nontarget analyses. Twelve of 25 target PFASs were quantified in at least one sample, and five perfluorocarboxylates and perfluorobutane sulfonate (PFBS) were quantified in all samples. PFBS was quantified at the highest concentration among the samples (8040 ng L-1) and we expect that its presence is related to the use of photoacid generators during photolithography. The sum concentrations of the target PFASs in the diluted discharge samples from each fab were 623, 394, and 376 ng L-1. Nontarget analysis revealed the presence of 41 homologous series of PFASs comprising 133 homologues. We proposed structures for 15 homologous series of nontarget PFASs, six of which are reported here for the first time. Using an approach for semiquantification of nontarget PFASs, we estimated that the sum concentrations of target and nontarget PFASs in the diluted discharge samples from each fab were 1490, 78 700, and 2170 ng L-1.Our findings are essential for developing alternative photolithography chemicals or informing the implementation of advanced wastewater treatment technologies at fabs.				1				-	-		
D162	分析	Wolf, ST; Reagen, WK	Method and validation for the analysis of perfluorinated compounds in water by pre-sampling isotope dilution-direct injection-LC/MS/MS	2013	Anal. Methods. 2013 :5(10):2444-2454. doi: 10.1039/c3ay26347a.	A pre-sampling isotope dilution-direct injection-liquid chromatography tandem mass spectrometry (DI-LC/MS/MS) analytical method for the analysis of perfluorinated compounds (PFCs) in water is presented. This pre-sampling isotope dilution method incorporates stable isotope internal standards (ISs) and surrogate recovery standards (SRSs) added to sample bottles prior to sample collection. Pre-sampling isotope dilution corrects for PFC adsorption losses and enables a simple quantitative DI-LC/MS/MS water method with a 28 day sample holding time. Method analytes include perfluorinated carboxylic acids (PFCAs) (C4-C12), perfluorinated sulfonic acids (PFSAs) (C4, C6, and C8), perfluorooctane sulfonamide (PFOSA), and four SRSs ([2,3,4-C-13(3)]PFBA, [1,2,3,4-C-13(4)]PFOA, [1,2,3,4-C-13(4)]PFOS, and [1,2-C-13(2)]PFUnA). At 28 day sample holding times, mean recoveries of laboratory reagent water samples (Milli-Q (TM) water containing hardness at 165 mg equivalent CaCO3 L-1) fortified with the PFC method analytes at 0.2-40 ng mL(-1) (0.1-1 ng mL(-1) SRSs) are 94.9-115% with relative standard deviations of 0.97-7.9%. At 28 day sample holding times in fortified laboratory reagent water samples, single laboratory lowest concentration minimum reporting levels of 0.010-0.020 ng mL(-1) (0.075 ng mL(-1) PFBA) are demonstrated for method analytes and SRSs. Method applications to synthetic chlorinated drinking water samples and three environmental sample matrices are presented that demonstrate method ruggedness. Mean recoveries of synthetic chlorinated drinking water samples fortified with the PFC method analytes at 0.1-10 ng mL(-1) and SRSs at 0.1-1 ng mL(-1) are 97.8-113% with relative standard deviations of 2.0-18%. Mean recoveries and relative standard deviations in environmental groundwater samples, production facility non-contact cooling water effluent samples, and production facility wastewater treatment effluent samples fortified with the PFC method analytes at 0.25-2.5 ng mL(-1), 0.25-10 ng mL(-1), 0.25-50 ng mL(-1) respectively and SRSs at 0.1 ng mL(-1) are 100 +/- 7.7% (RSD +/- 12%, PFBA +/- 23%), 100 +/- 5.5% (RSD +/- 11%), 100 +/- 5.2% (RSD +/- 11%) respectively. Excellent method correlation was obtained with USEPA Method 537 in a comparative analysis of synthetic chlorinated drinking water samples aged 7 days and fortified with C6-C12 PFCAs and C4, C6, and C8 PFSAs, and three SRSs [C-13(4)] PFOA, [C-13(2)] PFUnA, and [C-13(4)] PFOS at 0.1 ng mL(-1). The average absolute difference between the EPA Method 537 and DI-LC/MS/MS measurements for the method analytes and SRSs was 8%.	1							-	-		
D163	分析	Yin, MY; Che, LH; Jiang, SZ; Deng, QL; Wang, S	Sensing of perfluorinated compounds using a functionalized tricolor upconversion nanoparticle based fluorescence sensor array	2020	Environ. Sci.-Nano. 2020 Oct:7(10):3036-3046. doi: 10.1039/d0en00554a.	Detection and identification of perfluorinated compounds (PFCPs) plays a crucial role in environmental monitoring, food safety and public health. Fluorescence sensor arrays with multiple cross-reactive receptors can offer a highly effective approach for the purpose. Herein, we constructed an upconversion fluorescence sensor array based on perfluorooctyltriethoxysilane functionalized lanthanide-doped tricolor nanoparticles. The significant signal difference of probes toward targets endows such a sensor array an excellent discrimination property. The clustering map and dendrogram for identifying seven species of PFCPs (including perfluorooctanesulfonate potassium, perfluorodecanoic acid, perfluorononanoic acid, perfluorooctanoic acid, perfluoroheptanoic acid, perfluorohexanesulfonic acid potassium, and perfluorohexanoic acid) were obtained by linear discriminant analysis (LDA) and hierarchical clustering analysis (HCA), respectively. The resulting fluorescence sensor array displayed sensitive response to targets even at a low level (40 nM). Blends of PFCPs could be identified accurately. Furthermore, PFCPs in real samples (tap water, surface seawater, river water and food packaging) have been effectively discriminated with 92.9% accuracy. The developed upconversion fluorescence sensor array provides a powerful tool for high-throughput identification of PFCPs in food and environmental samples, which overcomes the time-consuming complex analysis and heavy dependence of specific recognition elements.		1	1					-	-		
D164	分析	Lashgari, M; Basheer, C; Lee, HK	Application of surfactant-templated ordered mesoporous material as sorbent in micro-solid phase extraction followed by liquid chromatography-triple quadrupole mass spectrometry for determination of perfluorinated carboxylic acids in aqueous media	2015	Talanta 2015 Aug:141:200-206. doi: 10.1016/j.talanta.2015.03.049	In the present study, micro-solid phase extraction (mu-SPE) followed by liquid chromatography-triple tandem mass spectrometery (LC-MS/MS) was developed for the determination of perfluorocarboxylic acids (PFCAs) at trace levels in water samples. The mu-SPE device comprised of a porous polypropylene membrane bag containing 5 mg sorbent. The membrane bag acted as a clean-up filter and prevented matrix compounds from interfering with the extraction process. Analysis was carried out by LC-MS/MS in negative electrospray ionization mode. MS/MS parameters were optimized for multiple reaction monitoring. Calcined and non-calcined MCM-41, as silica-ordered mesoporous materials, were used as sorbents in mu-SPE for the extraction of five PFCAs-perfluoropentanoic acid (PFPA), perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA)-from aqueous media. The performances of these two sorbents were compared with other sorbents such as octadecylsilane (C18) modified silica, HayeSep-A, HayeSep-B, and Porapak-R. It was found that non-calcined MCM-41 showed better extraction performance for the analytes considered. Parameters influencing extraction efficiency, such as desorption time, extraction time, desorption solvent, and salt concentration, were investigated. The effect of the matrix on MS signals (suppression or enhancement) was also evaluated. Only minor effects on ionization efficiencies were observed. The developed method proved to be convenient and offered good sensitivity and reproducibility. The limits of detection ranged from 0.02 to 0.08 ng L-1, with a relative standard deviations between 1.9 and 10.5. It was successfully applied to the extraction of PFCAs in river and rain water samples. As expected from the ubiquitous nature of PFCAs, contamination at low levels was detected for some analytes in the samples (with the highest concentration recorded for PFOA). Satisfactory relative recoveries ranging between 64% and 127% at spiking levels of 10 ng L-1 of each analyte were obtained.			1					-	-		
D165	分析	Gallocchio, F; Moressa, A; Zonta, G; Angeletti, R; Lega, F	Fast and Sensitive Analysis of Short- and Long-Chain Perfluoroalkyl Substances in Foods of Animal Origin	2022	Molecules. 2022 Nov;27(22):7899. doi: 10.3390/molecules27227899.	The availability of sensitive analytical methods to detect per- and polyfluoroalkyl substances (PFASs) in food of animal origin is fundamental for monitoring programs to collect data useful for improving risk assessment strategies. The present study aimed to develop and validate a fast and sensitive method for determining short and long-chain PFASs in meat (bovine, fish, and swine muscle), bovine liver, hen eggs, and cow's milk to be easily applicable in routine analysis of food. A QuEChERS extraction and clean-up method in combination with liquid chromatography coupled to mass spectrometry (LC-MSMS) were used. The method resulted in good linearity (Pearson's R > 0.99), low limits of detection (7.78-16.35 ng/kg, 8.26-34.01 ng/kg, 6.70-33.65 ng/kg, and 5.92-19.07 ng/kg for milk, liver, egg, and muscle, respectively), and appropriate limits of quantification (50 ng/kg for all compounds except for GenX and C6O4, where the limits of quantification were 100 ng/kg). Trueness and precision for all the tested levels met the acceptability criteria of 80-120% and <= 20%, respectively, regardless of the analyzed matrix. As to measurement uncertainty, it was <50% for all compound/matrix combinations. These results demonstrate the selectivity and sensitivity of the method for simultaneous trace detection and quantification of 14 PFASs in foods of animal origin, verified through the analysis of 63 food samples.					1			-	-		
D166	分析	Tang, SP; Qin, XH; Lv, YX; Hu, K; Zhao, SL	Adsorption of three perfluoroalkyl sulfonate compounds from environmental water and human serum samples using cationic porous covalent organic framework as adsorbents and detection combination with MALDI-TOF MS	2022	Appl. Surf. Sci. 2022 Nov:601:154224. doi: 10.1016/j.apsusc.2022.154224.	In this work, according to the structure of three perfluoroalkyl sulfonates (PFASs) (perfluorobutylenesulfonic acid (PFBS), perfluorohexanesulfonic acid (PFHxS), and perfluorooctylsulfonic acid (PFOS)) and the property of a medium, we synthesized good-compatibility and stable cationic covalent-organic frameworks (C-COFs). They were used as adsorbents to absorb and detect analytes with matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS). The structures of the C-COFs were characterized. Enrichment parameters, including adsorbent amount, enrichment time, pH, and type and volume of dispersion solution, were optimized to achieve the best enrichment efficiency. After the enrichment, the loaded C-COFs were directly analyzed by MALDI-TOF MS. The results indicated that the C-COFs had a high surface area (1105 m(2)/g) and microporous structure (1.1 nm); they are rapid and highly efficient for tested PFASs adsorption. The equilibrium adsorption capacity of the C-COFs for PFBS was 334.46 mg g(-1). Further, the detection limit for PFBS, PFHxS, and PFOS was 0.001, 0.01, and 0.3 ng mL(-1), respectively. Moreover, adsorption and ionization mechanism was discussed. Owing to high selectivity and sensitivity, high adsorption performance, good reproducibility, and satisfactory recoveries, the method was successfully applied to detect PFASs in a real sample.				1				-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D167	分析	Roberts, J; McNaughtan, M; Prieto, HD	Unwanted Ingredients-Highly Specific and Sensitive Method for the Extraction and Quantification of PFAS in Everyday Foods	2023	Food Anal. Meth. 2023 May:16(5):857-866. doi: 10.1007/s12161-023-02451-2.	Perfluorinated alkyl substances (PFAS) are anthropogenic substances and can only come from polluted sources. There are many classes of PFAS which can be transformed to perfluoalkyl carboxylic acids and perfluoroalkyl sulfonic acids in the environment. Once they are in this form, they are environmentally mobile and extremely stable with half-lives of decades. These compounds are not innocuous and are implicated in causing many different diseases. In this publication, a method for the extraction and quantitation of perflurocarboxylic acids and perfluorosulfonic acids, using high-resolution liquid chromatography mass spectrometry (HRMS), is evaluated. A QuEChERS extraction method was performed on tomatoes, strawberries and milk purchased from different supermarkets on different days. Recoveries from milk and tomatoes were between 80 and 120%. Matrix effects were significant for strawberries and tomatoes and stable isotope internal standards were required to compensate. PFBA was found in all 3 food types. The total PFAS was 0.68 ng g(-1) in milk, 0.20 ng g(-1) in strawberries and 0.36 ng g(-1) in tomatoes. This study demonstrates the importance of using a robust analytical method to investigate the PFAS content of complex food matrices and in particular the contribution of short-chain PFAS to overall dietary consumption.	1							-	-		
D168	分析	Boone, JS; Guan, B; Vigo, C; Boone, T; Byrne, C; Ferrario, J	A method for the analysis of perfluorinated compounds in environmental and drinking waters and the determination of their lowest concentration minimal reporting levels	2014	J. Chromatogr. A 2014 Jun:1345:68-77. doi: 10.1016/j.chroma.2014.04.001	A trace analytical method was developed for the determination of seventeen specific perfluorinated chemicals (PFCs) in environmental and drinking waters. The objectives were to optimize an isotope-dilution method to increase the precision and accuracy of the analysis of the PFCs and to eliminate the need for matrix-matched standards. A 250 mL sample of environmental or drinking water was buffered to a pH of 4, spiked with labeled surrogate standards, extracted through solid phase extraction cartridges, and eluted with ammonium hydroxide in methyl tert-butyl ether: methanol solution. The sample eluents were concentrated to volume and analyzed by liquid chromatography/tandem mass spectrometry (LC-MS/MS). The lowest concentration minimal reporting levels (LCMRLs) for the seventeen PFCs were calculated and ranged from 0.034 to 0.600 ng/L for surface water and from 0.033 to 0.640 ng/L for drinking water. The relative standard deviations (RSDs) for all compounds were <20% for all concentrations above the LCMRL. The method proved effective and cost efficient and addressed the problems with the recovery of perfluorobutanoic acid (PFBA) and other short chain PFCs. Various surface water and drinking water samples were used during method development to optimize this method. The method was used to evaluate samples from the Mississippi River at New Orleans and drinking water samples from a private residence in that same city. The method was also used to determine PFC contamination in well water samples from a fire training area where perfluorinated foams were used in training to extinguish fires.	1							-	-		
D169	分析	Zhou, YR; Lian, YJ; Sun, X; Fu, L; Duan, SR; Shang, CF; Jia, XX; Wu, YN; Wang, ML	Determination of 20 perfluoroalkyl substances in greenhouse vegetables with a modified one-step pretreatment approach coupled with ultra performance liquid chromatography tandem mass spectrometry(UPLC-MS-MS)	2019	Chemosphere 2019 Jul:227:470-479. doi: 10.1016/j.chemosphere.2019.04.034	A new rapid modified one-step QuEChERS (quick, easy, cheap, effective, rugged, and safe) approach was developed for the simultaneous determination of 20 perfluoroalkyl substances (PFASs) from samples of cucumber, lettuce, eggplant, tomato, and leek. Several parameters were optimized. Similar pretreatment approaches were employed for comparison; the results verified the satisfactory performance of this new method. The detection limits of this method for the selected matrices ranged from 0.003 to 0.034 mu g kg(-1), and the method was verified to be satisfactory in terms of precision, accuracy, and matrix effects. 35 greenhouse vegetable samples were determined. PFASs were detected in 26 samples, with perfluorooctanoic acid (PFOA) being detected most frequently and much higher levels of PFBA and PFPeA being found in some samples. The total PFAS concentrations ranged from not detectable to 0.683 mu g kg(-1). This method could be applied for large scale determination of vegetables to research the migration and accumulation trends of PFASs from the environment to crops in the future.	1							-	-		
D170	分析	Nxumalo, T; Akhdhar, A; Mueller, V; Simon, F; von der Au, M; Cossmer, A; Pfeifer, J; Krupp, EM; Meermann, B; Kindness, A; Feldmann, J	EOF and target PFAS analysis in surface waters affected by sewage treatment effluents in Berlin, Germany	2023	Anal Bioanal Chem. 2023 Mar;415(6):1195-1204. doi: 10.1007/s00216-022-04500-x.	Per- and polyfluoroalkyl substances (PFAS) are emerging organic pollutants and can occur in surface and groundwater. To identify the degree of pollution in surface water with PFAS, often targeted HPLC-ESI-MS/MS has been employed in which commonly 30-40 compounds are analyzed. However, other PFAS and organofluorines remain undetected. We sampled surface water of the river Spree and the Teltow Canal in Berlin, Germany, which are affected by the effluent discharge of wastewater treatment plants. Here, we employed high-resolution continuum source graphite furnace molecular absorption spectrometry (HR-CS-GFMAS) for measuring extractable organofluorines (EOF) and compared in a mass balance approach the total fluorine to the identified and quantified PFAS from the targeted analysis. The analysis highlights that the EOF are in the range expected for an urban river system (Winchell et al. in Sci Total Environ 774, 2021). However, downstream of an effluent discharge, the EOF increased by one order of magnitude, e.g., 40.3 to 574 ng F L-1, along the Teltow Canal. From our target analytes, mostly short-chained perfluorinated carboxylic acids and sulfonates occur in the water, which however makes up less than 10% of the EOF. The increase in EOF in the Teltow Canal correlates well with the increase of perfluorohexanoic acid (PFHxA), indicating that PFHxA is characteristic for the discharged EOF but not responsible for the increase. Hence, it points to PFHxA precursor discharge. The study highlights that EOF screening using HR-CS-GFMAS is necessary to identify the full scale of pollution with regard to PFAS and other organofluorines such as pharmaceutical compounds from the effluent of WWTPs.		1						-	-		
D171	分析	Becanova, J; Saleeba, ZSSL; Stone, A; Robuck, AR; Hurt, RH; Lohmann, R	A graphene-based hydrogel monolith with tailored surface chemistry for PFAS passive sampling	2021	Environ. Sci.-Nano. 2021 Oct:8(10):2894-2907. doi: 10.1039/d1en00517k.	Aquatic contamination by per- and polyfluorinated alkyl substances (PFAS) has attracted global attention due to their environmental and health concerns. Current health advisories and surface water regulatory limits require PFAS detection in the parts per trillion (ppt) range. One way to achieve those low detection limits is to use a reliable passive sampling-based monitoring tool for PFAS, as exists for numerous nonpolar persistent organic pollutants. Here we introduce a new graphene-based hydrogel monolith and describe its synthesis, chemical functionalization, property characterization, and testing as a PFAS equilibrium passive sampler. The graphene monoliths were self-assembled by hydrothermal treatment from graphene oxide (GO) aqueous dispersions to produce free standing cylinders of similar to 563 mm(3) volume consisting of 4 wt% thin-walled porous graphene and similar to 96 wt% water. The uptake of 23 PFAS was measured on the as-produced monoliths, and equilibrium partition coefficients (K-SW), were derived for longer chain (C >= 8) perfluoroalkyl acids (PFAA) and neutral precursors such as sulfonamides (log K-SW range 1.9-3.6). To increase the K-SW for shorter chain PFAA, the monoliths were chemically modified by a new diazonium-based grafting reaction that introduces positive surface charge without damage to the graphenic backbone. Introduction of benzylamine moieties through the diazonium intermediate switches zeta potential at pH 7 from -45 mV (as-produced graphene) to +5 mV. This modification increased the sorption of short and middle chain PFAA by ten-fold (e.g. log K-SW for PFBA increased from 1.3 to 2.2), thereby improving the functionality of the passive sampler device for a wider range of PFAS. Field deployments demonstrated that the graphene monoliths were capable of detecting key PFAS in the Delaware River.	1							-	-		
D172	分析	van Leeuwen, SPJ; Swart, CP; van der Veen, I; de Boer, J	Significant improvements in the analysis of perfluorinated compounds in water and fish: Results from an interlaboratory method evaluation study	2009	J. Chromatogr. A 2009 Jan:1216(3):401-409. doi: 10.1016/j.chroma.2008.11.029.	The 2nd international interlaboratory study (ILS) on perfluorinated compounds (PFCs) in environmental samples was organized to assess the performance of 21 North American and European laboratories on the analysis of PFCs in water and fish. A study protocol was provided to assess accuracy, precision, matrix effects and to study the use of in-house standards. The participants used shared native and mass-labelled standards that were provided for this study to quantify the PFC concentrations in the samples. Matrix effects in the determination of PFCs can be considerable and can decrease the sensitivity, the accuracy and internal standard recoveries. Therefore, two quantification methods were evaluated by all laboratories: standard addition quantification (SAQ) and solvent-based calibration curve quantification (SBCCQ: using mass-labelled internal standards (IS)). The between laboratory reproducibility (i.e. coefficient of variance) was smaller for the SBCCQ results (except for PFBS and PFHxS for which no mass-labelled analogues were available) compared to those obtained by the SAQ method. The within laboratory precision of individual laboratories is good (mean for all PFCs in water 12% and 6.8% in fish). The good performance is partially attributable to the use of well-defined native- and mass-labelled standards. Therefore, the SBCCQ method is recommended. The results show that analytical methods for PFCs in water and fish have improved considerably. Critical steps identified in this study are (i) the use of well-defined native standards for quantification, (ii) the use of mass-labelled internal standards (preferably one for each target compound) and (iii) minimization of matrix effects by a better clean up.				1				-	-		
D173	分析	Feng, YT; Dai, JX; Wang, CY; Zhou, HY; Li, JH; Ni, G; Zhang, MF; Huang, YJ	Ag Nanoparticle/Au@Ag Nanorod Sandwich Structures for SERS-Based Detection of Perfluoroalkyl Substances	2023	ACS Appl. Nano Mater. 2023 Jul:6(15):13974-13983. doi: 10.1021/acsanm.3c01815.	Perfluoro- and polyfluoroalkyl substances (PFAS) arewidely usedthroughout the world and are extensively found in the environment.The detection of PFAS has become essential to ensuring environmentalsustainability and human health. Herein, AuNRs were synthesized bythe seed growth method and then the samples were coated with silvershells to form Au@Ag core-shell nanorods (Au@AgNRs). Au@AgNRsmonolayer was prepared by oil-water self-assembly on a siliconwafer and then was constructed as a plasmonic AgNPs/Au@AgNRs sandwichstructure for surface-enhanced Raman scattering (SERS) detection ofPFAS. The shell thickness of Au@AgNRs was optimized and displayeda 11.9-fold SERS intensity higher than the pristine AuNRs. Moreover,the hotspots generated by the electromagnetic field coupling betweenthe interlayer gap achieved 3.6-fold SERS signal enhancement comparedto that of the Au@AgNRs monolayer. Besides, the excellent structuraluniformity (RSD & SIM; 8.0%) makes it ideal for quantitative SERSdetection applications. More importantly, the use of the AgNPs/Au@AgNRssandwich structure sensor enables the highly sensitive detection ofmodel molecules (10(-11) M) and quantitative detectionof a wide range of fluorinated alkyl substances of perfluorooctanoicacid (PFOA), perfluorohexanoic acid (PFHxA), and potassium perfluoro-butanesulfonate(PPFBS), even with a portable Raman device. And the detection concentrationcan be down to 0.1 ppm for PFAS. This sensitive and quantitative SERStechnique has promising prospects in the monitoring of fluorinatedalkyl substance contaminations.		1		1				-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D174	分析	Hale, SE; Canivet, B; Rundberget, T; Langberg, HA; Allan, IJ	Using Passive Samplers to Track per and Polyfluoroalkyl Substances (PFAS) Emissions From the Paper Industry: Laboratory Calibration and Field Verification	2021	Front. Environ. Sci. 2021 Dec:9:796026. doi: 10.3389/fenvs.2021.796026.	Per and polyfluoroalkyl substances (PFAS) are becoming more stringently regulated and as such, a more diverse suite of environmental monitoring methods is needed. In this work a polar organic chemical integrative sampler (POCIS) with a nylon membrane and a combination of Oasis WAX and Fluoroflash(R) sorbents was calibrated in the laboratory and deployed in the field. A static renewal system was used to determine sampling rates for 12 PFAS which ranged between 0.69 +/- 0.27 to 5.68 +/- 1.80 L/day. POCIS devices were deployed for 10 days in lake Tyrifjorden, Norway which is known to be contaminated by a closed down factory producing paper products, in order to track the evolution of the PFAS contamination in a river system draining into the lake. Th sampling campaign enabled the stretch of the river which was responsible for the emissions of PFAS to lake Tyrifjorden to be identified. Freely dissolved concentrations determined with the POCIS were lowest at the site considered to reflect a diffuse PFAS contamination and highest at the site located downstream the factory. Perfluorooctanesulfonic acid (PFOS), perfluorohexanoic acid (PFHxA) and perfluorooctane sulfonamidoacetic acid (EtFOSAA) dominated the concentration profile at this site. Emissions of PFAS to lake Tyrifjorden were estimated to be 3.96 g/day for the sum of the 12 investigated PFAS.		1						-	-		
D175	分析	Yao, XY; Song, NN; Wang, J; Zhao, X; Cheng, MY; Zuo, JQ; Qiu, KP	Influence of Electrolyte Concentration on Single-Molecule Sensing of Perfluorocarboxylic Acids	2021	Front. Chem. 2021 Aug:9:732378. doi: 10.3389/fchem.2021.732378.	Perfluorocarboxylic acids (PFCAs) are an emerging class of persistent organic pollutants. During the fabrication process, it is unavoidable to form PFCA homologs or isomers which exhibit distinct occurrence, bioaccumulation, and toxicity. The precision measurement of PFCAs is therefore of significant importance. However, the existing characterization techniques, such as LC-MS/MS, cannot fully meet the requirement of isomer-specific analysis, largely due to the lack of authentic standards. Single-molecule sensors (SMSs) based on nanopore electrochemistry may be a feasible solution for PFCAs determination, thanks to their ultra-high spatiotemporal resolutions. Hence, as a first step, this work was to elucidate the influence of electrolyte concentration on the four most critical indicators of nanopore measurements, and furthermore, performance of nanopore SMSs. More specifically, three of the most representative short-chain PFCAs, perfluoropentanoic acid (PFPeA), perfluorohexanoic acid (PFHxA) and perfluoroheptanoic acid (PFHpA), were adopted as the target analytes, aerolysin nanopore was employed as the sensing interface, and 2, 3 and 4 M KCl solutions were used as electrolytes. It was found that, when the concentration of KCl solution increased from 2 to 4 M, the conductance of aerolysin nanopore increased almost linearly at a rate of 0.5 nS per molar KCl within the whole voltage range, the current blockade of PFPeA at -50 mV increased from 61.74 to 66.57% owing to the enhanced steric exclusion effect, the maximum dwell time was more than doubled from 14.5 to 31.5 ms, and the barrier limited capture rate increased by 8.3 times from 0.46 to 3.85 Hz. As a result, when using 4 M KCl as the electrolyte, over 90% of the PFPeA, PFHxA and PFHpA were accurately identified from a mixed sample, and the calculated limit of detection of PFPeA reached 320 nM, more than 24 times lower than in 2 M KCl. It was thus clear that tuning the electrolyte concentration was a simple but very effective approach to improve the performance of nanopore SMSs for PFCAs determination.		1						-	-		
D176	分析	Vughs, D; Baken, KA; Dingemans, MML; de Voogt, P	The determination of two emerging perfluoroalkyl substances and related halogenated sulfonic acids and their significance for the drinking water supply chain	2019	Environ. Sci.-Process Impacts 2019 Nov:21(11):1899-1907. doi: 10.1039/c9em00393b.	In the present study analytical methodologies were developed for two newly emerging polar perfluorinated alkyl substances (PFAS), namely F-3-MSA, and HFPO-DA, in order to assess the occurrence and levels of these PFAS in Dutch and Belgian waters. Two separate methods were needed for analysing F-3-MSA and HFPO-DA. A mixed-mode and a reversed phase C18 method were developed for F-3-MSA and HFPO-DA, respectively, using a high resolution Orbitrap Fusion mass spectrometer for detection, yielding satisfactory LOD and LOQ results for both analytes. A sample campaign was performed collecting single grab samples from various locations and different stages of the drinking water production chain. Whereas both PFAS were absent in groundwaters, they were found to be present in surface waters, river bank and dune infiltrates, process water, and drinking water, demonstrating the persistence and mobility of both compounds. Based on provisional health-based guideline values (0.15 mu g L-1 for HFPO-DA, 11.9 mg L-1 for F-3-MSA), the current levels in drinking water from the suppliers involved in this study do not pose a health risk for the human population. Common removal processes used in drinking water production appeared to remove these polar compounds at most partially. At locations close to potential sources of these chemicals (e.g. fluoropolymer production sites), the quality of surface water or river bank filtrate abstracted for production of drinking water must therefore be monitored.					1			-	-		
D177	分析	Chiesa, LM; Nobile, M; Pasquale, E; Balzaretti, C; Cagnardi, P; Tedesco, D; Panseri, S; Arioli, F	Detection of perfluoroalkyl acids and sulphonates in Italian eel samples by HPLC-HRMS Orbitrap	2018	Chemosphere 2018 Feb:193:358-364. doi: 10.1016/j.chemosphere.2017.10.082	Perfluoroalkyl substances (PFASs) contain one or more carbon-bound hydrogens substituted by fluorine. Since the 1950s, these compounds have been used to manufacture fat- and water-resistant fabrics, paper and food containers, and to produce photographic films, firefighting foams, detergents and insecticides. The widespread use and global distribution of PFASs, have led to their accumulation in the environment. Food, particularly fish and other seafood, is considered the main route of human exposure to PFASs. Consequently, the European Food Safety Authority (EFSA) recommends that more data be collected, to build a database on the contamination levels of the individual PFASs in food, to evaluate a reliable chronic risk to the European consumers. This requires high-sensitivity analytical methods, to increase the number of quantifiable samples and, thereby, improve the credibility of exposure assessments. In this context, the aim of the present research is to develop and validate a sensitive and specific method based on high-performance liquid chromatography-high resolution mass spectrometry (HPLC-HRMS) analysis, to monitor the presence of 16 PFASs in Italian eels (Anguilla anguilla) from the Italian Lake Garda. The detection limits (CC alpha) and detection capability (CC beta) in the order of pg g(-1), the recoveries between 80 and 101% and the other validation parameters fulfilled the requirements of Commission Decision 657/2002/EC. The identification and quantification of PFASs, up to 11 in the same sample, showed a similar distribution among 90 eels. Perfluorooctane sulphonic acid (PFOS) and perfluorobutanoic acid (PFBA) were the analytes more frequently found in the eel samples (94 and 82%, respectively).	1							-	-		
D178	分析	Janda, J; Nodler, K; Scheurer, M; Happel, O; Nurenberg, G; Zwiener, C; Lange, FT	Closing the gap - inclusion of ultrashort-chain perfluoroalkyl carboxylic acids in the total oxidizable precursor (TOP) assay protocol	2019	Environ. Sci.-Process Impacts 2019 Nov:21(11):1926-1935. doi: 10.1039/c9em00169g.	An improved protocol of the total oxidizable precursor (TOP) assay was developed for precursors to C-2-C-14 perfluoroalkyl carboxylic acids (PFCAs) and C-4-C-8 and C-10 perfluoroalkyl sulfonic acids (PFSAs). The proposed protocol was tested and validated for contaminated soil samples. The perfluoroalkyl acids (PFAAs) present in the soil extract solutions after oxidation with persulfate were separated from the inorganic salts by vacuum-assisted drying of the digestion solution followed by solid-liquid extraction of the PFAAs with acetonitrile from the dry residue. Ion chromatography (for C-2-C-4 PFCAs) and reversed phase liquid chromatography (for all other PFASs), both coupled to tandem mass spectrometry, were used for quantification. High procedural recoveries of PFAAs between 68% and 123% with RSDs between 0.2% and 25% (n = 3) were achieved. The method was validated using selected polyfluoroalkyl phosphoric acid esters (PAPs) and bis-[2-(N-ethyl perfluorooctane-1-sulfonamido)ethyl] phosphoric acid ester (diSAmPAP) as model precursors in pure solutions and in the presence of soil matrix. The oxidation led to characteristic and reproducible PFCA patterns (in the case of PAPs) or PFOA (in the case of diSAmPAP) with total reaction yields between 92 +/- 4% and 123 +/- 13% (n = 3). The impact of the soil matrix on transformation yields was negligible. In a soil core from a PFAS-polluted agricultural site, precursors were concentrated in the upper 40 cm with long-chain precursors being prevalent. After oxidative digestion, the total molar PFAA-concentrations increased by factors of 1.6 to 5.0. More than 40 cm below ground precursors of TFAA, PFPrA and PFBA accounted for similar to 50% of the reaction products, underlining the importance of their inclusion in mass balances based on the TOP assay.	1							-	-		
D179	分析	Berger, U; Haukas, M	Validation of a screening method based on liquid chromatography coupled to high-resolution mass spectrometry for analysis of perfluoroalkylated substances in biota	2005	J. Chromatogr. A 2005 Jul:1081(2):210-217. doi: 10.1016/j.chroma.2005.05.064.	A screening method for analysis of perfluoroalkylated substances (PFAS) in biota samples has been developed and validated using liver samples from polar cod (Boreogadus saida) and glaucous gull (Larus hyperboreus). The method was based on extraction of target compounds from homogenised samples into the solvent mixture used as mobile phase in high-performance liquid chromatography (HPLC), i.e. methanol/water (50:50; 2 mM ammonium acetate). The extract was filtered and directly injected into a HPLC/time-of-flight mass spectrometry (TOF-MS) system. Quantification was performed using 7H-perfluoroheptanoic acid as internal standard and a calibration standard solution dissolved in sample extract for each matrix type (matrix-matched calibration standard). The method is very time and cost efficient. Except for long-chain compounds and perfluorooctane sulfonamide (which cannot be covered by this method), recoveries were between 60% and 115% and method detection limits were in the range 0.04-1.3 ng/g wet weight. Blank values could be neglected with the exception of perfluorooctane sulfonate (PFOS), perfluorohexanoic acid (PFHxA) and perfluorooctanoic acid (PFOA). One of the major challenges in PFAS analysis is ionisation disturbance by co-eluting matrix in the ion source of the mass spectrometer. Both matrix and analyte specific signal enhancement and suppression was observed and quantified. Repeated extractions (n = 3) gave relative standard deviations (RSD) < 35% for all PFAS. Accuracy was examined by comparing the screening method to the generally applied ion pair extraction (IPE) method. PFAS concentration values of a glaucous gull liver sample deviated by less than 30% for the two methods, provided that matrix-matched calibration standards were employed in both methods.		1						-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D180	分析	Gao, K; Fu, JJ; Xue, Q; Li, YL; Liang, Y; Pan, YY; Zhang, AQ; Jiang, GB	An integrated method for simultaneously determining 10 classes of per- and polyfluoroalkyl substances in one drop of human serum	2018	Anal. Chim. Acta 2018 Jan:999:76-86. doi: 10.1016/j.aca.2017.10.038	Per- and polyfluoroalkyl substances (PFASs) represent a group of synthetic chemicals, and they have quite different physicochemical properties, which result in difficulties of their simultaneous determination in a single injection. A sensitive, reliable, and fully automated method was developed for simultaneously detecting 10 classes of PFASs (total of 43) in human serum using online Turboflow SPE-UHPLC-MS/MS. This method provided high linearity of matrix-matched calibration standards (R > 0.99), excellent method limits of detection (MLODs) (0.013-0.089 ng mL(-1)). satisfactory matrix spiked recoveries (84.3-109%) and relative standard deviations (RSDs) (intra-day RSDs: 1.3-12.6%, inter-day RSDs: 1.7-13.8%, inter-week RSDs: 1.8-13.5%, inter-month RSDs: 3.1-12.4%), short analysis time (19 min per sample) and small sample amount requirement (25 mu L), which were suitable for large-scale epidemiologic studies. Moreover, the method provided the feasibility of real-time monitoring for the degradation kinetics of PFASs precursors both in vitro and in vivo. The quality of the present method was further verified by repetitive analysis of a standard reference material (SRM 1957), with the deviations of the targeted PFAS concentrations ranging from 1.9% to 14.2% (n = 5) between the detected and reference values. The present study also determined values for several PFASs in SRM 1957 other than those on the certificate, for the first time, such as N-EtFOSA, 6:2 Cl-PFESA, and PFBA. Finally, the established method was applied to detect PFASs in serum samples of 15 ordinary people and 15 occupational workers, and 6:2 FTSA was found as the dominant precursor.	1							-	-		
D181	分析	Loos, R; Tavazzi, S; Paracchini, B; Canuti, E; Weissteiner, C	Analysis of polar organic contaminants in surface water of the northern Adriatic Sea by solid-phase extraction followed by ultrahigh-pressure liquid chromatography-QTRAP(A (R)) MS using a hybrid triple-quadrupole linear ion trap instrument	2013	Anal. Bioanal. Chem. 2013 Jul:405(18):5875-5885. doi: 10.1007/s00216-013-6944-8.	Water-soluble polar organic contaminants are discharged by rivers, cities, and ships into the oceans. Little is known on the fate, pollution effects, and thresholds of toxic chemical mixtures in the marine environment. A new trace analytical method was developed for the multi-compound analysis of polar organic chemical contaminants in marine waters. The method is based on automated solid-phase extraction (SPE) of one-liter water samples followed by ultrahigh-pressure liquid chromatography triple-quadrupole linear ion-trap mass spectrometry (UHPLC-QTRAP(A (R)) MS). Marine water samples from the open Adriatic Sea taken 16 km offshore from Venice (Italy) were analyzed. Method limits of quantification (LOQs) in the low picogram per liter (pg/l) concentration range were achieved. Among the 67 target chemicals analyzed, 45 substances could be detected above the LOQ. The chemicals detected at the highest concentrations were caffeine (up to 367 ng/l), nitrophenol (36 ng/l), 2,4-dinitrophenol (34 ng/l), 5-methyl-1H-benzotriazole (18.5 ng/l), sucralose (11 ng/l), 1H-benzotriazole (9.2 ng/l), terbuthylazine (9 ng/l), alachlor (7.7 ng/l), atrazine-desisopropyl (6.6 ng/l), diethyltoluamide (DEET) (5.0 ng/l), terbuthylazine-desethyl (4.3 ng/l), metolachlor (2.8 ng/l), perfluorooctanoic acid (PFOA) (2.5 ng/l), perfluoropentanoic acid (PFPeA) (2.3 ng/l), linuron (2.3 ng/l), perfluorohexanoic acid (PFHxA) (2.2 ng/l), diuron (2.0 ng/l), perfluorohexane sulfonate (PFHxS) (1.6 ng/l), simazine (1.6 ng/l), atrazine (1.5 ng/l), and perfluorooctane sulfonate (PFOS) (1.3 ng/l). Higher concentrations were detected during summer due to increased levels of tourist activity during this period.		1						-	-		
D182	分析	Vela-Soria, F; Serrano-Lopez, L; Garcia-Villanova, J; de Haro, T; Olea, N; Freire, C	HPLC-MS/MS method for the determination of perfluoroalkyl substances in breast milk by combining salt-assisted and dispersive liquid-liquid microextraction	2020	Anal. Bioanal. Chem. 2020 Nov:412(28):7913-7923. doi: 10.1007/s00216-020-02924-x.	The widespread use of perfluoroalkyl substances has resulted in the universal exposure of humans to these endocrine-disrupting chemicals, including the exposure of neonates through breastfeeding. The objective of this study was to develop a method to determine 10 perfluoroalkyl substances in breast milk (1-mL aliquot) by combining salt-assisted liquid-liquid extraction with dispersive liquid-liquid microextraction and using high-performance liquid chromatography-tandem mass spectrometry. Chemometric strategies were applied to optimize experimental parameters. The limit of quantification was 20 pg mL(-1)for all analytes, and inter-day variability (evaluated as relative standard deviation) ranged from 8.2 to 13.8%. The method was validated by a recovery assay with spiked samples. Percentage recoveries ranged from 85.9 to 110.8%. The method was satisfactorily applied to assess target compounds in 20 breast milk samples from donors. Perfluorooctanoic acid, perfluorooctane sulfonate, and perfluorohexanoic acid were the most frequently detected analytes. This analytical procedure can provide useful information on newborn's exposure to these xenobiotics.		1						-	-		
D183	分析	Wu, C; Wang, Q; Chen, H; Li, MY	Rapid quantitative analysis and suspect screening of per-and polyfluorinated alkyl substances (PFASs) in aqueous film-forming foams (AFFFs) and municipal wastewater samples by Nano-ESI-HRMS	2022	Water Res. 2022 Jul:219:118542. doi: 10.1016/j.watres.2022.118542.	A rapid analytical method for per- and polyfluoroalkyl substances (PFASs) combining nano-electrospray ionization and high-resolution mass spectrometry (Nano-ESI-HRMS) was developed and applied to aqueous filmforming foams (AFFFs) and wastewater samples collected from three local wastewater treatment plants (WWTPs). This method exhibited high sensitivity with lower limits of detection (LODs) of 3.2-36.2 ng/L for 22 target PFAS analytes. In AFFF formulations, Nano-ESI-HRMS enabled the first-time detection of trifluoromethanesulfonic acid (TFMS), perfluoroethyl cyclohexanesulfonate (PFECHS), 6:2 fluorotelomer sulfonyl amido sulfonic acid (6:2 FTSAS-SO2), N-ammoniopropyl perfluoroalkanesulfonamidopropylsulfonate (N-AmPFASAPS, n = 3-6), ketone-perfluorooctanesulfonic acid (Keto-PFOS), fluorotelomer unsaturated amide sulfonic acid (FTUAmS, n = 7), and 6:2 fluorotelomer amide (6:2 FTAm). Their structures were verified by the tandem MS analysis using collision-induced dissociation. Further, the combination of absolute and semi-quantification results revealed 16 PFASs from 9 PFAS classes as dominant AFFF constituents, accounting for 88.2-96.5% of the total detected anionic and zwitterionic PFASs, including perfluorinated sulfonic acids (PFSAs, n = 1,4-8), 6:2 fluorotelomer sulfonates (6:2 FTS), fluorotelomer thioether amido sulfonic acid (FTSAS, n = 6,8), fluorotelomer sulfinyl amido sulfonic acid (FTSAS-SO, n = 6,8), N-AmP-FASAPS (n = 6), 6:2 fluorotelomer sulfonamide alkylbetaine (6:2 FTAB), perfluoroalkylsulfonamido amino carboxylate (PFASAC, n = 6), 2-((perfluorooctyl)thio) acetatic acid (Thio-8:2 FTCA), and 6:2 FTAm. At WWTPs, aerobic and anaerobic biotransformation of PFAS precursors at the aeration tanks and secondary clarifiers were evident by the generation of mid/short-chain perfluoroalkyl acids, such as perfluoroheptanoic acid (PFHpA), perfluorohexanoic acid (PFHxA), perfluoropentanoic acid (PFPeA), as well as the emergence of ultrashort trifluoroacetic acid (TFA) and TFMS and several novel fluorotelomer carboxylic acids (FTCAs). Overall, Nano-ESI-HRMS enabled comprehensive PFAS quantitative analysis and suspect screening, applicable for rapid investigation and assessment of PFAS-related exposure and treatment in environmental matrixes. Our results also revealed that AFFFs and municipal wastewaters are two key sources contributing to the prevalent detection of ultrashort-chain PFASs (e.g., TFMS and TFA) in water.		1						-	-		
D184	分析	Surma, M; Piskula, M; Wiczkowski, W; Zielinski, H	The perfluoroalkyl carboxylic acids (PFCAs) and perfluoroalkane sulfonates (PFSAs) contamination level in spices	2017	Eur. Food Res. Technol. 2017 Feb:243(2):297-307. doi: 10.1007/s00217-016-2744-7.	Spices have been used since ancient times. Although they have been employed mainly as flavoring and coloring agents, their role in food safety is of increasing concern. In this study, the usefulness of a modified QuEChERS method, based on the d-SPE, with micro-HPLC-MS/MS system for the determination of selected perfluoroalkyl carboxylic acids (PFCAs) and perfluoroalkane sulfonates (PFSAs) in spices was addressed. The commonly used spices in Spain and Slovakia were investigated. The studies showed the presence of perfluorooctanoic acid in 19 spices of Spanish and Slovak origin, and it ranged from 0.11 ng g(-1) for garlic to 0.67 ng g(-1) for peppermint. The perfluorobutanoic acid was quantified in 10 Slovak spices (from 1.13 ng g(-1) for allspice to 37.82 ng g(-)1 for star anise), whereas perfluorobutane sulfonate was identified only in 12 Spanish spices and it ranged from 0.24 ng g(-1) for cinnamon to 1.01 ng g(-1) for coriander. In contrast, perfluoroheptanoic acid was identified only in Slovak cardamom (1.94 ng g(-1)) and coriander (0.74 ng g(-1)). The average consumption of spices in Europe is approximately 0.5 g day(-1), while in Asia and northern Africa, it is many times higher. Average content of PFASs in this evaluation has a value 4.67 ng g(-1) giving 2.33 ng day(-1) per person. This study showed that daily used spices may contribute to the overall contamination of food by perfluoroalkyl substances.	1			1				-	-		
D185	分析	Amziane, A; Monteau, F; Lalaouna, A; Alamir, B; Le Bizec, B; Dervilly, G	Optimization and validation of a fast supercritical fluid chromatography tandem mass spectrometry method for the quantitative determination of a large set of PFASs in food matrices and human milk	2022	J. Chromatogr. B. 2022 Nov:1210:123455. doi: 10.1016/j.jchromb.2022.123455.	An Ultra-High Performance Supercritical Fluid Chromatography coupled with tandem Mass Spectrometry analytical method (UHPSFC-MS/MS) was developed for the determination of 34 perfluoroalkylated substances (PFASs) in food-related matrices. Two parameters (i.e. stationary phase and co-solvent) were selected and optimized using a step-by-step method, while a design of experiment (DoE) method using a central composite design (CCD) was implemented to optimize column temperature, mobile phase flow rate, co-solvent concen-tration and automated back pressure regulator (ABPR). The Torus 2-PIC column was selected along with ammonium acetate AcoNH4 as additive in the co-solvent. DoE optimization of both peak width and resolution enabled validating an optimized model (desirability 0.613) and setting column temperature at 38.7 C, AcoNH4 concentration at 8 mM, mobile phase flow rate of 1.9 mL/min and ABPR at 1654 psi. The validated resulting method enabled reaching limits of quantification below 0.2 ng/g (w.w.) for 97 % PFASs in accordance with current EU requirements. The strategy was successfully applied to the characterization of a range (n > 30) of food-related matrices (red meat, poultry meat, eggs, fish and breast milk) collected in Algeria in 2019. PFOA and PFBA were observed as the most frequently detected PFASs, i.e. in 96.96 % and 90.9 % of the samples respec-tively. The highest concentrations were determined in fishery products up to 4.42 ng/g (w.w.) for PFTeDA and 0.75 ng/g (w.w.) for PFOS.	1							-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D186	分析	Borrull, J; Colom, A; Fabregas, J; Pocurull, E; Borrull, F	A liquid chromatography tandem mass spectrometry method for determining 18 per- and polyfluoroalkyl substances in source and treated drinking water	2020	J. Chromatogr. A. 2020 Oct:1629:461485. doi: 10.1016/j.chroma.2020.461485.	Per - and polyfluoroalkyl substances (PFASs) have been determined in waters intended for human consumption, causing concern due to their potential toxic effects in humans and the environment. Drinking water is acknowledged to be one of the major routes of exposure to PFASs, which has led to the implementation of regulatory guidelines for PFASs in drinking water. In this study a fast, simple, sensitive and cost-effective method is developed for the determination of 18 PFASs in river and drinking water. The proposed method consists of directly injecting 900 mu L of sample into a liquid chromatograph coupled to a triple quadrupole mass analyser, which involves minimal sample treatment as the sample only needs to be filtered. The method was validated in influent and effluent water from a drinking water treatment plant. Strong matrix effects were found for some of the target PFASs, and matrix-matched calibration curves were performed to enable accurate (87-114%) and precise (%RSD between 3 and 18%) quantification (n = 5, at 5 and 75 ng.L-1) with very good sensitivity (method quantitation limits between 0.1 and 2.0 ng.L-1). The method was applied to water samples from the influent and effluent of a drinking water treatment plant located in Catalonia (Spain), as well as in tap water and bottled water. The most abundant PFAS in all the types of water was PFBA, which represents 48%, 49%, 66% and 69% of total PFASs found in influent, effluent, tap and bottled water respectively. Relative mean abundances and the sum of mean concentrations in influent and effluent water suggests poor removal of PFASs during drinking water treatment. The concentrations of PFASs in bottled waters were generally lower than those in tap waters.	1							-	-		
D187	分析	Gardiner, C; Robuck, A; Becanova, J; Cantwell, M; Kaserzon, S; Katz, D; Mueller, J; Lohmann, R	Field Validation of a Novel Passive Sampler for Dissolved PFAS in Surface Waters	2022	Environ. Toxicol. Chem. 2022 Oct:41(10):2375-2385. doi: 10.1002/etc.5431.	Numerous per- and polyfluoroalkyl substances (PFAS) are of growing concern worldwide due to their ubiquitous presence, bioaccumulation and adverse effects. Surface waters in the United States have displayed elevated concentrations of PFAS, but so far discrete water sampling has been the commonly applied sampling approach. In the present study we field-tested a novel integrative passive sampler, a microporous polyethylene tube, and derived sampling rates (R-s) for nine PFAS in surface waters. Three sampling campaigns were conducted, deploying polyethylene tube passive samplers in the effluent of two wastewater treatment plant (WWTP) effluents and across Narragansett Bay (Rhode Island, USA) for 1 month each in 2017 and 2018. Passive samplers exhibited linear uptake of PFAS in the WWTP effluents over 16-29 days, with in situ R-s for nine PFAS ranging from 10 ml day(-1) (perfluoropentanoic acid) to 29 ml day(-1) (perfluorooctanesulfonic acid). Similar sampling rates of 19 +/- 4.8 ml day(-1) were observed in estuarine field deployments. Applying these R-s values in a different WWTP effluent predicted dissolved PFAS concentrations mostly within 50% of their observations in daily composite water samples, except for perfluorobutanoic acid (where predictions from passive samplers were 3 times greater than measured values), perfluorononanoic acid (1.9 times), perfluorodecanoic acid (1.7 times), and perfluoropentanesulfonic acid (0.1 times). These results highlight the potential use of passive samplers as measurement and assessment tools of PFAS in dynamic aquatic environments.	1		1					-	-		
D188	分析	Gao, Y; Li, XM; Li, XQ; Zhang, QH; Li, HM	Simultaneous determination of 21 trace perfluoroalkyl substances in fish by isotope dilution ultrahigh performance liquid chromatography tandem mass spectrometry	2018	J. Chromatogr. B 2018 May:1084:45-52. doi: 10.1016/j.jchromb.2018.03.008	Perfluoroalkyl substances (PFASs) have been identified as emerging environmental contaminants. In this study, an efficient and accurate ultrahigh performance liquid chromatography tandem mass spectrometry (UHPLC-MS/MS) method was developed for simultaneous determination of 21 PFASs in fish. Acetonitrile was used for sample extraction. Solid phase extraction (SPE) by WAX cartridges and then freezing at - 30 degrees C were adopted as cleanup strategies. Strict measurements were performed to control background contamination during the whole procedure. Matrix effects were evaluated by external standard and isotope dilution mass spectrometry (IDMS) methods. IDMS can compensate the matrix effects to a large extent. The method detection limits (MDLs) ranged from 2 pg/g to 10 pg/g except for PFBA (120 pg/g). The method quantitation limits (MQLs) ranged from 5 pg/g to 30 pg/g except for PFBA (300 pg/g). The matrix spiked recoveries of three spiked levels were in the range of 79.6%-109%. The antra-day relative standard deviation (RSD) and inter-day RSD were from 0.94% to 13.9% and 0.36% to 11.2% respectively. Two fish tissue reference materials were analyzed by the developed method. The results of reference materials were within the uncertainty of the given value. The quantitative results of IDMS and standard addition (SA)- IDMS were comparable. The developed UHPLC-MS/MS method was applied for PFASs detection in 20 marine fish samples. 9 PFASs were detected in the samples with the Sigma(9)PFASs concentration range of 0.04 to 2.14 ng/g wet weight (ww).	1							-	-		
D189	分析	Wold, C; van de Grampel, R	Identification of flame retarding organic alkali metal salt additives in polycarbonate by flow injection electrospray ion trap mass spectrometry	2009	Polym. Test. 2009 Aug:28(5):495-499. doi: 10.1016/j.polymertesting.2009.03.012.	Three commonly used flame retarding organic alkali metal salt additives in polycarbonate, potassium diphenylsulfone sulfonate, potassium perfluorobutane sulfonate and p-toluenesulfonic acid sodium salt could be simultaneously, quickly and conveniently identified in a polycarbonate sample by utilizing electrospray ion trap mass spectroscopy detection in flow injection mode after dissolution and precipitation of the polymer. The resulting method offered advantages of speed, selectivity and precision of identification based on two stage mass spectroscopy fragmentation patterns and mass spectral library matching for the three salts tested, and is likely to be applicable to other compounds of similar class.				1				-	-		
D190	分析	Ahmadireskety, A; Da Silva, BF; Townsend, TG; Yost, RA; Solo-Gabriele, HM; Bowden, JA	Evaluation of extraction workflows for quantitative analysis of per- and polyfluoroalkyl substances: A case study using soil adjacent to a landfill	2021	Sci. Total Environ. 2021 Mar:760:143944. doi: 10.1016/j.scitotenv.2020.143944.	Specific aspects of previously reported extraction workflows, for measurement of per- and polyfluoroalkyl substances (PFAS) in solid matrices, have not been adequately interrogated. The objective of this study was to explore the importance of each workflow step in providing the most appropriate extraction for a comprehensive set of PFAS (51 different species) in soil. We compared different procedures, including two pre-extraction set ups (overnight handling of samples prior to extraction), two extraction solvents (methanol (MeOH), and acetonitrile (ACN)), two extraction solvent volumes (10 mL and 8.5 mL), and two post-extraction cleanup strategies (ENVI-Carb and ion-pair). Of the 51 species targeted, 21 were at quantifiable levels in soil samples collected adjacent to a landfill, ofwhich 13 PFAS were consistently detected among the different extraction workflows. Overall, results showed no significant difference in PFAS concentration between different extraction solvents and cleanup strategies. Perfluoropentanoic acid, perfluorohexanoic acid, and perfluorooctanoic acid had the highest concentrations in all extraction workflows, accounting for nearly 13%, 38%, and 17% of the total monitored PFAS (SPFAS), respectively. While final concentration values were similar across methods, recovery and accuracy studies showed that MeOH had the best recovery, with 88% of the isotopically labeled PFAS standards showing extraction recovery within the acceptable range of 80% to 120% (compared to 14% of isotopically labeled PFAS standards in workflows using ACN). Upon examination of additional cleanup steps, 67% of monitored PFAS (out of 51 total PFAS monitored), on average, exhibited higher accuracy (relative error <= 20%) using ENVI-Carb clean up (in comparison with 51% in workflows using ion pair clean up). Results also demonstrated that larger volumes of MeOH(and subsequent re-extractions) did not yield a better recovery, enabling a reduction in overall analysis time and cost in comparison to many published methods.		1		1				-	-		
D191	分析	Pan, JL; Yuan, JH; Ye, L; Zhang, JY; Du, XT; Ma, AD	Nonaqueous Electroextraction with Tunable Selectivity for Direct, Fast, and Exhaustive Enrichment of Per- and Polyfluoroalkyl Acids from Oils and Food Contact Materials	2022	Anal. Chem. 2022 Nov:94(45):15663-15670. doi: 10.1021/acs.analchem.2c02727.	Widespread concerns have been raised due to the ever-increasing number of novel per-and polyfluoroalkyl acids (PFAAs) and the ever-decreasing level of legacy PFAAs. Most analytical methods for PFAAs suffer from a narrow range of analyzable PFAAs, insufficient sensitivity, poor performance for oil samples, and defective quantification without internal standards or blank matrices. To solve these challenges, a highly selective method for multiple PFAAs from oils and food contact materials (FCMs) was developed based on nonaqueous electroextraction (NE). Through theoretical derivation and experimental investigation, the selectivity of NE was discovered to be tunable, and the range of extractable analytes could be tuned by adjusting the dielectric constant of the sample solution. For PFAAs, the selectivity was attributed to the pKa-based differential migration mechanism, as PFAAs exhibited less variable pKa values in different solvents compared to interference components. The method achieved nonmatrix-matched calibration without internal standards and integration of sample cleanup, selective extraction, and exhaustive enrichment into a fast and convenient operation. The method provided low limits of detection (0.002-0.03 mu g center dot kg-1), satisfactory accuracy (88.0-107.8%), and RSDs (<11.7%). Migration experiments from 33 FCMs to oils were further investigated. PFBS (<0.05-2.34 mu g center dot kg-1) and PFBA (<0.2-0.398 mu g center dot kg-1) were detected from most FCMs. This was the first attempt at PFAA analysis as well as oil sample analysis using an electric field-assisted extraction technique and also the first report on PFAA migration from FCMs into edible oils.	1			1				-	-		
D192	分析	Niu, XZ; Abrell, L; Sierra-Alvarez, R; Field, JA; Chorover, J	Analysis of hydrophilic per- and polyfluorinated sulfonates including trifluoromethanesulfonate using solid phase extraction and mixed-mode liquid chromatography-tandem mass spectrometry	2022	J. Chromatogr. A. 2022 Feb:1664:462817. doi: 10.1016/j.chroma.2022.462817.	Ultra-hydrophilic perand polyfluorinated sulfonates (PFSA) are increasingly scrutinized in recent years due to their ubiquitous occurrence, persistence, and aqueous mobility in the environment, yet analysis remains a challenge. This study developed methods for the analysis of trifluoromethanesulfonate, perfluorobutanesulfonate, 10-camphorsulfonate, and a di-fluorinated sulfonate utilizing mixed-mode liquid chromatography, where all analytes were adequately retained and separated. Chromatography and electrospray ionization parameters were optimized; instrumental limits of quantification for the anionic target analytes were in the range of 4.3 - 16.1 ng L-1. Solid phase extraction (SPE) methods were developed using Oasis WAX cartridges; SPE recoveries for the analytes ranged from 86% to 125%. Salinity and total organic carbon both impaired the SPE performance to different extents, depending on the respective analyte. Utilizing widely accessible instrumentation and materials, this is a single method to simultaneously analyze conceivably the most hydrophilic PFAS chemical, i.e., trifluoromethanesulfonate, and moderately hydrophobic PFSAs.				1				-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D193	分析	Liang, M; Xian, YP; Wang, B; Hou, XC; Wang, L; Guo, XD; Wu, YL; Dong, H	High throughput analysis of 21 perfluorinated compounds in drinking water, tap water, river water and plant effluent from southern China by supramolecular solvents-based microextraction coupled with HPLC-Orbitrap HRMS	2020	Environ. Pollut. 2020 Aug;263(Pt B):114389. doi: 10.1016/j.envpol.2020.114389.	The present work reported a high-throughput strategy for the analysis of 21 perfluorinated compounds (PFCs) in drinking water, tap water, river water and plant effluent from southern China by supramolecular solvent (SUPARS) vortex-mixed microextraction combined with high performance liquid chromatography-Orbitrap high resolution mass spectrometry (HPLC-Orbitrap HRMS). The SUPRAS without heating assistance is less solvent-consumption, meeting the requirements for green environmental protection and sustainable development. Parameters in the microextraction such as volume of dodecanol and tetrahydrofuran (THF), vortexing extraction and centrifugation time, salt concentration were investigated. The optimal extraction conditions were 250 mu L of undecanol, 1.0 mL of THF and 20.0% (w/v, 4 g) NaCl. Under the optimum conditions, method limit of detection and method limit of quantitation in the ranges of 0.01-0.08 mu g/L and 0.03-0.25 mu g/L, good recoveries (72.5-117.8%) and intra-day precision (1.1-11.2%, n = 6), high enrichment factors (48-78) were obtained. The developed method was successfully applied for analysis of PFCs in 13 drinking water, tap water, river water and plant effluent samples collected from southern China. Perfluorobutane sulfonic acid was detected in one river water with concentration of 0.48 mu g/L and 1H,1H,2H,2H-Perfluorooctane sulfonic acid was detected in one river water and two plant effluent samples with concentrations in the range of 0.14-0.67 mu g/L.				1				-	-		
D194	分析	Houtz, EF; Sedlak, DL	Oxidative Conversion as a Means of Detecting Precursors to Perfluoroalkyl Acids in Urban Runoff	2012	Environ. Sci. Technol. 2012 Sep:46(17):9342-9349. doi: 10.1021/es302274g.	A new method was developed to quantify concentrations of difficult-to-measure and unidentified precursors of perfluoroalkyl carboxylic (PFCA) and sulfonic (PFSA) acids in urban runoff. Samples were exposed to hydroxyl radicals generated by thermolysis of persulfate under basic pH conditions and perfluoroalkyl acid (PFAA) precursors were transformed to PFCAs of related perfluorinated chain length. By comparing PFCA concentrations before and after oxidation, the concentrations of total PFAA precursors were inferred. Analysis of 33 urban runoff samples collected from locations around the San Francisco Bay, CA indicated that PFOS (2.6-26 ng/L), PFOA (2.1-16 ng/L), and PFHxA (0.9-9.7 ng/L) were the predominant perfluorinated compounds detected prior to sample treatment. Following oxidative treatment, the total concentrations of PFCAs with 5-12 membered perfluoroalkyl chains increased by a median of 69%, or between 2.8 and 56 ng/L. Precursors that produced PFHxA and PFPeA upon oxidation were more prevalent in runoff samples than those that produced PFOA, despite lower concentrations of their corresponding perfluorinated acids prior to oxidation. Direct measurements of several common precursors to PFOS and PFOA (e.g., perfluorooctanesulfonamide and 8:2 fluorotelomer sulfonate) accounted for less than 25% of the observed increase in PFOA, which increased by a median value of 37%. Exposure of urban runoff to sunlight, advanced oxidation processes, or microbes could result in modest, but measurable, increases in concentrations of PFCAs and PFSAs.		1						-	-		
D195	分析	Risha, K; Flaherty, J; Wille, R; Buck, W; Morandi, F; Isemura, T	Method for trace level analysis of C8, C9, C10, C11, and C13 perfluorocarbon carboxylic acids in water	2005	Anal. Chem. 2005 Mar:77(5):1503-1508. doi: 10.1021/ac0490548.	A method was developed for the trace level analysis of pentadecafluorooctanoic acid (C8), heptadecafluorononanoic acid (C9), nonadecafluorodecanoic acid (C10), heneicosafluoroundecanoic acid (C11) and pentacosafluorotridecanoic acid (03) in water. Samples were concentrated by solid-phase extraction (SPE) before analysis by combined liquid chromatography/electrospray tandem mass spectrometry (LC/MS/M.S). A surrogate standard, 9-hydrohexadecafluorononanoic acid (9H), was used to monitor recovery. The lower limit of quantitation (LLOQ) for C8, C9, C10, C11, and C13 was determined to be 25 ng/L in water. The specificity of the method was established by showing no significant interferences (< 20% of the LLOQ standard) in control samples of well, stream, spring, tap, omnisolve, and type I water at the retention time of the target analytes. The linearity of the method was determined; the coefficients of determination for the five calibration curves generated were all > 0.985. Good within-day and between-day accuracy and precision were demonstrated. Extracts and standards were shown to be stable after remaining at room temperature for similar to 24 h. Samples fortified with C8, C9, C10, and C1 1 were shown to be stable after remaining at room temperature for 14 days before extraction. Samples fortified with C13 were shown to be stable after remaining at room temperature for 7 days before extraction. Fortified samples, extracts, and standards demonstrated stability after being stored in a refrigerator for 14 days for all analytes. Long-term storage stability was demonstrated for methanolic stock solutions.			1					-	-		
D196	分析	Delatour, T; Theurillat, X; Eriksen, B; Mujahid, C; Mottier, P	Inadequate definition of the limit of quantification used for the analysis of perfluoroalkyl substances in food by liquid chromatography-tandem mass spectrometry may compromise the reliability of the data requested by the European regulation	2023	Rapid Commun. Mass Spectrom. 2023 JUN 15;37(11):e9507. doi: 10.1002/rcm.9507.	Liquid chromatography-tandem mass spectrometry (LC-MS/MS) is a widespread technology used for the quantitative determination of per- and polyfluoroalkyl substances (PFAS) in foodstuff. Specifically, LC-MS/MS offers an attractive performance by combining the sensitivity and selectivity required by the European Union for testing perfluorooctane sulfonic acid, perfluorooctanoic acid, perfluorononanoic acid, and perfluorohexane sulfonic acid with maximum limits of quantification (LOQ) in the sub-parts-per-billion (mu g/kg) or the parts-per-trillion (ng/kg) domains. In this article, we highlight the important diversity in LOQ definitions applied in LC-MS/MS methods described in the literature that raise concerns about the capability of some of those to generate reliable data requested by the European regulation. Here, we point out the risk of false response or misquantification if the criteria for assessing LOQ suffer from a lack of rigor. We emphasize the need to use PFAS-free samples spiked with the analyte(s) of interest and the application of identification criteria according to official documents for a sound measurement of the LOQ.			1					-	-		
D197	分析	Fan, XQ; Jiang, YM; Guan, XY; Bao, YX; Gu, MB; Mumtaz, M; Huang, J; Yu, G	Determination of total reducible organofluorine in PFAS-impacted aqueous samples based on hydrated electron defluorination	2022	Sci. Total Environ. 2022 Jul:829:154548. doi: 10.1016/j.scitotenv.2022.154548.	Per-and polyfluoroalkyl substances (PFASs) is a large group of thousands of anthropogenic chemicals. Recently, measurement of total organic fluorine (TOF) to reflect the total PFASs has been recommended in limits and advisories. In this study, a total reducible organofluorine (TROF) assay is developed based on hydrated electron (e(aq)(-)) conversion of PFASs into inorganic fluorine combined with ion chromatograph, which is a common and widespread instrument. The e(aq)(-) is generated in UV/sulfite system with alkaline condition, and the concentration of TROF (C-F_TROF) is the difference of fluoride concentration before and after assay. Method validation uses perfluorooctanesulfonic acid, perfluorooctanoic acid and their main alternatives, and F- recoveries are 76.6%-101%, except for perfluorobutanesulfonic acid (48.5%). Method application of TROF assay uses industrial surfactant products and fluorochemical industry-contaminated water, meanwhile, target PFAS analysis and total oxidizable precursors (TOP) assay are concurrently conducted. Concentrations of PFASs detected in target analysis and TOP assay were converted to fluorine equivalents concentrations (C-F_Target and C-F_TOP). sigma C-F_Target and sigma C-F_TOP account for 0.80%-36% of C-F_TROF in industrial samples, 0.12%-54% in environmental water and 9.7%-14% in wastewater. The TROF assay can be used to initially judge whether PFASs contamination occurred near a hotspot with known sources. The C-F_TROF could infer the extent of PFAS contamination in PFAS-impacted samples and estimate the fraction of uncharacterized PFAS.				1				-	-		
D198	分析	Bartolome, M; Gallego-Pico, A; Huetos, O; Lucena, MA; Castano, A	A fast method for analysing six perfluoroalkyl substances in human serum by solid-phase extraction on-line coupled to liquid chromatography tandem mass spectrometry	2016	Anal. Bioanal. Chem. 2016 Mar:408(8):2159-2170. doi: 10.1007/s00216-016-9319-0.	We have developed and validated an on-line TurboFlow solid-phase extraction procedure coupled to high-performance liquid chromatography with tandem mass spectrometry for the analysis of six perfluoroalkyl substances (PFAS), two sulfonates (perfluorooctane sulfonate and perfluorohexane sulfonate), three carboxylates (perfluorooctanoic acid, perfluorononanoic acid and perfluorodecanoic acid), and one sulfonamide (N-methylperfluorooctane sulfonamide), in human serum samples. This method requires only 100 mu L of sample and involves a short pre-treatment with acetonitrile followed by addition of a labelled internal standard for quantification and ultracentrifugation. All PFAS were detected with a run time of 8.5 min. Linearity ranges stay between 0.1 and 20 mu g L-1 (R (2) > 0.9960). Recoveries were determined by spiking blank serum samples with a mixture of six PFAS and found to be in the range 96-110 % for all compounds. Isotopic dilution was used to quantify the selected analytes. The low limits of quantification obtained, between 0.16 and 0.34 mu g L-1, small volume of sample required and short run time used (from two to three times shorter than any other described method), make this validated method highly recommended for human biomonitoring studies.			1					-	-		
D199	分析	Skov, K; Hadrup, N; Smedsgaard, J; Frandsen, H	LC-MS analysis of the plasma metabolome-A novel sample preparation strategy	2015	J. Chromatogr. B 2015 Jan:978:83-88. doi: 10.1016/j.jchromb.2014.11.033	Blood plasma is a well-known body fluid often analyzed in studies on the effects of toxic compounds as physiological or chemical induced changes in the mammalian body are reflected in the plasma metabolome. Sample preparation prior to LC-MS based analysis of the plasma metabolome is a challenge as plasma contains compounds with very different properties. Besides, proteins, which usually are precipitated with organic solvent, phospholipids, are known to cause ion suppression in electrospray mass spectrometry. We have compared two different sample preparation techniques prior to LC-gTOF analysis of plasma samples: the first is protein precipitation; the second is protein precipitation followed by solid phase extraction with sub-fractionation into three sub-samples: a phospholipid, a lipid and a polar sub-fraction. Molecular feature extraction of the data files from LC-qTOF analysis of the samples revealed 1792 molecular features from the protein precipitation procedure. The protein precipitation followed by solid phase extraction procedure with three sub-samples gave a total of 4234 molecular features. This suggests that sub-sampling into polar, lipid and phospholipid fractions enables extraction of more metabolomic information as compared to protein precipitation alone. Chromatography showed good separation of the metabolites with little retention time drift (<1 s) and a mass accuracy below 3 ppm was observed. The performance of the method was investigated using plasma samples from rats administered the environmental pollutant perfluorononanoic acid.			1					-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D200	分析	Zhou, X; Ling, H; Yue, Q	APPLICATION OF LIQUID CHROMATOGRAPHY TANDEM HIGH RESOLUTION MASS SPECTROMETRY (LC-HRMS) IN SURFACE WATER ENVIRONMENTAL PROTECTION	2022	Fresenius Environ. Bull. 2022;31(2):2221-2229.	As one of the important sources of water for human life, the pollution of surface water has attracted extensive attention. How to efficiently identify a large number of organic pollutants from the surface water environment and quickly grasp the pollution distribution of organic pollutants in the surface water environment has become one of the hot and difficult issues in the surface water environmental protection work. Taking the typical lakes in Southeast China as an example, 24 points are arranged in the lake body of the sample lake and the surrounding connected rivers to collect water samples. Through LC-HRMS high-throughput screening technology and comparison with the local database without the use of standard products, 36 suspected pollutants including veterinary drugs, pesticides, personal care drugs, plasticizers and perfluorinated compounds are quickly screened. The confidence level reaches level 2. The relative value of chromatographic peak area response of suspected pollutants is used to deduce the clue of pollution traceability. For suspected pollutants detected at high frequency, some suspected pollutants show effective spatial distribution differences by ArcGIS mapping. Six suspected pollutants such as PFHxS, metformin, melamine, flutriafol, PFBs and amantadine are relatively serious in the Western Lake area and the eastern Lake area, which has a high correlation with the distribution of sewage treatment plants around the sample lake. The spatial distribution of florfenicol and Carbendazim is similar. The pollution is mainly concentrated in the southwest Lake area of the sample lake, and there is also a certain degree of pollution in the East Lake area. For the suspected pollutants with few detected points, although the amount of data is not enough to draw the Arcgis spatial distribution map, the obtained data still has certain guiding significance for the evaluation and traceability of sample lakes. According to the test data, it is inferred that there are exogenous inputs in Valsartan, Sulpiride and Imidacloprid. This study also found that there are regulatory blind areas in the southwest and east of the sample lake, especially in the east of the sample lake, which is more likely to have exogenous pollution input, but it has not been paid attention to by the local monitoring authorities. This study does not use blank sample background deduction and standard qualitative and quantitative as the conventional detection methods, but only qualitative through local database comparison, and the source of pollution is judged by the difference of semi quantitative values of suspected pollutants. This study provides an economic and feasible new method for efficient identification of organic pollutants in surface water environment and accurate traceability, and has important guiding significance for guiding surface water environmental protection.				1				-	-		
D201	分析	Goh, SXL; Lee, HK	Automated bundled hollow fiber array-liquid-phase microextraction with liquid chromatography tandem mass spectrometric analysis of perfluorinated compounds in aqueous media	2018	Anal. Chim. Acta 2018 Aug:1019:74-83. doi: 10.1016/j.aca.2018.03.003	An automated bundled hollow fiber array (BHF)-liquid-phase microextraction (LPME) methodology in combination with ultra-high-performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS) has been developed for the determination of perfluorinated compounds (PFCs) in environmental aqueous matrices. Eight PFCs were considered, including perfluoroheptanoic acid, perfluorooctanoic acid, perfluorononanoic acid, perfluorodecanoic acid, perfluoroundecanoic acid, perfluorododecanoic acid, perfluorotridecanoic acid, perfluorotetradecanoic acid. Experimental parameters influencing extraction efficiency, such as number of hollow fibers in the BHF extraction device, type of extraction and desorption solvent, extraction conditions (stirring rate, temperature and duration), elution conditions and the salting out effect were examined. Under the most favourable conditions, enrichment factors of between 9 and 40 were achieved for the target compounds when extracting from 10 mL of sample. Good intra and inter-day precision were obtained with relative standard deviations of less than 12%. The linearity range investigated was between 5 and 10,000 ng L-1, with coefficients of determination (r(2)) >= 0.991. The developed method was applied for the UHPLC-MS/MS determination of environmental PFCs in industrial water discharge samples. The automation of BHF-LPME together with UHPLC-MS/MS rendered the method efficient, rapid and sensitive to determine PFCs, with the possibility of on-site real-time monitoring of contaminants in environmental waters.			1					-	-		
D202	分析	Li, MY; Li, PF; Han, YH; Han, DD; Yan, HY	Rapid and inexpensive nylon-66-filter solid-phase extraction followed by gas chromatography tandem mass spectrometry for analyzing perfluorinated carboxylic acids in milk	2022	J. Chromatogr. A. 2022 Aug:1677:463288. doi: 10.1016/j.chroma.2022.463288.	In this study, a new rapid and inexpensive filter solid-phase extraction method (FSPE) was developed for the extraction and separation of five perfluorinated carboxylic acids (PFCAs) (namely, perfluorooctanoic acid, perfluorononanoic acid, perfluorodecanoic acid, perfluoroundecanoic acid, and perfluorododecanic acid) from milk samples. Commercial nylon 66 syringe filters were used as adsorbents without additional modification. The proposed method could achieve the fast adsorption of analytes by benefitting from the advantages of using the nylon 66 filter membrane on PFCAs with multiple adsorption interactions, namely, hydrophobic interactions and hydrogen bonds. The FSPE was designed to achieve the rapid iso-lation of analytes based on the rapid solid-liquid separation while using the solid-phase extraction disk. PFCAs residues in milk were extracted by first flowing the samples through a nylon 66 syringe filter from top to bottom. Double contact desorption with methanol was then accomplished by pulling and pushing the syringe, followed by derivatization with acetyl chloride-methanol. Finally, the extracted PFCAs residues were monitored using gas chromatography-tandem mass spectrometry (GC-MS/MS) quantification. Under optimal conditions, the established method presented good linearity (correlation coefficient >= 0.9996), precision (relative standard deviation <= 13%), accuracy (81-105%), sensitivity (limits of quantification: 4-18 ng kg (-1)) and extraction performance (10 min).			1					-	-		
D203	分析	Huerta, B; McHugh, B; Regan, F	Development and application of an LC-MS method to the determination of poly- and perfluoroalkyl substances (PFASs) in drinking, sea and surface water samples	2022	Anal. Methods. 2022 Jun:14(21):2090-2099. doi: 10.1039/d2ay00300g.	Poly- and perfluoroalkyl substances (PFASs) are a group of synthetic organic surfactants that have become a global concern because of their toxicity and widespread presence in the aquatic environment and organisms globally. In this study, a new analytical method has been developed and validated for the analysis of 15 perfluorinated compounds in different water matrices: river water, drinking water and seawater. Water extraction was performed in anion exchange solid phase extraction cartridges, and extracts were analysed by liquid chromatography in tandem with mass spectrometry. Recoveries for target analytes were between 35 and 120%, depending on the water matrix. Method detection limits were in the range of 0.5-17 ng L-1. The validated method was applied to the determination of perfluorinated compounds in water samples around Ireland. Eight compounds out of fifteen were detected at least in one sample. Measured concentrations were higher in river water than seawater, and drinking water had the lowest levels, although still detectable for a considerable amount of compounds. The most prevalent compounds were PFPeA, PFOA and PFHxA, present in all types of water, and they had the highest concentrations.		1						-	-		
D204	分析	Lloyd, AS; Bailey, VA; Hird, SJ; Routledge, A; Clarke, DB	Mass spectral studies towards more reliable measurement of perfluorooctanesulfonic acid and other perfluorinated chemicals (PFCs) in food matrices using liquid chromatography/tandem mass spectrometry	2009	Rapid Commun. Mass Spectrom. 2009 Sep:23(18):2923-2938. doi: 10.1002/rcm.4190.	Liquid chromatography/mass spectrometry (LC/MS) experiments are described, leading to a reliable method for the measurement of perfluorooctanesulfonic acid (PFOS) and other perfluorinated chemicals (PFCs) in foods. Separations were performed on new fluorinated stationary phases, RP octyl (-C8F17) or propyl-perfluorobenzene (-C3H6-C6F5), to ensure resolution of PFOS and interfering taurohydroxycholate isomers. Aqueous ammonium formate (5 mM) and methanol were used as the mobile phases. The mass spectrometer was operated in negative electrospray ionisation mode, recording two transitions for each analyte and one for each internal standard. The purities of the analytical standards for the eleven target perfluoro analytes (C-7 to C-12 carboxylic acids, C-4, C-6 and C-8 sulfonic acids, and octanesulfonamide (PFOSA)) were found to be in close agreement with the supplied values; the lowest purity was 91%. Five candidate internal standards were investigated, C-13(4)-PFOS, C-13(4)-perfluorooctanoic acid, C-13(2)-perfluorodecanoic acid, D-9-n-ethylperfluorooctane-sulfonamidoethanol (D-9-n-Et-FOSE) and D-3-n-methylperfluorooctanesulfonamide (D-3-n-Me-FOSA); the purities were all >98%. The use of tetrahydro-PFOS generated backgrounds (>1 mu g/kg) for perfluoroheptanoic acid and perfluorobutanesulfonic acid. Similarly D-9-n-Et-FOSE was unacceptable and D3-n-Me-FOSA was volatile, leaving no clear candidate for normalisation of the measurement of PFOSA. Severe matrix-induced suppression and enhancement effects influenced ionisation, making external calibration and quantification problematic. This was addressed by a parallel standard addition and matrix-matching approach, comparing ionisation in methanol, in procedural blanks and in food-based extracts. The limits of detection (LODs) of 0.001-0.01 mu g/kg in solvent and 0.01-1 mu g/kg in foods demonstrate that this method is suitable for the determination of PFCs in all food to the required 1 mu g/kg reporting level.					1			-	-		
D205	分析	Gao, XY; Wang, YX; Chen, DW; Li, JG; Zhong, YX; Zhao, YF; Wu, YN	On-line solid phase extraction-ultra high performance liquid chromatography-quadrupole/Orbitrap high resolution mass spectrometry determination of per- and polyfluoroalkyl substances in human serum	2022	J. Chromatogr. B. 2022 Dec:1212:123484. doi: 10.1016/j.jchromb.2022.123484.	A rapid, high-performance, and accurate on-line TurboFlow ultra high performance liquid chromatography-quadrupole/Orbitrap high resolution mass spectrometry method was developed for the analysis of 46 perand polyfluoroalkyl substances (PFAS), including 17 perfluoroalkylcarboxylic acids, 15 perfluoroalkylsulfonates, 3 fluorinated telomer sulfonates, 2 perfluoroalkyl unsaturated carboxylates, 2 perfluorooctanesulfonamidoacetic acid, 3 perfluorooctanesulfonamides, hexafluoropropylene oxide-dimer acid, ammonium 4,8-dioxa-3H-perfluorononanoate, 6:2 chlorinated polyfluorinated ether sulfonate (Cl-PFESA), and 8:2 Cl-PFESA, in human serum. The TurboFlow column, mobile phase, sample injection volume, loading flow rate, and elution time were optimized. The linearities of matrix calibration curves, method limits of quantification, accuracy and precision were investigated for method validation. Serum samples (50 mu L) were precipitated with acetonitrile and directly injected into the system. The method showed good linearity (R2 > 0.99), satisfactory recoveries (matrix-spiked recoveries range: 68.9%-115.7%), good precision (relative standard deviation ranges: 1.2%-12.1%) and a low method limit of quantification (0.1-1 ng mL-1). The developed method is rapid, accurate and convenient for large-scale biomonitoring of PFAS in humans. Fifty real serum samples from China were analyzed and the results showed that br-perfluorooctanesulfonate (PFOS) accounted for approximately 30% of the n-ary sumation PFOS in serum, which suggested there was high exposure to 6:2 Cl-PFESA.			1					-	-		

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D206	分析	Zhu, PF; Ling, X; Liu, WW; Kong, LC; Yao, YY	Simple and fast determination of perfluorinated compounds in Taihu Lake by SPE-UHPLC-MS/MS	2016	J. Chromatogr. B 2016 Sep:1031:61-67. doi: 10.1016/j.jchromb.2016.07.031	A simple and fast analytical method for determination of eleven Polyfluorinated Compounds (PFCs) in source water was developed in the present work. The water sample was prepared without filtered through microfiltration membrane and 500 mL of source water was enriched by the solid phase extraction (SPE). The targent compounds were analyzed by ultra high performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS). The optimized analytical method was validated in terms of recovery, precision and method detection limits (MDLs). The recovery values after correction with the corresponding labeled standard were between 97.3 and 113.0% for samples spiked at 5 ng/L, 10 ng/L and 20 ng/L. All PFCs showed good linearity and the linear correlation coefficient was over 0.99. The precisions were 1.0-9.0% (n = 6). As the result of the enrichment, the MDL values ranged from 0.03 to 1.9 ng/L and were enough for analysis of the trace levels of PFCs in the Taihu Lake. The method was further validated in determining the source water and the results showed that PFHxS, PFHxA, PFOA and PFOS were the primary PFCs in Taihu Lake which might be different from the other researches. The method can be used for determination of PFCs in water with a stable recovery, good reproducibility, low detection limit, less solvent consumption, time saving and labor saving. To our knowledge, this is the first method that describes the effect of the filter membrane on the determination of PFCs in water which might acquire more accurate concentration of PFCs in Taihu Lake.		1						-	-		
D207	分析	Koronaiou, LA; Nannou, C; Xanthopoulou, N; Seretoudi, G; Bikiaris, D; Lambropoulou, DA	High-resolution mass spectrometry-based strategies for the target analysis and suspect screening of per- and polyfluoroalkyl substances in aqueous matrices	2022	Microchem J. 2022 Aug:179:107457. doi: 10.1016/j.microc.2022.107457.	Per-and polyfluoroalkyl substances (PFASs) are a man-made diverse group of highly fluorinated aliphatic molecules, entailing risks to the ecosystems and human health. Herein, a streamlined, single-shot, HRMS-based analytical workflow for the quantitation and suspect screening of various PFAS was developed. Sample preparation was based on weak-anion exchange solid phase extraction, while instrumental analysis was performed by highly sensitive liquid chromatography Orbitrap-high-resolution mass spectrometry. The target method was optimized and validated for drinking water, surface water, and wastewater, while it was also modified to be efficient for leachates. Method performance was excellent in terms of linearity (R2 > 0.99), detection/quantification limits (reaching even at pg L-1 scale), recoveries (70-108 %, for most of the compounds), and precision (< 20%). Isotopically labelled internal standards and matrix-matched calibration curves were used for quantification. The suspect analysis performed on a single-stage HRMS method operating in data-dependent 'discovery' mode. Thus, content-rich spectra were acquired and once combined with suspect screening features such as peak picking, feature alignment, and compound annotation enabled the putative annotation of the tested PFAS with high confidence. After evaluation, the presented fully elaborated workflow was applied to real samples to explore the putative annotation of the tested PFAS with high confidence for the first time in Greece for five different matrices, revealing maximum concentrations for PFOS 1.5 ng L-1 in tap water and 394.4 ng L-1 in effluent wastewater, and PFHxA 4284.8 ng L-1 in leachates.		1						-	-		
D208	分析	Kudo N, Bandai N, Kawashima Y.	Determination of perfluorocarboxylic acids by gas-liquid chromatography in rat tissues	1998	Toxicol Lett. 1998 Nov 12;99(3):183-90. doi: 10.1016/s0378-4274(98)00154-4.	A method for the determination of tissue perfluorocarboxylic acids (PFCA) was developed using gas-liquid chromatography with an electron capture detector (ECD). Perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA) were efficiently extracted from rat liver, methylated with diazomethane, and separated on GLC. Internal standards that were added to liver homogenates were used in the quantitative analysis of PFCAs to correct the loss during the extraction and derivatization. The concentration of PFDA in rat liver 24 h after intraperitoneal administration at a dose of 20 mg/kg body weight was 113.9 +/- 11.4 microg/g liver. The value corresponds to the previously reported results that were obtained using [14C]PFDA.			1					-	-		
D209	分析	Ohya T, Kudo N, Suzuki E, Kawashima Y.	Determination of perfluorinated carboxylic acids in biological samples by high-performance liquid chromatography	1998	J Chromatogr B Biomed Sci Appl. 1998 Dec 11;720(1-2):1-7. doi: 10.1016/s0378-4347(98)00448-4.	This paper describes a method for the quantitative determination of perfluorinated carboxylic acids (PFCAs), perfluorohexanoic acid (C6-PFCA), perfluoroheptanoic acid (C7-PFCA), perfluorooctanoic acid (C8-PFCA), perfluorononanoic acid (C9-PFCA) and perfluorodecanoic acid (C10-PFCA), in biological samples. PFCA in liver homogenates was extracted as an ion pair with tetrabutylammonium (TBA) ion into organic solvent, then the PFCA was derivatized with 3-bromoacetyl-7-methoxycoumarin (BrAMC) and quantified by HPLC with fluorescence detection. This method is applicable for the studies on tissue accumulation and elimination of PFCAs in animals after the administration.		1	1					-	-		
D210	分析	Kotrebai M, Tyson JF, Block E, Uden PC.	High-performance liquid chromatography of selenium compounds utilizing perfluorinated carboxylic acid ion-pairing agents and inductively coupled plasma and electrospray ionization mass spectrometric detection	2000	J Chromatogr A. 2000 Jan 7;866(1):51-63. doi: 10.1016/s0021-9673(99)01060-2.	Increasing speciation demands in clinical chemistry, toxicology and nutrition have made the determination of the total elements in a sample inadequate; the amount of an element and the chemical forms in which it is present need to be known. Inductively coupled plasma mass spectrometry (ICP-MS) was used after high-performance liquid chromatographic (HPLC) separation, as was electrospray ionization mass spectrometry (ESI-MS). The effect of variation of the number of carbon atoms in perfluorinated carboxylic acids used as ion-pairing agents for the separation of selenium compounds was examined. Trifluoroacetic acid (0.1%), pentafluoropropanoic acid (0.1%) or heptafluorobutanoic acid (0.1%; HFBA) were alternatively used as additives to methanol-water (1:99, v/v) solutions as mobile phases. Reversed-phase HPLC-ICP-MS with 0.1% HFBA in the mobile phase allowed more than 20 selenium compounds to be separated in 70 min in an isocratic elution mode; the separation of natural selenium-enriched sample extracts was examined and explained. The pH of the 0.1% HFBA solution was modified with hydrochloric acid or ammonia and the pH of the sample extracts before injection was modified in order to overcome unwanted double peak formation in the chromatograms of sample extracts. Oxidations of standard gamma-glutamyl-Se-methylselenocysteine and Se-methylselenocysteine were carried out using 30% H2O2 solution and identifications of selenium-containing oxidation products were made using HPLC-ICP-MS and HPLC-ESI-MS. The principal organic oxidation product in both cases was methaneseleninic acid (MeSeO2H).	1							-	-		
D211	分析	Montes R, Aguirre J, Vidal X, Rodil R, Cela R, Quintana JB.	Screening for Polar Chemicals in Water by Trifunctional Mixed-Mode Liquid Chromatography-High Resolution Mass Spectrometry	2017	Environ Sci Technol. 2017 Jun 6;51(11):6250-6259. doi: 10.1021/acs.est.6b05135. Epub 2017 May 12.	The presence of persistent and mobile organic contaminants (PMOC) in aquatic environments is a matter of high concern due to their capability of crossing through natural and anthropogenic barriers, even reaching drinking water. Most analytical methods rely on reversed-phase liquid chromatography (RPLC), which is quite limited for the detection of very polar chemicals. Thus, many of these PMOCs may have not been recognized as water pollutants yet, due to the lack of analytical methods capable to detect them. Mixed-mode LC (MMLC), providing the combination of RP and ion-exchange functionalities is explored in this work with a trifunctional column, combining RPLC, anion and cation exchange, which allows the simultaneous determination of analytes with extremely different properties. A nondiscriminant sample concentration step followed by a MMLC-high resolution mass spectrometry method was developed for a group of 37 very polar model chemicals with different acid/base functionalities. The overall method performance was satisfactory with a mean limit of detection of 50 ng/L, relative standard deviation lower than 20% and overall recoveries (including matrix effects) higher than 60% for 54% of model compounds. Then, the method was applied to 15 real water samples, by a suspect screening approach. For those detected PMOC with standard available, a preliminary estimation of concentrations was also performed. Thus, 22 compounds were unequivocally identified in a range of expected concentrations from 6 ng/L to 540 μg/L. Some of them are well-known PMOC, such as acesulfame, perfluorobutanoic acid or metformin, but other novel pollutants were also identified, as for example di-o-tolylguanidine or trifluoromethanesulfonic acid, which had not or were scarcely studied in water so far.	1							-	-		

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D212	分析	Song XL, Wang N, He FY, Cheng CL, Wang F, Wang JL, Zhang LH.	[Determination of trace perfluorinated compounds in environmental water samples by dispersive solid-phase extraction-high performance liquid chromatography-tandem mass spectrometry using carbon nanotube composite materials]	2023	Se Pu. 2023 May 8;41(5):409-416. doi: 10.3724/SP.J.1123.2022.09016.	In this work, carbon nanotubes (CNTs) on silica rod (SiO2) composite materials were prepared to extract six perfluorinated compounds (PFCs) in real environmental water samples by high performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS). The as-synthesized sorbents, hereafter referred to as CNT@SiO2, were employed for dispersive solid-phase extraction (d-SPE). Perfluoroheptanoic acid (PFHpA), perfluorohexane sulfonate (PFHxS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorooctane sulfonate (PFOS), and perfluorodecanoic acid (PFDA) were selected as target analytes. The main extraction parameters were systematically optimized using the single-factor optimization method. The optimum adsorption parameters were as follows: adsorption time of 30 min, sorbent amount of 10 mg, pH 6 and NaCl concentration of 1.7 mol/L for sample solution, and 4 mL acetone as desorption solvent, desorption for 4 min. LC-triple quadrupole MS was conducted to quantify the selected PFCs in water samples. The mobile phase was 5 mmol/L ammonium acetate and methanol, the flow rate was set to 0.4 mL/min, the column temperature was set to 40 °C, and the injection volume was 5.0 μL. The chromatographic separation system was equipped with a Kinetex C18 column (100 mm × 2.1 mm, 1.7 μm). The mass spectrometer was operated with negative electrospray ionization in multi-reaction monitoring mode. CNT@SiO2 was prepared in five batches and used as the d-SPE sorbent, and the relative standard deviations (RSDs) of the PFC recoveries among these five batches ranged from 4.9% to 9.3%. The reusability of the CNT@SiO2 sorbent was assessed. After eight d-SPE cycles using the same sorbent, the RSDs of the PFC recoveries were 3.7%-8.2%. These results indicated that the sorbent had good stability and reusability for d-SPE. Excellent results were achieved under optimal extraction conditions. The method validation results indicated that the linear ranges were 0.4-1000 ng/L for PFNA, PFOS, and PFDA, 0.9-1000 ng/L for PFHpA, 0.7-1000 ng/L for PFHxS, and 0.6-1000 ng/L for PFOA. The correlation coefficients were 0.973-0.997. The limit of detection (LOD) and limit of quantification of the method were 0.10-0.26 ng/L and 0.33-0.87 ng/L, respectively. At 20 ng/L, the RSDs of the intra- and inter-day precisions were 2.73%-7.75% and 3.38%-8.21%, respectively. At 100 ng/L, the RSDs of the intra- and inter-day precisions were 2.95%-8.46% and 4.16%-9.14%, respectively. Finally, at 500 ng/L, the RSDs of the intra- and inter-day precisions were 2.51%-7.48% and 3.59%-9.63%, respectively. The developed method was applied to analyze six PFCs in tap water, barreled drinking water, and river water samples. PFOA and PFOS were determined in tap water at mass concentrations of 5.6 and 8.7 ng/L, respectively. No PFCs were found in barreled drinking water and river water. Satisfactory recoveries of 72.1%-109.6% at low, middle, and high spiking levels were also obtained. In conclusion, the d-SPE-LC-MS/MS method based on CNT@SiO2 composite sorbents is accurate and sensitive. The results of this study demonstrate that CNT@SiO2 is a good choice for the rapid and effective determination of PFCs from water			1					-	-		
D213	分析	Yu C, Stevenson G, De Araujo J, Crough R.	Application of in-source fragmentation to the identification of perfluoropentanoic acid and perfluorobutanoic acid in environmental matrices and human serum by isotope dilution liquid chromatography coupled with tandem mass spectrometry	2023	Chemosphere. 2023 Aug 10;340:139756. doi: 10.1016/j.chemosphere.2023.139756. Online ahead of print.	Liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS) is the most common analytical technique for per- and polyfluoroalkyl substances (PFASs) research and monitoring. The PFAS identification requires a minimum of two multiple reaction monitoring (MRM) transition ions as quantifier transition ion and qualifier transition ion, respectively. The second transition ion abundance for perfluoropentanoic acid (PFPeA) and perfluobutanoic acid (PFBA) is too low for practical use. A method using the in-source fragment ions as the precursor ion for MRM or pseudo-MRM has been developed and evaluated for PFPeA and PFBA identification in various environmental abiotic and biotic samples including water, soil, sediment, WWTP sludge, fruits, vegetables, egg, macrophytes, fish, dolphin liver and human serum. The PFPeA qualifier MRM transition ion (m/z = 219 > 69) has been successfully applied in all the matrices with spike recoveries (90-125%), signal to noise ratios (>10) and transition ions ratio variation (80-120%). The PFBA qualifier pseudo-MRM transition ion (m/z = 169 > 169) works well in all the matrices except dolphin liver sample. The interpretation of pseudo-MRM results should be with cautions due to lower specificity compared to MRM. In addition, this project indicated under typical chromatographic conditions the MRM isobaric interference does happen frequently to PFPeA quantifier transition ion (m/z = 263 > 219) in serum and fish composite samples, and to PFBA quantifier transition ion (m/z = 213 > 169) in macrophytes, fish composite and dolphin liver samples.	1							-	-		
D214	分析	Stecconi T, Tavoloni T, Stramenga A, Bacchiocchi S, Barola C, Dubbini A, Galarini R, Moretti S, Sagratini G, Piersanti A.	A LC-MS/MS procedure for the analysis of 19 perfluoroalkyl substances in food fulfilling recent EU regulations requests	2023	Talanta. 2023 Aug 7;266(Pt 2):125054. doi: 10.1016/j.talanta.2023.125054. Online ahead of print.	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are synthetic, stable, fluorinated molecules widely used in consumer products. They are non-biodegradable, persistent and bio-accumulating. In 2020 European Food Safety Authority (EFSA) lowered the Tolerable Weekly Intake (TWI) for the four PFASs (PFOA, PFOS, PFNA, PFHxS) and in 2022, the EU issued a Recommendation asking to monitor twenty-one PFASs in food. Since 1st January 2023 limits in food were set. Here we report a sensitive, straightforward and robust procedure enabling the determination of 19 PFAS in food matrices using a liquid chromatography mass spectrometer (LC-MS/MS). Few are the published methods applicable to the different food matrices and covering the molecules listed in Recommendation 2022/1431, fulfilling the LOQs requested. The method was satisfactory validated (UNI CEI EN ISO/IEC 17025:2018 and Regulation (EU) 2022/1428) and used to investigate hen egg samples, highlighting home-produced eggs as the more critical egg farming process for PFAS accumulation.			1					-	-		
D215	分析	Norihiro Kobayashi, Sokichi Takagi, Teruaki Kinoshita, Osamu Sakata, Fumi Nakano, Naoto Watanabe, Azumi Nomura, Nobuyuki Kawai, Toshiya Hiraiwa, Manabu Okumura, Koji Furukawa, Tomohiro Kasuya, Noritomo Iwama, Jun Yonekubo, Reika Takahara, Seiya Tanaka, Yuko Tsuchiya, Yoshiaki Ikarashi	Development and Validation of an Analytical Method for Simultaneous Determination of Perfluoroalkyl Acids in Drinking Water by Liquid Chromatography/Tandem Mass Spectrometry	2022	Journal of Water and Environment Technology, 2022年 20 巻 6 号 219-237. doi: 10.2965/jwet.22-058	The environmental presence and drinking water contamination of per- and polyfluoroalkyl substances (PFAS) have been reported since the early 2000s. This study seeks to develop a liquid chromatography/tandem mass spectrometry analytical method for the simultaneous determination of 21 perfluoroalkyl acids (PFAAs) in drinking water to support future regulations in Japan. Inter-laboratory tests were conducted in 16 laboratories using different instrument to verify the applicability of the developed method for a wide range of drinking water samples in Japan. Recovery tests of PFAA-fortified tap water samples obtained in each laboratory were conducted at set points of 1 and 10 ng/L. Calibration curve linearity, trueness (recovery), repeatability (RSDr), and reproducibility (RSDR) at these analyte concentrations were calculated using data obtained from the recovery tests. The trueness, RSDr, and RSDR of most PFAA analytes were satisfactory when the recoveries were corrected by 13C-PFAA extraction standards with similar recovery to the corresponding PFAS analytes. The developed analytical method is valid for the quantification of the target PFAAs in drinking water. However, satisfactory PFAA quantification requires recovery adjustment using surrogates with similar recovery characteristics to the PFAA analytes.								-	-		
D216	分析	高木 総吉, 吉田 仁	水道水中におけるペルフルオロおよびポリフルオロアルキル化合物の分析法検討	2021	水道協会雑誌, 2021年 90 巻 6 号 2-15. doi: 10.34566/jwwa.90.6_2	水道中のPFOS とPFOA を含むペルフルオロおよびポリフルオロアルキル化合物（PFASs）を分析するために、標準品、容器、抽出固相および内部標準物質の検討を行った。その結果、標準品の中には直鎖以外の化合物も含まれているものがあった。プラスチック製の容器には炭素鎖の長いPFASsが吸着した。抽出用の固相は弱アニオン交換系の固相が最も多種類のPFASs を回収できた。内部標準物質の使用により、前処理時の経路等への吸着による回収率の低下を補正できた。水道水を用いて妥当性評価を実施した結果、妥当性評価のガイドラインの目標を満たした。水道水にPFOS・PFOA 以外のPFASs も存在していることがわかった。								-	-		
D217	分析	山崎 絵理子, 谷保 佐知, 島村 紘大, 佐々木 俊哉, 山下 信義	外洋海水中ペルフルオロ化合物微量分析のための固相抽出法の開発	2015	分析化学, 2015年 64 巻 10 号 759-768. doi: 10.2116/bunsekikagaku.64.759	ペルフルオロオクタン酸をはじめとするペルフルオロアルキル化合物（PFASs）の一般環境水中モニタリングは近年活発に行われているが，一方で外洋海水分析報告は現在でもまれである．外洋海水分析データが乏しい原因の一つとして，市販の固相抽出（SPE）カートリッジの性能が海水分析に最適化されていないことが考えられるため，本論文では現在流通しているSPEの問題点を検証した．特に一般的なC18系固相と陰イオン交換能を有する固相を検討し，後者について充填量と粒子径を500 mg，30 μmとすることで，外洋海水中PFASs微量分析に最適化した固相抽出カートリッジである「WAXsea」を開発した．マトリクス効果の低減に有効な脱塩操作技術も含め，ここで明らかになった精度管理条件を用いることで，1 pg L−1前後で外洋海水中に存在するPFASsの高精度分析が一般分析機関でも可能となり，ストックホルム条約外洋汚染モニタリング計画等に貢献が期待される．								-	-		
D218	分析	竹峰 秀祐, 高田 光康, 山本 勝也, 松村 千里, 藤森 一男, 渡辺 信久, 中野 武, 近藤 明	粒状活性炭中の有機フッ素化合物の分析	2013	環境化学, 2013年 23 巻 1 号 55-60. doi: 10.5985/jec.23.55	In this study, an analytical method for perfluorinated compounds (PFCs) in granular activated carbon (GAC) was investigated. The investigation of analysis was conducted by using GAC which adsorbed PFCs from artificial waste water containing PFCs of known amount. As results, it was confirmed that Accelerated solvent extraction (ASE) method using acetone as the solvent was appropriate for the extraction of PFCs in GAC. PFCs in used GAC samples, regenerated GAC samples, and a new GAC sample were analyzed by using the investigated method. The concentration of PFCs in the regenerated GAC was decreased by more than 99.9% compared with the used one. PFCs in GAC may transform and/or desorb at regeneration processes.								-	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D219	分析	Hiroyuki NAKAZAWA, Yusuke IWASAKI, Rie ITO	Analytical Methods for the Quantification of Bisphenol A, Alkylphenols, Phthalate Esters, and Perfluoronated Chemicals in Biological Samples	2014	Analytical Sciences, 2014;30(1):25-34. doi: 10.2116/analsci.30.25.	Our modern society has created a large number of chemicals that are used for the production of everyday commodities including toys, food packaging, cosmetic products, and building materials. We enjoy a comfortable and convenient lifestyle with access to these items. In addition, in specialized areas, such as experimental science and various medical fields, laboratory equipment and devices that are manufactured using a wide range of chemical substances are also extensively employed. The association between human exposure to trace hazardous chemicals and an increased incidence of endocrine disease has been recognized. However, the evaluation of human exposure to such endocrine disrupting chemicals is therefore imperative, and the determination of exposure levels requires the analysis of human biological materials, such as blood and urine. To obtain as much information as possible from limited sample sizes, highly sensitive and reliable analytical methods are also required for exposure assessments. The present review focuses on effective analytical methods for the quantification of bisphenol A (BPA), alkylphenols (APs), phthalate esters (PEs), and perfluoronated chemicals (PFCs), which are chemicals used in the production of everyday commodities. Using data obtained from liquid chromatography/mass spectrometry (LC/MS) and LC/MS/MS analyses, assessments of the risks to humans were also presented based on the estimated levels of exposure to PFCs.							-	-		
D220	分析	Yuki Igarashi, Miki Takahashi, Tomoaki Tsutsumi, Koichi Inoue, Hiroshi Akiyama	Monitoring Analysis of Perfluoroalkyl Substances and F-53B in Bottled Water, Tea and Juice Samples by LC-MS/MS	2021	Chemical and Pharmaceutical Bulletin, 2021 Volume 69 Issue 3 Pages 286-290. doi: 10.1248/cpb.c20-00888	Monitoring analysis of 14 per- and polyfluoroalkyl substances (PFAS), 9-chlorohexadecafluoro-3-oxanonane-1-sulfonate (F-53B) and dodecafluoro-3H-4,8-dioxanonanoate (ADONA) in bottled drinking water, tea and juice samples was performed using LC coupled with tandem mass spectrometry (LC-MS/MS) and solid-phase extraction (SPE). In the electrospray negative ion mode, the limit of detection and limit of quantification (LOQ) values were 0.1 to 0.8 ng/mL and 0.2 to 1.6 ng/mL, respectively. The calibration curves were linear from LOQ to 50 ng/mL ($r2 > 0.999$). The SPE procedure (Presep PFC-II) was utilized for sample preparation and recovery rates for three standards (35, 70 and 140 ng/L) were 80.4–118.8% with relative standard deviation (RSD) ≤ 0.6%. Using the developed method, various samples ($n = 54$) from Japanese markets were investigated for PFAS and F-53B contamination, and values below the LOQ were observed. It is concluded that for monitoring products in the Japanese market, our method represents a significant improvement over complex techniques for the quantification of PFAS and related compounds from various foods.							-	-		
D221	分析	松村 益代(兵庫県立健康科学研究所健康科学部), 風見 眞紀子	有機フッ素化合物(PFASs)の直接注入-LC-MS/MSによる分析法の検討	2022	兵庫県立健康科学研究所研究報告(2434-1908)3-4号 Page15-20(2022.03)	液体クロマトグラフ-タンデム質量分析計(LC-MS/MS)による水道水中の有機フッ素化合物(PFASs)の直接注入法について検討した。標準液としてPFASs混合品、内部標準液としてPFASs安定同位体混合品を用いた。直接注入法の対象化合物はスルホン酸類では炭素数4～8であるペルフルオロブタンスルホン酸、ペルフルオロヘキサンスルホン酸、ペルフルオロオクタンスルホン酸、カルボン酸類では炭素数6～10のペルフルオロヘキサン酸、ペルフルオロヘプタン酸、ペルフルオロオクタン酸、ペルフルオロノナン酸およびペルフルオロデカノン酸とした。5ng/L濃度のPFASsの添加回収試験を水道水で行った結果、真度95～105%、併行精度4.3～8.4%、室内精度4.6～10%とガイドラインの目標を満たす良好な結果が得られた。本分析法は水道水中のPFASsの8化合物について、迅速かつ高精度な分析が可能な手法であると考えられた。							-	-		
D222	分析	Huber, S; Haug, LS; Schlabach, M	Per- and polyfluorinated compounds in house dust and indoor air from northern Norway - A pilot study	2011	Chemosphere. 2011 Sep:84(11):1686-1693. doi: 10.1016/j.chemosphere.2011.04.075.	Polyfluorinated compounds (PFCs) are an extremely versatile class of compounds and are used in a variety of consumer applications and products. Recent studies have suggested that PFCs in indoor air and dust could act as sources of human exposure and outdoor air contamination. This study presents method development and analysis of a wide range of PFCs in dust and air using active sampling techniques with commercially available sampling equipment (forensic nozzles with filter housings for dust collection and polyurethane foam (PUF)-XAD(2)-PUF sandwich-tubes for air sampling) using both liquid and gas chromatography mass spectrometry. The developed method was validated and tested for applicability to analyze dust and air samples at both low and high concentrations (0.5 ng and 25 ng per analyte per air sample, respectively). Samples from private households and an office building were analyzed to explore differences in distribution patterns and concentrations. Perfluorooctane sulfonate, perfluorodecane sulfonate, perfluoroheptanoate, perfluorooctanoate and perfluorononanoate were observed in all samples of dust from private households, in the range from 1 to 80.1 ng g(-1). Fluorotelomer alcohols (FTOHs) were the predominant PFCs in indoor air samples with Sigma FTOHs ranging between 4.7 and 17.9 ng m(-3). The concentrations found in the present study are generally lower than those previously reported. This variation may be due to differences associated with geographical locations and lifestyles. However, use of different sampling techniques and strategies among studies can introduce large variations in PFC concentration found, making direct comparisons challenging.			1				-	-		
D223	分析	古川 浩司, 橋本 真, 萩尾 珠世, 木村 貴明, 本澤 大生, 大谷 美怜, 平田 紗希, 小林 珠美, 松田 彰子, 辻 加奈枝, 金子 聡	水道水中のPFOS，PFOA，PFHxS 及び PFHxA 同時分析法の検討	2020	環境技術, 2020年 49 巻 3 号 154-159. doi: 10.5956/jriet.49.154	液体クロマトグラフィー/タンデム型質量分析法（LC/MS/MS）による水道水中のPFOS，PFOA，PFHxS及びPFHxA 同時分析法の検討を行った．検討の結果，各物質の標準液の検量線は0.05～2.0 μg/L の濃度範囲で，良好な直線性と良好な妥当性評価結果が得られた．疑似水道水（ミネラルウォーター：添加濃度0.1ng/L）への添加回収試験をn＝5，5日間で実施し妥当性を評価した結果，併行精度5.0～12%，室内精度5.8～14%，真度95.9～112%であり，PFOS，PFOA，PFHxS 及びPFHxA 共に良好な妥当性評価結果が得られた．また，水道水（添加濃度：1.0 ng/L）への添加回収試験をn＝5で実施した結果，併行精度1.5～10%，真度96.0～112%であった。　本検討結果は，本分析法がPFOS，PFOA，PFHxS 及びPFHxA の水道水質検査法として有効であることを示している．		1					-	-		
D224	分析	尾川 裕紀, 鈴木 裕識, 髙沢 麻里, 小口 正弘, 栗栖 太	LC-QTOF/MSによる簡易・迅速なターゲットスクリーニングを用いた木曽三川流域における新興汚染物質の含有プロファイル解析	2022	土木学会論文集G（環境）, 2022年 78 巻 7 号 III_327-III_338. doi: 10.2208/jscejer.78.7_III_327	LC-QTOF/MSによる水環境中の新興汚染物質群（CECs）の簡易かつ迅速なターゲットスクリーニング（TS）解析の実現を目的として，TSデータベース（TS-DB）におけるフラグメントイオンの精密m/z値の登録内容と予測保持時間の設定，解析条件における質量誤差範囲と保持時間許容範囲の設定の各条件を検討し，整理した．次に，CECs102種を収録したTS-DBと見出したTS手順を木曽三川流域の河川水15試料に適用した結果，CECs30種を検出した．CECsの含有プロファイル解析から揖斐川，長良川，木曽川の本川と支川におけるLAS類，PPCPs，PFASsの各挙動が示された．TS結果に加え，用途情報や検出強度相対値を用いることで，定量せずに対象物質の存在状況や特徴を把握できる可能性が示された．							-	-		
D225	分析	吉田 光方子, 竹峰 秀祐, 松村 千里, 中野 武, 高田 光康, 東海 明宏, 盛岡 通	廃棄物試料における有機フッ素化合物(PFCs)の含有及び溶出状況	2011	環境化学, 2011年 21 巻 2 号 135-140. doi: 10.5985/jec.21.135	The concentration of perfluorinated compounds (PFCs) contained in waste samples and eluted from the waste samples were measured respectively using sensitive method. The PFCs contained in the samples were extracted with methanol, while the PFCs were eluted with water. Afterward, the PFCs were separated, concentrated with nitrogen-gas and analyzed by LC/MS/MS. The results were considered focusing on the proportion and the difference in elution ratio of each PFCs. As a result, it was confirmed that the concentration of PFCs contained in the samples can be measured without pulverizing solid waste. The differences in the concentrations contained in various kinds of waste samples were found depending on the category of industry, and treatment process. The elution ratio for the contained amount was different based on compounds. The short carbon chain compounds (C5-C8) had high elution rate, while long compounds (C9-C14) were low.							-	-		
D226	ばく露	Zhong, HF; Zheng, MG; Liang, Y; Wang, YJ; Gao, W; Wang, YW; Jiang, GB	Legacy and emerging per- and polyfluoroalkyl substances (PFAS) in sediments from the East China Sea and the Yellow Sea: Occurrence, source apportionment and environmental risk assessment	2021	Chemosphere 2021 Nov:282:131042. doi: 10.1016/j.chemosphere.2021.131042.	The Yellow Sea (YS), the East China Sea (ECS) and their coastal areas have undergone rapid urbanization and industrialization. These areas are important sinks for many persistent organic pollutants. In this study, the concentration of legacy and emerging per- and polyfluoroalkyl substances (PFAS) in marine sediments from the YS and ECS were investigated. Nineteen PFAS were identified, ranging in concentration from 0.21 ng/g to 4.74 ng/g (mean: 1.60 ng/g). Legacy long-chain PFAS [e.g., perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorooctane sulfonate (PFOS)] were the dominant contaminants. Alternative PFAS such as 6:2 chlorinated polyfluorinated ether sulfonate (6:2 Cl-PFESA) and 2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) propanoic acid (HFPO-DA) were identified within the detection range of 16%-100%. HFPO-DA was measured in all sediments in equivalent levels to PFOS (0.119 ng/g and 0.139 ng/g, respectively). This is the first reported occurrence of perfluoro-1-butanesulfonamide (FBSA) and HFPO-DA in marine sediments, indicating a replacement in the production of PFAS from legacy to emerging ones along with eastern coastal cities of China. The results of the potential source identification demonstrated that metal plating plants, textile treatments, fluoropolymer products, food packaging, and the degradation of volatile precursor substances were the main sources of PFAS in the ECS and YS. The environmental risk assessment based on the risk quotient demonstrated that PFOA and PFOS in the ECS and YS may present a low to medium risk at most sampling points.			1		1		B	-		
D227	ばく露	Martinez, B; Robey, NM; Da Silva, BF; Ditz, H; Sobczak, WJ; Quinones, KYD; Bowden, JA	Swimming with PFAS in public and private pools	2023	Chemosphere. 2023 Jan:310:136765. doi: 10.1016/j.chemosphere.2022.136765.	Per- and polyfluoroalkyl substances (PFAS) are a class of anthropogenic chemicals used to provide water and stain resistance in many consumer products. Their widespread use, nearly ubiquitous presence across multiple environments, and growing list of adverse health effects has raised concerns among communities. PFAS have been frequently detected and quantified globally in wastewater, groundwater, surface and drinking water; however, the presence of PFAS in swimming pool water - a unique matrix in which constituents may concentrate through evaporation and which also may present a high risk of direct human exposure - has not been reported. Here, ultra-high performance liquid chromatography - tandem mass spectrometry (UHPLC-MS/MS) was used to monitor 92 PFAS in 54 water samples collected from city, apartment, hotel, and personal swimming pools in six Florida cities. In total, 14 PFAS were detected with six perfluoroalkyl acids - perfluorobutanoic acid (PFBA), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA) and perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorobutane sulfonate (PFBS) - detected in every sample. PFHxA accounted for 49% of all PFAS quantified in this study. PFAS profiles were compared between sites as a function of pool type, rate of use, and geographic location. Total Sigma PFAS concentrations were similar across pool types, with both the highest (633 ng/L) and lowest (1.9 ng/L) measurements found in public city pools. Between sites, higher PFAS levels were observed in city pools in Miami, Melbourne and Tampa compared to Naples, Orlando andGainesville. Our findings highlight the potential exposure of PFAS in an underexplored and yet important exposure pathway in communities.	1	1	1	1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D228	ばく露	DeLuca, NM; Angrish, M; Wilkins, A; Thayer, K; Hubal, EAC	Human exposure pathways to poly- and perfluoroalkyl substances (PFAS) from indoor media: A systematic review protocol	2021	Environ. Int. 2021 Jan:146:106308. doi: 10.1016/j.envint.2020.106308.	Background: Human exposure to perand polyfluoroalkyl substances (PFAS) has been primarily attributed to contaminated food and drinking water. However, additional PFAS exposure pathways have been raised by a limited number of studies reporting correlations between commercial and industrial products and PFAS levels in human media and biomonitoring. Systematic review (SR) methodologies have been widely used to evaluate similar questions using an unbiased approach in the fields of clinical medicine, epidemiology, and toxicology, but the deployment in exposure science is ongoing. Here we present a systematic review protocol that adapts existing systematic review methodologies and study evaluation tools to exposure science studies in order to investigate evidence for important PFAS exposure pathways from indoor media including consumer products, household articles, cleaning products, personal care products, plus indoor air and dust. Objectives: We will systematically review exposure science studies that present both PFAS concentrations from indoor exposure media and PFAS concentrations in blood serum or plasma. Exposure estimates will be synthesized from the evidence to answer the question, For the general population, what effect does exposure from PFAS chemicals via indoor media have on blood, serum or plasma concentrations of PFAS? We adapt existing systematic review methodologies and study evaluation tools from the U.S. EPA's Systematic Review Protocol for the PFBA, PFHxA, PFHxS, PFNA, and PFDA IRIS Assessments and the Navigation Guide for exposure science studies, as well as present innovative developments of exposure pathway-specific search strings for use in artificial intelligence screening software. Data Sources: We will search electronic databases for potentially relevant literature, including Web of Science, PubMed, and ProQuest. Literature search results will be stored in EPA's Health and Environmental Research Online (HERO) database. Study eligibility and criteria: Included studies will present exposure measures from indoor media including con sumer products, household articles, cleaning products, personal care products, plus indoor air and dust, paired with PFAS concentrations in blood, serum or plasma from adults and/or children in the general population. We focus on a subset of PFAS chemicals including perfluorooctanoic acid (PFOA), perfluorooctanesulfonate (PFOS), perfluorobutanoic acid (PFBA), perfluorobutane sulfonate (PFBS), perfluorodecanoic acid (PFDA), perfluorohexanoic acid (PFHxA), perfluorohexanesulfonate (PFHxS), and perfluorononanoic acid (PFNA). Study appraisal and synthesis methods: Studies will be prefiltered at the title and abstract level using computationally intelligent search strings to expedite the screening process for reviewers. Two independent reviewers will screen the prefiltered studies against inclusion criteria at the title/abstract level and then full-text level, after which the reviewers will assess the studies' risk of bias using an approach modified from established systematic review tools for exposure studies. Exposure estimates will be calculated to investigate the proportion of blood, serum or plasma) PFAS concentrations that can be	1	1	1	1				B	-		
D229	ばく露	Sharma, BM; Bharat, GK; Tayal, S; Larssen, T; Becanova, J; Karaskova, P; Whitehead, PG; Futter, MN; Butterfield, D; Nizzetto, L	Perfluoroalkyl substances (PFAS) in river and ground/drinking water of the Ganges River basin: Emissions and implications for human exposure	2016	Environ. Pollut. 2016 Jan;208(Pt B):704-713. doi: 10.1016/j.envpol.2015.10.050.	Many perfluoroalkyl substances (PFAS) are ubiquitous environmental contaminants. They have been widely used in production processes and daily-use products or may result from degradation of precursor compounds in products or the environment. India, with its developing industrialization and population moving from traditional to contemporary lifestyles, represents an interesting case study to investigate PFAS emission and exposure along steep environmental and socioeconomic gradients. This study assesses PFAS concentrations in river and groundwater (used in this region as drinking water) from several locations along the Ganges River and estimates direct emissions, specifically for PFOS and PFOA. 15 PFAS were frequently detected in the river with the highest concentrations observed for PFHxA (0.4 -4.7 ng L-1) and PFBS (		1		1				B	-		
D230	ばく露	Wang, XF; Mo, MS; Chen, HG; Wang, Q; Yang, JL; Zhao, DH	Distribution and Exposure Risk Assessment of Perfluorinated Alkyl Substances in Aquatic Products along the Coastal Region of the South China Sea	2021	Expo. Health. 2021 Sep:13(3):505-515. doi: 10.1007/s12403-021-00399-4.	The purpose of the research was to monitor the contamination characters and spatial and temporal distributions of 23 Perfluorinated alkyl substances (PFASs) in seafood. Total of 844 samples, including 391 shellfish and 94 crustaceans, were collected from Guangdong, Guangxi, and Hainan provinces along South China Coastal Regions and analyzed by UPLC-MS/MS. Finally, 16 PFASs were detected in the survived samples and the total detection rates reached to 99.2%. The highest concentration of n-ary sumation PFASs in each sample was 28.3 mu g/kg, and the average and medium values of n-ary sumation PFAS were 1.83 mu g/kg and 1.18 mu g/kg, respectively. Perfluorooctane sulfonic acid (PFOS) and perfluorobutyric acid (PFBA) have been considered as predominant PFAS components with the corresponding pollution contribution rates of 29.1% and 24.7%, respectively. However, it is noted that perfluorohexane sulfonate (PFNA) and perfluorobutanesulfonic acid (PFBS) were primarily enriched in the oyster and mussel. During the period of this investigation (2014-2016), n-ary sumation PFAS average concentrations turned out constantly rising trend and new pollution component perfluorohexanesulfonic acid (PFHxS) detected in 2016, indicating that the contamination status of PFASs was getting worse in South China Coastal Regions. n-ary sumation PFAS concentrations of Guangdong, Guangxi, and Hainan provinces were approximately at similar level (1.79 mu g/kg, 1.91 mu g/kg and 2.02 mu g/kg), and the highest concentration sample contaminated with PFNA appeared in Guangxi province. The average and medium concentrations of n-ary sumation PFAS in samples collected from Guangzhou, Zhuhai, and Sanya were the top three. Safety and risk exposure assessments of perfluorooctanoic acid (PFOA) and PFOS via daily diet intakes showed relatively low potential to local residents.	1			1	1			B	-		
D231	ばく露	Zhu, WY; Khan, K; Roakes, H; Maker, E; Underwood, KL; Zemba, S; Badireddy, AR	Vermont-wide assessment of anthropogenic background concentrations of perfluoroalkyl substances in surface soils	2022	J. Hazard. Mater. 2022 Sep:438:129479. doi: 10.1016/j.jhazmat.2022.129479.	Shallow surface soils from 66 suburban sampling locations across Vermont were analyzed for 17 different per-fluoroalkyl acids (PFAA). PFAA were detected in all 66 surface soils, with a total concentration of PFAA ranging from 540 to 36,000 ng/kg dry soil weight (dw). Despite the complexity of site-specific factors, some general trends and correlations in PFAA concentrations were observed. For instance, perfluoro-1-octanesulfonate (PFOS) dominated in all soil samples while seven other PFAA, including perfluoro-n-nonanoic acid, perfluoro-n-octanoic acid, perfluoro-n-hexanoic acid, perfluoro-n-heptanoic acid, perfluoro-n-decanoic acid, perfluoro-n-undecanoic acid, perfluoro-1-butanesulfonate, and perfluoro-1-hexanesulfonate (PFNA, PFOA, PFHxA, PFHpA, PFDA, PFUnDA, and PFBS, respectively), were identified at more than 50 % of the locations. Perfluoroalkyl carboxylic acids (PFCA) showed a positive correlation with total organic carbon, whereas no clear correlation was observed for perfluoroalkyl sulfonate acids (PFSA). In addition, variations in geographical distributions of PFAA were observed, with relatively higher total PFAA in northern regions when compared to Southern Vermont. Moreover, PFHxA, PFNA, PFDA, PFUnDA, PFOS, and total PFAA were positively correlated to land-use types in Northern Vermont. These results are useful for understanding unique behaviors of PFCA vs. PFSA in geospatially distributed surface soils and for providing anthropogenic background data for setting PFAS cleanup standards for surface soils.		1	1	1				B	-		
D232	ばく露	Endirlik, BU; Bakir, E; Bosgelmez, II; Eken, A; Narin, I; Gurbay, A	Assessment of perfluoroalkyl substances levels in tap and bottled water samples from Turkey	2019	Chemosphere 2019 Nov:235:1162-1171. doi: 10.1016/j.chemosphere.2019.06.228	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) draw considerable attention for their potential toxic effects in humans and environment. Drinking water is accepted as one of the major exposure pathways for PFASs. In this study, we measured concentrations of 10 perfluoroalkyl substances in 94 tap water samples collected in two different sampling periods (August 2017 and February 2018) from 33 provinces of Turkey, as well as in 26 different brands of plastic and glass-bottled water samples sold in supermarkets in Turkey. Perfluorohexanoic acid (PFHxA), perfluorobutane sulfonate (PFBS) and perfluoropentanoic acid (PFPeA) were the most frequently detected PFASs in the samples of tap waters. The maximum concentrations in tap waters were measured as 2.90, 2.37, 2.18, 2.04, and 1.93 ng/L, for PFHxA, perfluorooctanoic acid (PFOA), perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), and perfluorobutanoic acid (PFBA), respectively. The most abundant perfluorinated chemical in tap water samples was PFBA with 17%, followed by PFOS (13%), PFBS (12%), perfluoroheptanoic acid (PFHpA) (11%), PFHxA (11%), and PFOA (11%). The total PFASs concentration in tap water ranged from 0.08 to 11.27 ng/L. As regards bottled waters, the concentrations of PFASs were generally lower than those in tap water samples. These results revealed that tap water samples in Turkey might be considered generally safe based on the established guidelines around the world. However, due to their persistence and potential to accumulate and reach higher concentrations in the environment, careful monitoring of PFASs in all types of water is critical.	1	1		1				B	-		
D233	ばく露	Olmsted, JL; Ahmadireskety, A; Da Silva, BF; Robey, N; Aristizabal-Henao, JJ; Bonzongo, JCJ; Bowden, JA	Using Regulatory Classifications to Assess the Impact of Different Land Use Types on Per- and Polyfluoroalkyl Substance Concentrations in Stormwater Pond Sediments	2021	J. Environ. Eng.-ASCE. 2021 Oct;147(10):6021005. doi: 10.1061/(ASCE)EE.1943-7870.0001906.	Current research on the fate and transport of per- and polyfluoroalkyl substances (PFAS) has primarily focused on point-source releases, with less focus on nonpoint-source releases, such as stormwater runoff. In this study, 51 PFAS were investigated in sediment collected from two locations at nine stormwater ponds classified by different land-use types. PFAS concentrations were then related to two different land-use disturbance indicators, the Landscape Development Intensity (LDI) index and the Florida Department of Transportation (FDOT) road type functional classification, to discern a potential metric for estimating PFAS burden by using the proximity to and different types of anthropogenic activity. Of the 51 compounds analyzed, 28 in total were quantified with concentrations ranging from 7.2 to 4,800 ng kg(-1). Perfluorinated carboxylic acids were the most commonly identified class of PFAS, as perfluorobutanoic acid (PFBA), perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUdA), perfluorododecanoic acid (PFDoA), and perfluorotridecanoic acid (PFTrDA) were all found at eight out of nine sites, as well as perfluorooctane sulfonic acid (PFOS), a perfluorinated sulfonic acid. Within the framework of this study, the LDI index did not appear to be significantly correlated to PFAS burden, whereby only the 0.4 km radius of the LDI weighted average resulted in a potential metric for the lowest PFAS contaminated sites (which had correspondingly low LDI weighted means). The FDOT functional classification was a better predictor across all sites for PFAS burden, in which a significant difference was found between the number of PFAS detected at rural and urban sites. Most notably, perfluorohexanoic acid (PFHxA) concentrations were found to be significantly different between rural and urban sites. Moving forward, the potential of utilizing road type functional classification should be explored as a predictive tool to help better prioritize stormwater pond monitoring for PFAS.	1	1	1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D234	ばく露	Li, YN; Niu, ZG; Zhang, Y	Occurrence of legacy and emerging poly- and perfluoroalkyl substances in water: A case study in Tianjin (China)	2022	Chemosphere. 2022 Jan;287(Pt 4):132409. doi: 10.1016/j.chemosphere.2021.132409.	Due to the water solubility and environmentally persistent properties of poly-and perfluoroalkyl substances (PFAS), the contamination of PFAS in drinking water is raising widespread concerns for their potential adverse health risks. In the present study, the behavior of PFAS from source waters to effluent water was analyzed by taking samples from three drinking water sources (Yuqiao Reservoir, Beidagang Reservoir, and Yangtze River) and effluent of several treatment processes used in one drinking water treatment plant (DWTP) of Tianjin (China), including pre-chlorination, coagulation, sand filtration, and chlorination. The range of total concen-tration of PFAS (n-ary sumation 21PFAS) in three source water was 6.64-19.80 ng/L (Yuqiao Reservoir), 80.00-119.86 ng/L (Beidagang Reservoir), and 15.87 ng/L (Yangtze River), respectively. As for individual PFAS, PFBA (per-fluorobutanoic acid) was the most abundant PFAS, followed by PFOA (perfluorooctanoic acid), PFBS (per-fluorobutane sulfonate), and PFOS (perfluorooctane sulfonate), especially, 6:2 Cl-PFESA (6:2 Cl-polyflurinated ether sulfonate) was detected in all samples. During treatment, the removal rate of n-ary sumation 21PFAS was 11%, and the removal rate of long-chain PFAS such as PFNA (perfluorononanoic acid), PFOS, and PFDS (perfluorodecane sulfonate) were relatively higher than short-chain PFAS due to their hydrophobic characteristic. Besides, the influence of seasonal factor (precipitation) on the occurrence and composition characteristics of PFAS in the aquatic environment was also investigated, and the results demonstrated that precipitation affected the total concentrations of PFAS in the aquatic environment, but barely on the composition characteristics of PFAS. Furthermore, the ecological risks could be negligible based on the concentration of PFAS measured in surface water. In the meanwhile, the health risks were also assessed based on the concentration of PFAS detected in drinking water, the result indicated that the concentrations of PFAS were less than the suggested drinking water advisories. In addition, more attention should be paid to the risk caused by the frequently detected emerging PFAS such as 6:2 Cl-PFESA and HFPO-DA (hexafluoropropylene oxide-dimer acid).	1		1	1	1			B	-		
D235	ばく露	Codling, G; Vogt, A; Jones, PD; Wang, TY; Wang, P; Lu, YL; Corcoran, M; Bonina, S; Li, A; Sturchio, NC; Rockne, KJ; Ji, K; Khim, JS; Naile, JE; Giesy, JP	Historical trends of inorganic and organic fluorine in sediments of Lake Michigan	2014	Chemosphere 2014 Nov:114:203-209. doi: 10.1016/j.chemosphere.2014.03.080	Total fluorine (TF), extractable organic fluorine (EOF) and poly- and per-fluorinated compounds (PFCs) were measured in eight dated cores of sediment taken along with 27 surface sediments from Lake Michigan in 2010. Based on rates of sedimentation, total concentrations of PFCs (Sigma PFCs) reached a maximum in the later 1990s and early 2000s. This result is consistent with rapid changes in production and subsequent sedimentation. Perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) are still the predominant PFCs in the cores, but in surface sediments, concentrations of perfluorobutane sulfonate (PFBS) and perfluorobutanoic acid (PFBA) are now occurring at concentrations comparable to those of PFOS and PFOA. This observation is consistent with shifts in patterns of production and use in the US and Canada. Concentrations of TF in sediments were greater than those of EOF. This result is consistent with a larger proportion of un-extractable fluorinated material in both surface sediments and in cores.	1			1				B	-		
D236	ばく露	Arvaniti, OS; Asimakopoulos, AG; Dasenaki, ME; Ventouri, EI; Stasinakis, AS; Thomaidis, NS	Simultaneous determination of eighteen perfluorinated compounds in dissolved and particulate phases of wastewater, and in sewage sludge by liquid chromatography-tandem mass spectrometry	2014	Anal. Methods 2014 :6(5):1341-1349. doi: 10.1039/c3ay42015a.	Perfluorinated compounds (PFCs) are known chemicals that are used in a wide variety of industrial and consumer products, and have been reported to exist in the environment as contaminants. In this study, a liquid chromatography-electrospray-tandem mass spectrometry (LC-ESI-MS/MS) method was developed for simultaneous determination of 10 perfluoroalkyl carboxylate acids (PFCAs), 5 perfluoroalkyl sulfonates (PFASs), and 3 perfluoroalkyl sulfonamides (PFSAs) (18 PFCs in total), in dissolved and particulate phases of wastewater (raw and treated), and in dewatered sewage sludge. The target PFCAs were perfluoropentanoic acid (PFPeA; C5), perfluorohexanoic acid (PFHxA; C6), perfluoroheptanoic acid (PFHpA; C7), perfluorooctanoic acid (PFOA; C8), perfluorononanoic acid (PFNA; C9), perfluorodecanoic acid (PFDA; C10), perfluoroundecanoic acid (PFUdA; C11), perfluorododecanoic acid (PFDoA; C12), perfluorotridecanoic acid (PFTrDA; C13), and perfluorotetradecanoic acid (PFTeDA; C14). The target PFASs were potassium perfluorobutanesulfonate (PFBS; C4), sodium perfluorohexanesulfonate (PFHxS; C6), sodium perfluoroheptanesulfonate (PFHpS; C7), sodium perfluorooctanesulfonate (PFOS; C8), and sodium perfluorodecanesulfonate (PFDS; C10), and the target PFSAs were perfluorooctane sulfonamide (PFOSA), N-methylperfluorooctane sulfonamide (N-MeFOSA), and N-ethylperfluorooctane sulfonamide (N-EtFOSA). Wastewater samples were filtered after collection and extracted/purified/pre-concentrated by a solid-phase extraction (SPE) procedure. Particulate matter and sludge samples were extracted by a liquid-solid extraction (LSE) and ultra-sonication procedure, and thereafter purified/preconcentrated by the same SPE procedure that was followed for the dissolved phase of wastewater. The internal standards, perfluoro-n-[1,2,3,4-C-13(4)]octanoic acid (C-13(4)-PFOA), sodium perfluoro-1-[1,2,3,4-C-13(4)]octanesulfonate (C-13(4)-PFOS), and N-methyl-d(3)-perfluoro-1-octanesulfonamide (D-2(3)-N-MeFOSA) provided adequate compensation for variations in the extraction percentages and instrumental response. The limits of quantification (LOQs) ranged from 0.29 (PFHpS) to 3.0 ng L-1 (PFDoA) for dissolved phase samples, and from 0.15 (PFHpS) to 1.5 ng g(-1) dry weight (dw) (PFDoA) for particulate matter and sludge samples. The developed methods were applied successfully to wastewater and sludge samples originated from Athens WWTP. PFC concentrations up to 113 ng L-1 (PFUdA), 33 ng L-1 (PFOA) and 1042 ng g(-1) (PFUdA) were determined in influent wastewater, treated wastewater and dewatered sludge, respectively. Analysis of PFCs in the particulate matter of wastewater is needed to avoid underestimation of their concentrations.		1	1	1				B	-		
D237	ばく露	Helmer, RW; Reeves, DM; Cassidy, DP	Per- and Polyfluorinated Alkyl Substances (PFAS) cycling within Michigan: Contaminated sites, landfills and wastewater treatment plants	2022	Water Res. 2022 Feb:210:117983. doi: 10.1016/j.watres.2021.117983.	Concentrations of Per-and Polyfluorinated Alkyl Substances (PFAS) from public and private sources in Michigan compiled for wastewater treatment plants (WWTPs) (influent, effluent, biosolids), contaminated sites, and landfill leachates reveal complex cycling within the natural and engineered environment. Analysis of 171 contaminated sites in Michigan by source release indicate four dominant PFAS sources - landfills, aqueous film-forming foams (AFFF), metal platers, and automotive/metal stamping - account for 75% of the contamination. Diverse chemical signatures were observed for leachates collected from 19 landfills (mostly type II municipal) with the dominant PFAS ranging from perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) to shorter-chained compounds, perfluorohexanoic acid (PFHxA), perfluorobutanoic acid (PFBA), and per-fluorobutanesulfonic acid (PFBS). Analysis of PFAS carbon chain length as a function of landfill age shows the transition of C8s in leachate from older landfills to C4s and C6s in younger landfills, consistent with the phasing out and replacement of C8s. PFAS mass flux in leachate for landfills studied range between 5 - 2,000 g/yr and are highest for active landfills, which generate greater leachate volumes and contain fresh PFAS wastes. Detailed study of 10 WWTPs with industrial pretreatment programs indicate numerous chemical transformations across the plants that yield effluent PFAS concentrations as much as 19 times greater than influent, attributed to transformations of unmeasured precursors in the influent to measured, stable PFAS in the effluent. PFOA, PFHxA, perfluoropentanoic acid (PFPeA), PFBA, and PFBS show the greatest increases across the plant ranging from 20% to nearly 2,000%. PFOS concentrations decreased across 6 WWTPs, consistent with a strong tendency to adsorb onto biosolids. Estimated mass of discharge of (mostly unregulated) PFAS from WWTPs to receiving waters range from 40 g/yr to 128 kg/yr.	1	1		1				B	-		
D238	ばく露	Martin, KV; Hilbert, TJ; Reilly, M; Christian, WJ; Hoover, A; Pennell, KG; Ding, QX; Haynes, EN	PFAS soil concentrations surrounding a hazardous waste incinerator in East Liverpool, Ohio, an environmental justice community	2023	Environ. Sci. Pollut. Res. 2023 Jul:30(33):80643-80654. doi: 10.1007/s11356-023-27880-8.	Per- and polyfluoroalkyl substances (PFAS) are a class of synthetic compounds widely used in industrial and consumer products. While PFAS provide product durability, these chemicals are ubiquitous, persistent, bioaccumulative, and toxic. These characteristics make the ultimate disposal of PFAS a challenge. One current disposal method is incineration; however, little research has been conducted on the safety and effectiveness of PFAS incineration. The characteristics of communities with hazardous waste incinerators that have received PFAS shipments indicate that more individuals with lower incomes and individuals with less education than the US average are at higher risk of exposure, which presents important environmental justice and health equity concerns of PFAS incineration. Situated in eastern Ohio, East Liverpool is an Appalachian community that is home to a large hazardous-waste incinerator, operated by Heritage WTI, that began accepting PFAS in 2019. Residents are concerned that the disposal lacks the research necessary to assure safety for the residents. Due to both community interest and data gaps regarding PFAS incineration, our research team conducted a pilot study to examine the distribution and concentration of PFAS in soil samples surrounding the incinerator. All 35 soil samples had measurable amounts of PFAS including perfluorobutanesulfonic acid (PFBS), perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and hexafluoropropylene oxide dimer acid (HFPO-DA)/GenX. PFOS was measured in the majority of soil samples (97%) with a range of 50-8,300 ng/kg. PFOA was measured in 94% of soil samples with a range of 51 ng/kg to 1300 ng/kg. HFPO-DA/GenX was measurable in 12 soil samples with concentrations of ranging from 150 ng/kg to 1500 ng/kg. Further research on PFAS disposal will advance knowledge and action related to regulatory requirements and exposure prevention, ultimately improving individual and community protections and health equity.				1	1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D239	ばく露	Zhao, Z; Xie, ZY; Tang, JH; Sturm, R; Chen, YJ; Zhang, G; Ebinghaus, R	Seasonal variations and spatial distributions of perfluoroalkyl substances in the rivers Elbe and lower Weser and the North Sea	2015	Chemosphere 2015 Jun:129:118-125. doi: 10.1016/j.chemosphere.2014.03.050	The spatial distributions and seasonal variations of perfluoroalkyl substances (PFASs) in surface waters were investigated for the German rivers Elbe and lower Weser, and the North Sea. Sigma PFAS concentrations ranged from 4.1 to 250 ng L-1 in the River Elbe, from 3.8 to 16 ng L-1 in the lower Weser, and from 0.13 to 10 ng L-1 in the North Sea. The most abundant compound was perfluorobutanesulfonate (PFBS) with a proportion of 24% in river water and 31% in seawater samples. The concentrations of perfluorohexanoic acid (PFHxA) and perfluorooctanoic acid (PFOA) in Elbe River water showed significant seasonal variation in 2011. The seasonal variations might be related to the variations of water discharge. The highest concentrations of PFOA and PFHxA were detected in August. Pearson correlations showed that perfluorobutanoic acid (PFBA) and PFBS had different sources from other PFASs, and the current manufacturing and use of C-4-based products could explain the distinction. The estimated fluxes of individual substances and Sigma PFASs in the River Elbe showed no significant seasonal variation. The annual fluxes of PFASs to the North Sea were estimated to be 335 +/- 100 kg year(-1) from the River Elbe and 102 +/- 22 kg year(-1) from the River Weser.	1	1		1				B	-		
D240	ばく露	Wang, Q; Song, X; Wei, CL; Ding, D; Tang, ZW; Tu, XM; Chen, X; Wang, SH	Distribution, source identification and health risk assessment of PFASs in groundwater from Jiangxi Province, China	2022	Chemosphere. 2022 Mar;291(Pt 2):132946. doi: 10.1016/j.chemosphere.2021.132946.	There is an urgent need to investigate on the distribution and fate of short-chain analogues and emerging per -and polyfluoroalkyl substances (PFASs) in groundwater, and little research on their source apportionment and health risks through the drinking water exposure pathway has been carried out. In present study, the concen-tration and source of 22 PFASs, including five alternatives: 6:2 fluorotelomer sulfonate (6:2 FTS), potassium 9-chlorohexadecafluoro-3-oxanonane-1-sulfonate (F-53B), hexafluoropropylene oxide trimer acid (HFPO-TA), hexafluoropropylene oxide dimer acid (HFPO-DA) and ammonium 4, 8-dioxa-3H-perfluorononanoate (ADONA), were analyzed in 88 groundwater samples from wells in Jiangxi Province, southeastern China. The total PFASs concentration (Sigma(18)PFASs) in groundwater varied from 1.27 to 381.00 ng/L (mean 47.60 ng/L). Short-chain perfluorobutanoic acid (PFBA) and perfluoropentanoic acid (PFPeA) were the most abundant perfluorinated carboxylic acids (PFCAs), and short-chain perfluorobutanesulfonate (PFBS) was the most abundant per-fluorinated sulfonic acids (PFSAs) in groundwater samples. The quantitative source apportionment by nonneg-ative matrix/tensor factorization coupled with k-means clustering (NMFk) model suggested that short-chain homologues and emerging alternatives have been used as substitutes for legacy PFOS and PFOA. Furthermore, the human risk assessment results showed that the estimated daily intakes (EDIs) for short-chain PFCAs were higher than that of PFOA, whereas the EDIs of PFBS, 6:2 FTS and F-53B were comparable to that of PFOS.	1		1	1	1			B	-		
D241	ばく露	So, MK; Miyake, Y; Yeung, WY; Ho, YM; Taniyasu, S; Rostkowski, P; Yamashita, N; Zhou, BS; Shi, XJ; Wang, JX; Giesy, JP; Yu, H; Lam, PKS	Perfluorinated compounds in the Pearl River and Yangtze River of China	2007	Chemosphere. 2007 Aug:68(11):2085-2095. doi: 10.1016/j.chemosphere.2007.02.008.	A total of 14 perfluorinated compounds (PFCs) were quantified in river water samples collected from tributaries of the Pearl River (Guangzhou Province, south China) and the Yangtze River (central China). Among the PFCs analyzed, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) were the two compounds with the highest concentrations. PFOS concentrations ranged from 0.90 to 99 ng/1 and < 0.01-14 ng/1 in samples from the Pearl River and Yangtze River, respectively; whereas those for PFOA ranged from 0.85 to 13 ng/l and 2.0-260 ng/l. Lower concentrations were measured for perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), perfluorooctanesulfoamide (PFOSA), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perflurononoaoic acid (PFNA), perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUnDA). Concentrations of several perfluorocarboxylic acids, including perfluorododecanoic acid (PFDoDA), perfluorotetradecanoic acid (PFTeDA), perfluorohexadecanoic acid (PFHxDA) and perfluorooctadecanoic acid (PFOcDA) were lower than the limits of quantification in all the samples analyzed. The highest concentrations of most PFCs were observed in water samples from the Yangtze River near Shanghai, the major industrial and financial centre in China. In addition, sampling locations in the lower reaches of the Yangtze River with a reduced flow rate might serve as a final sink for contaminants from the upstream river runoffs. Generally, PFOS was the dominant PFC found in samples from the Pearl River, while PFOA was the predominant PFC in water from the Yangtze River. Specifically, a considerable amount of PFBS (22.9-26.1% of total PFC analyzed) was measured in water collected near Nanjing, which indicates the presence of potential sources of PFBS in this part of China. Completely different PFC composition profiles were observed for samples from the Pearl River and the Yangtze River. This indicates the presence of dissimilar sources in these two regions.		1	1	1				B	-		
D242	ばく露	Gebbink, WA; van Leeuwen, SPJ	Environmental contamination and human exposure to PFASs near a fluorochemical production plant: Review of historic and current PFOA and GenX contamination in the Netherlands	2020	Environ. Int. 2020 Apr:137:105583. doi: 10.1016/j.envint.2020.105583.	Fluorochemical production plants (FPP) are primary emission sources of per- and polyfluoroalkyl substances (PFASs) to the local environment. An FPP located in the Netherlands has historically used perfluorooctanoic acid (PFOA) for fluoropolymer production and is currently using GenX (HFPO-DA; 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)propionic acid) as a replacement. This study reviewed existing data from open access reports and peer reviewed publications on the environmental presence of PFOA and GenX in environmental matrices such as surface water, groundwater, soil and vegetation. Published data on human exposure to PFOA and GenX (i.e. via drinking water and food as well as blood monitoring) were reviewed in order to assess the influence of the FPP on contamination of the local population. Concentrations in environmental and human exposure samples were compared to (inter)national quality standards or risk limits. The data showed higher PFOA and GenX concentrations in surface water, groundwater, soil and vegetation samples taken close to point sources, and the highest observed concentrations exceeded these standards and limits (except for PFOA in soil). Drinking water and food also contained higher PFOA and GenX concentrations in samples taken close to point sources compared to samples further away. Tolerable daily intake (TDIs) for both PFASs were exceeded, however, only in a maximum exposure scenario. Blood monitoring of the local population near the FPP, and FPP workers, confirmed high exposure can occur as blood concentrations of several individuals exceeded the safe level. This paper provides a comprehensive overview on PFOA and GenX contamination close to point sources in the Netherlands.		1	1	1	1			B	-		
D243	ばく露	Steele, M; Griffith, C; Duran, C	Monthly Variations in Perfluorinated Compound Concentrations in Groundwater	2018	Toxics. 2018 Sep;6(3):56. doi: 10.3390/toxics6030056.	Large-scale manufacturing of poly- and perfluorinated compounds in the second half of the 20th century has led to their ubiquity in the environment, and their unique structure has made them persistent contaminants. A recent drinking water advisory level issued by the United States Environmental Protection Agency lowered the advisory level concentration of perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) from 200 nanograms per liter and 400 nanograms per liter, respectively, to 70 nanograms per liter separately or combined. Small temporal variations in PFOS and PFOA concentrations could be the difference between meeting or exceeding the recommended limit. In this study, newly sampled data from a contaminated military site in Alaska and historical data from former Pease Air Force Base were collected. Data were evaluated to determine if monthly variations within PFOS and PFOA existed. No statistically significant temporal trend was observed in the Alaska data, while the results from Pease, although statistically significant, showed the spread of observed contaminant concentrations around the fitted line is broad (as indicated by the low R-2 values), indicating that collection date has little value in predicting contaminant concentrations. Though not currently the subject of a US EPA health advisory, data on perfluorobutanesulfonic acid (PFBS), perfluorohexane sulfonic acid (PFHxS), perfluoroheptanoic acid (PFHpA), and perfluorononanoic acid (PFNA) were collected for each site and their average concentrations evaluated.			1	1				B	-		
D244	ばく露	Venkatesan, AK; Lee, CS; Gobler, CJ	Hydroxyl-radical based advanced oxidation processes can increase perfluoroalkyl substances beyond drinking water standards: Results from a pilot study	2022	Sci. Total Environ. 2022 Nov:847:157577. doi: 10.1016/j.scitotenv.2022.157577.	Advanced oxidation processes (AOPs) are popular technologies employed across the U.S. for wastewater reclamation and drinking water treatment of recalcitrant chemicals. Although there is consensus about the ineffectiveness of AOPs to treat perfluoroalkyl substances (PFASs; not polyfluoro compounds by definition here), there is a lack of field data demonstrating their impact on the transformation of unknown PFAS precursors during groundwater treatment. In this study, the fate of PFASs in seven pilot-scale AOPs, including four different technologies (UV/H2O2, UV/Cl-2, UV/TiO2, and O-3/H2O2), was assessed at four drinking water systems across New York State (NYS), USA. Seven of 18 PFASs were detected in the influent at concentrations ranging from below method detection to 64 ng/L. Across all systems, all detected PFASs showed an increase in concentration after treatment presumably due to unknown precursor transformation with specific increases for perfluorobutane sulfonate (PFBS), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perfluorohexane sulfonate (PFHxS), perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), and perfluorononanoic acid (PFNA) averaging 405 (range: 0 - 1220) %, 1.0 (-7 - 9) %, 3.8 (0 - 9.5) %, 3.3 (-11 - 13) %, 14 (0 - 48) %, 13 (3 - 25) %, and 2 (0 - 5.2) %, respectively. The increase in PFAS concentration was dependent on UV and oxidant dose, further confirming that transformation reactions were occurring due to AOPs similar to a total oxidizable precursor assay. At one of the sites, PFOA levels exceeded the current NYS drinking water standard of 10 ng/L after, but not before treatment, highlighting the importance of considering the potential impact of AOP on treated water quality when designing treatment systems for regulatory compliance. The increase in PFAS concentration in the AOP systems positively correlated (r = 0.91) with nitrate levels in groundwater, suggesting that onsite septic discharges may be an important source of PFAS contamination in these unsewered study areas. Results from this pilot-scale demonstration reveal that hydroxyl radical-based AOPs, although ineffective in treating PFASs, can help to reveal the true extent of PFAS contamination in source waters.		1	1	1				B	-		

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D245	ばく露	Chen, SQ; Zhou, YQ; Meng, J; Wang, TY	Seasonal and annual variations in removal efficiency of perfluoroalkyl substances by different wastewater treatment processes	2018	Environ. Pollut. 2018 Nov;242(Pt B):2059-2067. doi: 10.1016/j.envpol.2018.06.078.	Municipal wastewater treatment plants (WWTPs) are important in the migration and transformation of perfluoroalkyl substances (PFASs) in water bodies. Six municipal WWTPs located in the upper reaches of the Guanting reservoir, along the Yanghe River, were sampled from November 2016 to July 2017. Influents, effluents, and activated sludge solutions were sampled and the concentrations of 17 PFASs were analyzed. Perfluorobutanoic acid (PFBA), Perfluorooctanoic acid (PFOA), Perfluorohexanoic acid (PFHxA), Perfluoropentanoic acid (PFPeA), Perfluorobutane sulfonat (PFBS) and Perfluorooctane sulfonate (PFOS) accounted for more than 90% of these. Seasonal variations in PFASs in influent directly influenced concentrations in supernatant and effluent. The annual average PFAS concentrations were 46.4, 45.1, and 38.5 ng L-1 in influent, supernatant, and effluent, respectively, indicating that WWTPs do not efficiently remove PFASs from wastewater. Annual average PFAS removal efficiencies differed among WWTPs, were influenced primarily by the treatment process used at each, and followed the order Cyclic Activated Sludge System (CASS, 32.2%) > Orbal Oxidation Ditch (OD, 17.5%) > Anaeroxic-Anoxic-Oxic (A(2)/O, -1.49%). Short-chain PFASs were removed significantly more efficiently in the CASS compared to the other systems. These results can show how traditional wastewater treatment plants can help remove PFASs from the environment.	1	1		1				B	-		
D246	ばく露	Zhang, W; Zhang, YT; Taniyasu, S; Yeung, LWY; Lam, PKS; Wang, JS; Li, XH; Yamashita, N; Dai, JY	Distribution and fate of perfluoroalkyl substances in municipal wastewater treatment plants in economically developed areas of China	2013	Environ. Pollut. 2013 May:176:10-17. doi: 10.1016/j.envpol.2012.12.019	Wastewater treatment plants (WWTPs) are a significant source for poly-/perfluoroalkyl substances (PFASs) entering the environment. The presence of PFASs in twenty-eight municipal WWTPs from eleven cites in economically developed areas of China were screened. Overall, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) were dominant in wastewater and sludge, and were not effectively removed during wastewater treatment. Elevated influent concentration ratios of perfluorobutanoic acid (PFBA) to PFOA and perfluorobutane sulfonate (PFBS) to PFOS in some WWTPs suggested that short chains substitution were adopted in these cities. Cluster analysis showed treatment processes had important impacts on PFASs profiles in effluent and sludge. Average concentration of total PFCAs in influent from each city and its gross domestic product (GDP) had significant positive correlation. This study provides a snapshot of both domestic and industrial discharges of PFAS to WWTPs as well as PFAS discharge from WWTPs to the aquatic environment in China.	1			1				B	-		
D247	ばく露	Ahrens, L; Plassmann, M; Xie, ZY; Ebinghaus, R	Determination of polyfluoroalkyl compounds in water and suspended particulate matter in the river Elbe and North Sea, Germany	2009	Front. Environ. Sci. Eng. China. 2009 Jun:3(2):152-170. doi: 10.1007/s11783-009-0021-8.	The distribution of polyfluoroalkyl compounds (PFCs) in the dissolved and particulate phase and their discharge from the river Elbe into the North Sea were studied. The PFCs quantified included C-4-C-8 perfluorinated sulfonates (PFSAs), 6:2 fluorotelomer sulfonate (6:2 FTS), C-6 and C-8 perfluorinated sulfonates (PFSiAs), C-4-C-12 perfluorinated carboxylic acids (PFCAs), perfluoro-3,7-dimethyl-octanoic acid (3,7m(2)-PFOA), perfluorooctane sulfonamide (FOSA), and n-ethyl perfluroctane sulfonamidoethanol (EtFOSE). PFCs were mostly distributed in the dissolved phase, where perfluorooctanoic acid (PFOA) dominated with 2.9-12.5 ng/L. In the suspended particulate matter FOSA and perfluorooctane sulfonate (PFOS) showed the highest concentrations (4.0 ng/L and 2.3 ng/L, respectively). The total flux of Sigma PFCs from the river Elbe was estimated to be 802 kg/year for the dissolved phase and 152 kg/year for the particulate phase. This indicates that the river Elbe acts as a source of PFCs into the North Sea. However, the concentrations of perfluorobutane sulfonate (PFBS) and perfluorobutanoic acid (PFBA) in the North Sea were higher than that in the river Elbe, thus an alternative source must exist for these compounds.	1			1				B	-		
D248	ばく露	MacInnis, JJ; Lehnherr, I; Muir, DCG; Quinlan, R; De Silva, AO	Characterization of perfluoroalkyl substances in sediment cores from High and Low Arctic lakes in Canada	2019	Sci. Total Environ. 2019 May:666:414-422. doi: 10.1016/j.scitotenv.2019.02.210	Perfluoroalkyl substances (PFASs) are synthetic environmentally-persistent pollutants that are amenable to long-range transport and accumulation in remote Arctic ecosystems. In this study, historical inventories of twenty-three PFASs (i.e. C-4-C-14, C-16 perfluoroalkane carboxylic acids (PFCAs); C-4, C-6-C-8, C-10 perfluoroalkane sulfonic acids (PFSAs); perfluoro-4-ethyl-cyclohexane sulfonic acid (PFECHS); dodecafluoro-3H-4,8-dioxanonanoic acid (ADONA); 8-chloro-perfluoro-1-octane sulfonic acid (8-Cl-PFOS); chlorinated polyfluorinated ether sulfonic acids (Cl-PFESAs) including 9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (6:2 Cl-PFESA) and 11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (8:2 Cl-PFESA); as well as perfluorooctane sulfonamide (FOSA)) are determined in two intact sediment cores collected from Lake Hazen, located in northern Ellesmere Island at 82 degrees N in 2012 and Lake B35, located in central Nunavut at 64 degrees N in 2009. In Lake Hazen, fluxes of perfluorooctanoic acid (PFOA), perfluorodecanoic acid (PFDA), perfluorobutane sulfonic acid (PFBS), and perfluorooctane sulfonic acid (PFOS) increased during 19632011. In Lake B35, fluxes of perfluoroheptanoic acid (PFHpA), PFOA, perfluorononanoic acid (PFNA), and perfluoroundecanoic acid (PFUnDA) increased during 19522009. The temporal trends for PFASs in Lake Hazen and Lake B35 sediments are consistent with the continuous annual delivery of PFASs to the Arctic of Canada. Temporal trends in sediment cores appear to follow historical market changes in PFAS manufacturing inventory. The doubling time of PFAS fluxes are faster in Lake Hazen sediments than Lake B35 sediments. In Lake Hazen, this may be attributed to the enhanced delivery of sediment and historically-archived PFASs promoted by climate-induced glacier melting in the Lake Hazen watershed post-2005. Exponentially increasing PFAS temporal trends in High and Low Arctic lakes in Canada stress the importance of developing effective global regulatory policies for PFAS manufacturing and highlights the potential for climate change-induced contaminant release from melting glaciers in the Arctic.			1	1				B	-		
D249	ばく露	Harrad, S; Wemken, N; Drage, DS; Abdallah, MAE; Coggins, AM	Perfluoroalkyl Substances in Drinking Water, Indoor Air and Dust from Ireland: Implications for Human Exposure	2019	Environ. Sci. Technol. 2019 Nov:53(22):13449-13457. doi: 10.1021/acs.est.9b04604.	Perfluoroalkyl substances (PFASs) were measured in air and dust from cars, homes, offices, and school classrooms in Ireland, along with drinking water from homes and offices. Perfluorooctanoic acid (PFOA) dominated air and drinking water, while perfluorobutane sulfonate (PFBS) dominated dust. This is the first report of PFOA, perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), PFBS, and perfluorononanoic acid (PFNA) in air inside cars and school classrooms. PFOS concentrations in classroom air exceeded significantly ($p <= 0.05$) those in homes. Atmospheric concentrations of PFOA, PFNA, and methyl perfluorooctane sulfonamido ethanol (MeFOSE) ($p <= 0.05$) were significantly higher in cars containing child car seats than in cars without. PFOS, PFOA, PFBS, and PFHxS were all detected frequently in drinking water, but concentrations of PFASs were low, and although Sigma PFASs were 64 ng/L in one bottled water sample, this fell below a Swedish Action Level of 90 ng EPFASs/L. The Irish population's exposure to PFOS and PFOA via non-dietary sources is well below estimates of dietary exposure elsewhere in Europe. Moreover, even under a high-end exposure scenario, it falls below the European Food Safety Authority's (EFSA) provisional tolerable weekly intakes for PFOS and PFOA.			1	1				B	-		
D250	ばく露	Yamazaki, E; Taniyasu, S; Noborio, K; Eun, H; Thaker, P; Kumar, NJI; Wang, XH; Yamashita, N	Accumulation of perfluoroalkyl substances in lysimeter-grown rice in Japan using tap water and simulated contaminated water	2019	Chemosphere 2019 Sep:231:502-509. doi: 10.1016/j.chemosphere.2019.05.022	Perfluoroalkyl substances (PFASs) are a group of contaminants of concern in agricultural crops, but little is known of their accumulation or behavior in grains. We grew Japanese rice (Oryza sativa subsp. indica) in lysimeters irrigated with tap water or tap water plus simulated contaminated water for 2 years, then analyzed the roots, straw, unhulled rice, white rice, bran, soil, and water for PFASs residues. Total fluorine was measured by combustion ion chromatography. Estimated per-plant residue levels were 3.0 pg perfluorooctanesulfonic acid (PFOS) (bran: 0.5%, hull: 99.5%), 0.54 pg N-ethylperfluorooctanesulfonamide (N-EtFOSA) (white rice: 67%, hull: 33%), 1.2 pg perfluorobutanoic acid (PFBA) (white rice: 13%, bran: 7%, hull: 79%), 0.68 pg perfluoropentanoic acid (hull: 100%), 0.50 pg perfluorohexanoic acid (PFHxA) (white rice: 65%, bran: 16%, hull: 19%), 0.21 pg perfluoroheptanoic acid (hull: 100%), 0.25 pg perfluorooctanoic acid (PFOA) (hull: 100%), and 0.12 pg perfluorodecanoic acid (PFNA) (white rice: 81%, bran: 19%). Estimated daily PFASs intakes were <1-3 ng perfluorooctanesulfonamide, <1-7 ng N-EtFOSA, 1-2 ng PFBA, <3-4 ng PFHxA, and 1-2 ng PFNA. Estimated PFOS, PFOA, and total PFASs in straw feed were 0.4, 0.1, and 2 kg yr(-1) and 0.7, 0.4, and 8 kg yr(-1) in 2015 and 2016, respectively. Estimated PFOS, PFOA, and total PFASs in straw fertilizer were 4,1, and 23 kg yr(-1) and 7, 4, and 86 kg yr(-1) in 2015 and 2016, respectively. PFASs accumulation may cause longer residence time in agricultural systems owing to straw being used as animal feed and organic fertilizer.	1	1	1					B	-		
D251	ばく露	Bao, J; Jin, YH; Liu, W; Ran, XR; Zhang, ZX	Perfluorinated compounds in sediments from the Daliao River system of northeast China	2009	Chemosphere. 2009 Oct:77(5):652-657. doi: 10.1016/j.chemosphere.2009.08.018.	Perfluorinated compounds (PFCs) have received much attention on their distributions in various matrixes of different areas globally, however, little is known about their existences in river sediments of China. In this study, eight target PFCs including perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluorododecanoic acid (PFDoA) and perfluorotetradecanoic acid (PFTA) were determined based upon the upper 10 cm surface sediment samples collected from eleven sites covering three main streams of the Daliao River system in northeast China, which received huge amount of industrial and domestic wastewater annually from the neighbouring areas. Analytical results indicated that total concentrations of PFCs were determined in the range of 0.29-1.03 ng g(-1) dry weight in sediments from this river system. As the dominant PFCs contaminants in sediment samples, concentrations of PFOS and PFOA were ranged between			1	1				B	-		

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D252	ばく露	Valsecchi, S; Conti, D; Crebelli, R; Polesello, S; Rusconi, M; Mazzoni, M; Preziosi, E; Carere, M; Lucentini, L; Ferretti, E; Balzamo, S; Simeone, MG; Aste, F	Deriving environmental quality standards for perfluorooctanoic acid (PFOA) and related short chain perfluorinated alkyl acids	2017	J. Hazard. Mater. 2017 Feb;323(Pt A):84-98. doi: 10.1016/j.jhazmat.2016.04.055.	The evidence that in Northern Italy significant sources of perfluoroalkylacids (PFAA) are present induced the Italian government to establish a Working Group on Environmental Quality Standard (EQS) for PFAA in order to include some of them in the list of national specific pollutants for surface water monitoring according to the Water Framework Directive (2000/60/EC). The list of substances included perfluorooctanoate (PFOA) and related short chain PFAA such as perfluorobutanoate (PFBA), perfluoropentanoate (PFPeA), perfluorohexanoate (PFHxA) and perfluorobutanesulfonate (PFBS), which is a substitute of perfluorooctanesulfonate. For each of them a dossier collects available data on regulation, physico-chemical properties, emission and sources, occurrence, acute and chronic toxicity on aquatic species and mammals, including humans. Quality standards (QS) were derived for the different protection objectives (pelagic and benthic communities, predators by secondary poisoning, human health via consumption of fishery products and water) according to the European guideline. The lowest QS is finally chosen as the relevant EQS. For PFOA a QS for biota was derived for protection from secondary poisoning and the corresponding QS for water was back-calculated, obtaining a freshwater EQS of 0.1 mu g L-1. For PFBA, PFPeA, PFHxA and PFBS threshold limits proposed for drinking waters were adopted as EQS.	1	1		1				B	-		
D253	ばく露	Kwok, KY; Yamazaki, E; Yamashita, N; Taniyasu, S; Murphy, MB; Horii, Y; Petrick, G; Kallerborn, R; Kannan, K; Murano, K; Lam, PKS	Transport of Perfluoroalkyl substances (PFAS) from an arctic glacier to downstream locations: Implications for sources	2013	Sci. Total Environ. 2013 Mar:447:46-55. doi: 10.1016/j.scitotenv.2012.10.091	Perfluoroalkyl substances (PFAS) have been globally detected in various environmental matrices, yet their fate and transport to the Arctic is still unclear, especially for the European Arctic. In this study, concentrations of 17 PFAS were quantified in two ice cores (n = 26), surface snow (n = 9) and surface water samples (n = 14) collected along a spatial gradient in Svalbard, Norway. Concentrations of selected ions (Na+, SO42-, etc.) were also determined for tracing the origins and sources of PFAS. Perfluorobutanoate (PFBA), perfluorooctanoate (PFOA) and perfluorononanoate (PFNA) were the dominant compounds found in ice core samples. Taking PFOA, PFNA and perfluorooctane-sulfonate (PFOS) as examples, higher concentrations were detected in the middle layers of the ice cores representing the period of 1997-2000. Lower concentrations of C8-C12 perfluorocarboxylates (PFCAs) were detected in comparison with concentrations measured previously in an ice core from the Canadian Arctic, indicating that contamination levels in the European Arctic are lower. Average PFAS concentrations were found to be lower in surface snow and melted glacier water samples, while increased concentrations were observed in river water downstream near the coastal area. Perfluorohexanesulfonate (PFHxS) was detected in the downstream locations, but not in the glacier, suggesting existence of local sources of this compound. Long-range atmospheric transport of PFAS was the major deposition pathway for the glaciers, while local sources (e.g., skiing activities) were identified in the downstream locations.	1		1					B	-		
D254	ばく露	Chen, HT; Reinhard, M; Nguyen, TV; You, LH; He, YL; Gin, KYH	Characterization of occurrence, sources and sinks of perfluoroalkyl and polyfluoroalkyl substances (PFASs) in a tropical urban catchment	2017	Environ. Pollut. 2017 Aug:227:397-405. doi: 10.1016/j.envpol.2017.04.091	Understanding the sources, occurrence and sinks of perfluoroalkyl and polyfluoroalkyl substances (PFASs) in the urban water cycle is important to protect and utilize local water resources. Concentrations of 22 target PFASs and general water quality parameters were determined monthly for a year in filtered water samples from five tributaries and three sampling stations of an urban water body. Of the 22 target PFASs, 17 PFASs were detected with a frequency >93% including PFCAs: C4-C12 perfluoroalkyl carboxylates, C4, C6, C8, and C10 perfluoroalkane sulfonates, perfluorooctane sulfonamides and perfluorooctane sulfonamide substances (FOSAMs), C10 perfluoroalkyl phosphonic acid (C10 PFPA), 6:2 fluorotelomer sulfonic acid (6:2 FTSA) and C8/C8 perfluoroalkyl phosphinic acid (C8/C8-PFPIA). The most abundant PFASs in water were PFBS (1.4-55 ng/L), PFBA (1.0-23 ng/L), PFOS (1.5-24 ng/L) and PFOA (2.0-21 ng/L). In the tributaries, PFNA concentrations ranged from 1.2 to 87.1 ng/L except in the May 2013 samples of two tributaries, which reached 520 and 260 ng/L. Total PFAS concentrations in the sediment samples ranged from 1.6 to 15 ng/g d.w. with EtFOSAA, PFDoA, PFOS and PFDA being the dominant species. Based on water and sediment data, two types of sources were inferred: one-time or intermittent point sources and continuous non-point sources. FOSAMs and PFOS released continually from non-point sources, C8/C8 PFPIA, PFDoA and PFUnA was released from point sources. The highly water soluble short-chain PFASs including PFBA, PFPeA and PFBS remained predominantly in the water column. The factors governing solution phase concentrations appear to be compound hydrophobicity and sorption to suspended particles. Correlation of the dissolved phase concentrations with precipitation data suggested stormwater was a significant source of PFBA, PFBS, PFUnA and PFDoA. Negative correlations with precipitation indicated sources feeding FOSAA and FOSA directly into the tributaries.	1		1	1				B	-		
D255	ばく露	Zhu, ZY; Wang, TY; Wang, P; Lu, YL; Giesy, JP	Perfluoroalkyl and polyfluoroalkyl substances in sediments from South Bohai coastal watersheds, China	2014	Mar. Pollut. Bull. 2014 Aug:85(2):619-627. doi: 10.1016/j.marpolbul.2013.12.042.	This study investigated the concentrations and distribution of Perfluoroalkyl and polyfluoroalkyl substances (PFAS) in sediments of 12 rivers from South Bohai coastal watersheds. The highest concentrations of Sigma PFAS (31.920 ng g(-1) dw) and PFOA (29.021 ng g(-1) dw) were found in sediments from the Xiaoqing River, which was indicative of local point sources in this region. As for other rivers, concentrations of Sigma PFAS ranged from 0.218 to 1.583 ng g(-1) dw were found in the coastal sediments and from 0.167 to 1.953 ng g(-1) dw in the riverine sediments. Predominant PFAS from coastal and riverine areas were PFOA and PFBS, with percentages of 30% and 35%, respectively. Partitioning analysis showed the concentrations of PFNA, PFDA and PFHxS were significantly correlated with organic carbon. The results of a preliminary environmental hazard assessment showed that PFOS posed the highest hazard in the Mi River, while PFOA posed a relative higher hazard in the Xiaoqing River.			1	1				B	-		
D256	ばく露	Khan, K; Younas, M; Zhou, YQ; Sharif, HMA; Li, X; Yaseen, M; Ibrahim, SM; Baninla, Y; Cao, XH; Lu, YL	First report of perfluoroalkyl acids (PFAAs) in the Indus Drainage System: Occurrence, source and environmental risk	2022	Environ. Res. 2022 Aug:211:113113. doi: 10.1016/j.envres.2022.113113.	Perfluoroalkyl acids (PFAAs) are of global interest due to their persistence in the aquatic environment. This study assessed the occurrence of PFAAs in the Indus Drainage System and discerned their potential sources and environmental risks for the first time in Pakistan. 13 perfluoroalkyl carboxylic acids (PFCAs) and 4 perfluoroalkyl sulfonates (PFSAs) were analyzed to verify the dominant prevalence of short-chain PFAAs in the environment since the phase-out of long-chain perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). A significant variation ($p <= 0.05$) of individual PFAAs between the monitoring sites was confirmed by data normality tests Kolmogorov-Smirnov and Shapiro-Wilk, suggesting that different locations contribute differently to individual PFAAs concentrations. Sigma PFAAs concentrations in riverine water and sediments ranged from 2.28 to 221.75 ng/L and 0.78-29.19 ng/g dw, respectively. PFBA, PFPeA, and PFHxA were the most abundant PFAAs, and on average accounted for 14.64, 13.75, and 12.97 ng/L of Sigma PFAAs in riverine water and 0.34, 0.64, and 0.79 ng/g dw of Sigma PFAAs in sediments. Sigma PFAAs mean contamination in the drainage was significantly ($p < 0.05$) high in River Chenab followed by River Indus > Soan > Ravi > Kabul > Swat with more prevalence of short chain (C4-C7) PFCAs followed by PFOA, PFBS, PFOS, PFNA, PFDA, PFHxS, PFUnDA, and PFDoDA. The correlation analysis determined the PFAAs' fate and distribution along the drainage, indicating that PFAAs with carbon chains C4-C12, except for PFSAs with carbon chains C6-C8, were most likely contaminated by the same source, the values of Kd and Koc increased linearly with the length of the perfluoroalkyl carbon chain, better understand the transport and partitioning of individual PFAAs between riverine water and sediments, where the HCA and PCA discerned industrial/municipal wastewater discharge, agricultural and surface runoff from nearby fields, and urban localities as potential sources of PFAAs contamination. The collective mass flux of short-chain (C4-C7) PFCAs was 5x higher than that of PFOS + PFOA, suggesting a continuous shift in the production and usage of fluorinated replacements for long-chain PFAAs with short-chain homologs. In terms of risk, individual PFAAs pollution in the drainage was within the world's risk thresholds for human health, with the exception of PFBA, PFPeA, PFHpA, PFHxA, PFOA, PFNA, and PFBS, whereas for ecology, the concentrations of individual PFAAs did not exceed the ecological risk thresholds of the United States of America, Canada, European Union (EU), Italy, Australia, and New Zealand, with the exception of PFSAs, whose detected individual concentrations were significantly higher than the EU, Australian and New Zealander PFSAs guidelines of 0.002 mu g/L, 0.00047 mu g/L, 0.00065 mu g/L, 0.00013 mu g/L, and 0.00023 mu g/L, respectively, which may pose chronic risks to the regional ecosystem and population.	1	1	1	1				B	-		
D257	ばく露	Wang, P; Lu, YL; Wang, TY; Zhu, ZY; Li, QF; Zhang, YQ; Fu, YN; Xiao, Y; Giesy, JP	Transport of short-chain perfluoroalkyl acids from concentrated fluoropolymer facilities to the Daling River estuary, China	2015	Environ. Sci. Pollut. Res. 2015 Jul:22(13):9626-9636. doi: 10.1007/s11356-015-4090-x.	After global commercialization of short-chain perfluoroalkyl acids (PFAAs) as substitutes to conventional long-chain PFAAs by the major manufacturers, two fluorine industry parks for production of short-chain PFAAs located in the Daling River Basin of northern China have developed rapidly in the last few years. This study provides a systematic assessment of sources, emissions, transportation, and potential risks of the PFAAs in this area. The C4 perfluorobutane sulfonic acid (PFBS) and perfluorobutanoic acid (PFBA) were the predominant short-chain PFAAs in river water, with maximum concentrations of 2.90 and 1.35 mu g/L, respectively. Park 1 equipped with a telomerization process was identified to be the source of linear and branched mixtures of PFBS, PFBA, and perfluorooctanoic acid (PFOA), while park 2 with an electrochemical fluorination process (ECF) was identified to be the source of linear and branched mixtures of PFBS and PFOA. Partition coefficients between water and sediment were consistent for C4-C8 perfluoroalkyl carboxylic acids (PFCAs) but directly proportional to C9-C11 PFCAs and perfluoroalkyl sulfonic acids (PFSAs). Analysis on the health risk of PFBS and PFBA suggested that they were not without risk since short chain PFAAs are known to be recalcitrant during water treatment.	1			1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D258	ばく露	Szabo, D; Coggan, TL; Robson, TC; Currell, M; Clarke, BO	Investigating recycled water use as a diffuse source of per- and polyfluoroalkyl substances (PFASs) to groundwater in Melbourne, Australia	2018	Sci. Total Environ. 2018 Dec:644:1409-1417. doi: 10.1016/j.scitotenv.2018.07.048	C The purpose of this study was to investigate the contribution of per- and polyfluoroalkyl substances (PFASs) to groundwater at a location where recycled water from a wastewater treatment plant (WWTP) is used to irrigate crops. Groundwater from Werribee South, located west of Melbourne, Australia, was sampled over two campaigns in 2017 and 2018, extracted using solid phase extraction (SPE) and analysed with liquid chromatography-tandemmass spectrometry (LC-MS/MS-QQQ). PFASs were detected in 100% of the groundwater samples. The sum total of twenty PFAS compounds (Sigma(20)PFASs) for all sites in the study ranged from <0.03 to 74 ng/L (n = 28) and the highest levels of which were observed in the centre of the irrigation district. Perfluorooctanesulfonic acid (PFOS) was the most detected compound overall (96%) with a mean concentration of 11 ng/L (<0.03-34 ng/L), followed by perfluorobutanesulfonic acid (PFBS; 86%, 4.4 ng/L), perfluorooctanoic acid (PFOA; 82%, 2.2 ng/L) and perfluorobutanoic acid (PFBA; 77%, 6.1 ng/L). Concentrations of PFASs found in this study are greater than background levels of PFASs detected in groundwater and are in the range of concentrations typically detected in wastewater effluent. This study presents evidence that the use of recycled water can be a source of PFAS contamination to groundwater.	1			1				B	-		
D259	ばく露	Guardian, MGE; Boongaling, EG; Bernardo-Boongaling, VRR; Gamonchuang, J; Boontongto, T; Burakham, R; Arnnok, P; Aga, DS	Prevalence of per- and polyfluoroalkyl substances (PFASs) in drinking and source water from two Asian countries	2020	Chemosphere. 2020 Oct:256:127115. doi: 10.1016/j.chemosphere.2020.127115.	The present study focuses on the determination of the occurrence and levels of per- and polyfluoroalkyl substances (PFASs) in the drinking and source water from the Philippines and Thailand. A total of 46 samples (18 commercial bottled waters, 5 drinking water from vending machine (re-fill stations) and 23 source water) were analyzed using liquid chromatography with tandem high-resolution mass spectrometry. Using the targeted method, 12 different PFASs were detected in the drinking water samples with total quantifiable PFASs (Sigma PFASs) levels ranging from 7.16 to 59.49 ng/L; 15 PFASs were detected in source water with Sigma PFASs ranging from 15.55 to 65.65 ng/L. A 100% detection frequency was observed for perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorosulfonic acid (PFOS) in all water samples. Six other PFASs, not included in the targeted analysis, were detected using the suspect screening approach. For the first time, the presence of 2-(N-methylperfluorooctanesulfonamido) acetic acid (N-MeFOSAA) in drinking water is reported, and 3 novel PFASs (C5H5OF8, C6H4O2F6, and C9H2O2F16) were detected using suspect screening in source water. Combined results from target and suspect screening analysis showed that PFASs detected were predominantly (52%) short-chain (with fluorinated alkyl chain of <= 6) which could be explained by their high mobility in the environment. The detected PFASs levels in drinking water will not likely pose immediate health risk to consumers according to US EPA health advisory for PFOS and PFOA of 70 ng/L, but inclusion of bottled and drinking water from re-fill stations in monitoring programs is warranted.			1					B	-		
D260	ばく露	Qi, YJ; Huo, SL; Hu, SB; Xi, BD; Su, J; Tang, ZW	Identification, characterization, and human health risk assessment of perfluorinated compounds in groundwater from a suburb of Tianjin, China	2016	Environ. Earth Sci. 2016 Mar;75(5):432. doi: 10.1007/s12665-016-5415-x.	This study investigated the occurrence of perfluorinated compounds (PFCs) in groundwater from 16 sampled wells for the public drinking water supply in a suburb of Tianjin, China. Thirteen PFC analytes were quantified by ultra-high performance liquid chromatography/electrospray tandem mass spectrometry. Concentrations of the total PFCs in groundwater ranged from 0.32 to 8.3 ng L-1 with an average of 2.4 ng L-1. The dominant PFCs were perfluorobutane sulfonic acid (PFBS) and perfluorooctanoic acid (PFOA) with averages of 1.1 and 0.81 ng L-1, respectively. Levels of perfluorocarboxylic acids containing 6-12 carbon atoms (except PFOA) in groundwater decreased with the increase of their carbon chain lengths. Strong positive correlations were observed between perfluoroheptanoic acid (PFHpA) and PFOA, PFHpA and perfluorononanoic acid (PFNA), PFHpA and PFBS, and PFOA and PFNA (Spearman Correlation test, p < 0.01), suggesting that these chemicals might originate from the same or similar pollution sources. The principal component analysis-multiple linear regression model analysis showed that PFCs mainly came from the fluorotelomer production and emission, followed by the introduction of the substitute compounds. PFC concentrations were positively correlated to the contents of dissolved organic carbon and Mn2+, and negatively correlated to the contents of total nitrogen and SO42- in groundwater. These indicated that PFC distributions and pollution levels in groundwater were related to organic carbon, nutrients and inorganic salts. The preliminary health risk assessment suggested that there was no significantly immediate harm of exposure to PFCs in drinking water for the villagers in the suburb of Tianjin, China.			1	1				B	-		
D261	ばく露	Zhang, M; Wang, P; Lu, YL; Shi, YJ; Wang, C; Sun, B; Li, XQ; Song, S; Yu, MZ; Zhao, JX; Du, D; Qin, WY; Wang, T; Han, GX; Liu, ZY; Baninla, Y; Zhang, AQ	Transport and environmental risks of perfluoroalkyl acids in a large irrigation and drainage system for agricultural production	2021	Environ. Int. 2021 Dec:157:106856. doi: 10.1016/j.envint.2021.106856.	The quality of irrigation water and drainage water is essential for local ecosystem and human health in agricultural regions. In this study, the transport analysis, source identification, and environmental risk assessment of perfluoroalkyl acids (PFAAs) were conducted in the largest irrigation area in northern China. The concentrations of the total PFAAs (sigma PFAA) ranged from 41.5 to 263 ng/L in surface water, and the short-chain perfluoroalkyl carboxylic acids (PFCAs) and perfluorooctanoic acid (PFOA), were dominant with a total contribution of 94%. Generally, the sigma PFAA levels increased from irrigation waters to drainage and receiving lake waters. PFOA showed the highest increase, with potential emission sources located in the catchment of the sub main drainage ditch D5. More PFOA (36.8 kg/y) was outflowed from Ulansuhai Lake to the Yellow River than that inflowed from the Yellow River to the irrigation district (6.15 kg/y). The results of a risk assessment indicated that avian wildlife living in Ulansuhai Lake were threatened by the PFOA and perfluorobutane sulfonate (PFBS) pollution. The estimated daily intakes (EDIs) of the sum of the PFOA, perfluorononanoic acid (PFNA), perfluorohexane sulfonic acid (PFHxS), and perfluorooctane sulfonic acid (PFOS) through aquatic food consumption for people with the different aquatic food preferences accounted for 6-42% (urban) and 4-27% (rural) of the strictest tolerant daily intake (TDI) value. The results of this study highlight the impact of local emissions of PFAS on massive irrigation and drainage systems, and ultimately, the ecosystem and human health.			1	1				B	-		
D262	ばく露	Bao, J; Liu, W; Liu, L; Jin, YH; Ran, XR; Zhang, ZX	Perfluorinated compounds in urban river sediments from Guangzhou and Shanghai of China	2010	Chemosphere. 2010 Jun:80(2):123-130. doi: 10.1016/j.chemosphere.2010.04.008.	Perfluorinated compounds (PFCs) have been determined in various matrices within China including water bodies, precipitations, biota and non-occupationally PFCs-exposed populations in recent years, yet little attention has been focused on the distributions of PFCs in urban river sediments from Chinese major metropolises such as Guangzhou and Shanghai so far. In this study, sediment samples of 0-2 cm were collected from 13 sites in the Zhujiang River across Guangzhou and nine sites in the Huangpu River across Shanghai. PFCs analysis on these sediments via high performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS) system was implemented targeting eight analytes involving perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluorododecanoic acid (PFDoA) and perfluorotetradecanoic acid (PFTA). According to the analytical results, total concentrations of PFCs (Sigma PFCs) in sediments from the Zhujiang River were between 0.09 and 3.6 ng/g dry weight (dw), with PFOS being the dominant PFC contaminant in the river ranged from below LOD to 3.1 ng/g dw: while Sigma PFCs in sediments from the Huangpu River were between 0.25 and 1.1 ng/g dw, with PFOA being the main PFC contaminant in the river determined in the levels of 0.20-0.64 ng/g dw. Additionally, an overall decreasing trend of PFCs contaminations with depth was observed in both of two 60 cm sediment cores from the Zhujiang River and the Huangpu River each.			1	1				B	-		
D263	ばく露	Stefano, PHP; Roisenberg, A; Acayaba, RD; Roque, AP; Bandoria, DR; Soares, A; Montagner, CC	Occurrence and distribution of per-and polyfluoroalkyl substances (PFAS) in surface and groundwaters in an urbanized and agricultural area, Southern Brazil	2023	Environ. Sci. Pollut. Res. 2023 Jan:30(3):6159-6169. doi: 10.1007/s11356-022-22603-x.	Per- and polyfluoroalkyl substances, known as PFAS, are emerging contaminants detected in surface water, groundwater, drinking water, air, and food. Due to its chemical stability and high hydrophobicity, these compounds are used as surfactants, surface protectors, flame retardants, textile impregnation, fire-fighting foam, and pesticides and may be a risk for human health in the long-term exposure. Currently, a little research has been carried out for these compounds in Brazil. In this study, the concentration and distribution of 23 PFAS were analyzed in groundwater samples collected from water wells in urbanized areas and in surface water samples from Porto Alegre, one of the biggest cities in Brazil. The total concentrations of PFAS (sigma PFAS) in a groundwater sample varied between 22 and 718 ng L-1. Eleven PFAS species were detected in groundwater, including PFOA, PFHxA, PFPeA, PFBA, PFDA, PFNA, and PFOS. Most of PFAS were quantified in samples located in the aquifer formed by medium to coarse sands intercalated with silty-sandy lenses and low organic matter content that could facilitate the percolation of these compounds. The total concentrations of PFAS (sigma PFAS) in a surface water sample varied between 11 and 17 ng L-1. Ten species were founded in surface water being PFOA, PFOS, and PFHpA the most dominant. Considering all the samples, PFOA was the predominant species in the study. In addition, tributary water bodies had higher concentrations of PFAS than the main water body (Guaiba Lake) probably due dilution process.	1	1	1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D264	ばく露	Cao, XH; Wang, CC; Lu, YL; Zhang, M; Khan, K; Song, S; Wang, P; Wang, C	Occurrence, sources and health risk of polyfluoroalkyl substances (PFASs) in soil, water and sediment from a drinking water source area	2019	Ecotox. Environ. Safe. 2019 Jun:174:208-217. doi: 10.1016/j.ecoenv.2019.02.058	Polyfluoroalkyl substances (PFASs) enter into environmental metric via various pathways in the process of manufacturing and consuming the products containing PFASs. Yuqiao reservoir (YQR) is a major drinking water source in Tianjin of China, where little attention was given to PFASs. To explore the occurrence, source and risk of 17 PFASs, multi -media environmental including soil, water, and sediment were sampled from this water source area. The Sigma PFASs concentrations of surface water, groundwater, soil and sediment ranged from 5.839 to 120.885 ng/L, 1.426 to 17.138 ng/L, 0.622 to 5.089 mu g/kg dw, and 0.240 to 1.210 mu g/kg dw respectively. Some short-chained (C4-C8) PFASs were detected widely such as PFOA, PFBA, PFHxA, PFBS, PFHpA and PFPeA in surface water and groundwater, with the detection frequency of > 78%, and PFBA and PFOA dominated in the 17 PFASs. In addition, the correlations between total PFASs and TOC were significant at 0.05 level, especially in surface water with R-2 = 0.9165 (p = 0.011). In terms of vertical distribution characteristics of Sigma PFASs, the Sigma PFASs in four sediment cores showed a decreasing trend at first, and then an increasing trend from the bottom to the top associated with TOC. PFBA/PFOA and PFHpA/PFOA showed better linear correlations with R-2 of 0.5541 (p = 0.039), and for PFNA/PFOA and PFHpA/PFOA with R-2 of 0.6312 (p = 0.032) at the 0.05 level in the surface water, which indicated that sewage and atmospheric precipitation were the major sources. Though the RQ results based on the measured concentrations and reference values in environmental media revealed lower risks, the potential hazard may occur due to accumulation characteristics and long-distance transmission capability of PFASs. Hence, the corresponding management strategies should be taken, such as control over emission at source, product substitution and strengthening legislation, to eliminate potential risks to human health.	1	1	1	1				B	-		
D265	ばく露	Mikolajczyk, S; Pajurek, M; Warenik-Bany, M	Perfluoroalkyl substances in hen eggs from different types of husbandry	2022	Chemosphere. 2022 Sep;303(Pt 1):134950. doi: 10.1016/j.chemosphere.2022.134950.	Poultry eggs from cage, ecological and free range production were analyzed in terms of perfluoroalkyl substances (PFASs). Taking into account all fourteen analyzed compounds, perfluorobutanoic acid (PFBA) reach the highest concentrations (mean 0.23, 0.24, 0.27 mu g/kg wet weight (w.w) for organic, cage and free range eggs respectively. Taking into account the lower bound sum of four PFASs: PFOS, PFOA, PFNA, PFHxS which according to EFSA, made up half of the lower bound exposure to PFASs, organic eggs were the most contaminated (0.10 mu g/kg wet weight) followed by free range (0.04 mu g/kg wet weight) and battery cage (0.00 mu g/kg wet weight). The percentage share in the lower bound concentration indicates the dominant role of PFOS (37-100%). Linear PFOS accounted for 71-92% of the sum of linear and branched PFOS. Estimates of PFOS, PFOA, PFNA, PFHxS intake via eggs based lower-bound concentrations were 0.00-0.65 ng/kg b. w for children and 0.00-0.21 ng/kg b. w for adults which corresponds to 0-15% of the tolerable weekly intake (TWI) and 0-5% TWI for children and adult respectively.	1		1					B	-		
D266	ばく露	Lin, Y; Jiang, JJ; Rodenburg, LA; Cai, MG; Wu, Z; Ke, HW; Chitsaz, M	Perfluoroalkyl substances in sediments from the Bering Sea to the western Arctic: Source and pathway analysis	2020	Environ. Int. 2020 Jun:139:105699. doi: 10.1016/j.envint.2020.105699.	Although perfluoroalkyl substances (PFASs) are ubiquitous in the Arctic, their dominant pathways to the Arctic remain unclear. Most modeling studies support major oceanic transport for PFASs in the Arctic seawater, but this conclusion contradicts the rapid response of PFASs to global emissions in some biota species. Sediments, which act as important PFAS sinks for seawater and potential PFAS source to the benthic food web, are important for interpreting the fate of PFASs in the Arctic. Here we investigate the occurrence of 9 PFASs in one core (1945-2014) and 29 surface sediments from the Bering Sea to the western Arctic. Total PFAS concentrations (0.06-1.73 ng/g dw) in surface sediments were dominated by perfluorooctane sulfonate (PFOS), per- fluorononanoic acid (PFNA) and perfluorobutyl sulfonate (PFBS), with higher levels in the Bering Sea slope and the northeast Chukchi Sea. Historical trends in PFASs varied among individuals, with PFOS declining in the early 2000s while PFNA showing an increasing up-core trend. Analysis of positive matrix factorization model identified that the major PFAS sources in the sediment core were dominated by the atmospheric oxidation of consumer use of PFOS precursor-based products (45.0%), while the oceanic transport of fluoropolymer manufacture of polyvinylidene fluoride (mainly PFNA) exhibited an increasing trend over time, becoming dominant in surface sediments (42.8%). Besides, local input of possible aqueous fire-fighting foams (mainly PFOS and PFBS) also acted as an important source currently (30.1%) and historically (34.9%). Our study revealed that the pathways of PFASs in Arctic sediments varied greatly for individuals and the conclusion of PFOS originating from mainly atmospheric oxidation was different from seawater modeling results. This, together with the high possibility of sediments as direct source to Arctic food web (supported by similar PFAS compositions and temporal variations), help provide additional evidence regarding PFAS pathways to the Arctic.			1	1				B	-		
D267	ばく露	Chen, SQ; Yan, M; Chen, Y; Zhou, YQ; Li, ZC; Pang, Y	Perfluoroalkyl substances in the surface water and fishes in Chaohu Lake, China	2022	Environ. Sci. Pollut. Res. 2022 Oct:29(50):75907-75920. doi: 10.1007/s11356-022-20753-6.	The concentration and composition of 13 perfluoroalkyl substances (PFASs) in surface water and fishes in Chaohu Lake, China, were systematically studied in October 2019. Results showed that the PFASs composition has changed greatly. The concentration levels of perfluorooctane sulfonate (PFOS) in the surface water of Chaohu Lake have decreased significantly compared with past years. Perfluorobutanoic acid (PFBA) has become the dominant component, and it was mainly come from industrial wastewater. The highest concentration of perfluorooctanoic acid (PFOA) was measured in the lake inlet of the Baishitian River (southwest part), which mainly received domestic sewage. Different types of wastewater lead to varying compositions of PFASs in the lake water. PFOA and PFBS were homologous in some areas of Chaohu Lake, which reflected the unbalanced promotion of prohibition and substitution of long-chain PFASs around Chaohu Lake. On the basis of the risk quotient and tolerable daily intake assessment, drinking water and eating fish from Chaohu Lake do not lead to apparent PFAS risk, but PFOS in fish has evident bioaccumulation and biomagnification effects. PFOS-based human daily intake of Channa argus accounts for 22.4% of the tolerable daily intake. Thus, the risk caused by PFOS needs close attention. This study is useful for enhancing people's understanding of the environmental behavior and the risk of PFASs in Chaohu Lake.	1			1				B	-		
D268	ばく露	Chen, HT; Reinhard, M; Nguyen, VT; Gin, KYH	Reversible and irreversible sorption of perfluorinated compounds (PFCs) by sediments of an urban reservoir	2016	Chemosphere 2016 Feb:144:1747-1753. doi: 10.1016/j.chemosphere.2015.10.055	Uncertainty about the extent to which contaminant sorption by suspended solids and bed sediments is irreversible is a major impediment for modeling and managing the water quality of surface water resources. This study examined reversible and irreversible sorption of several perfluorinated compounds (PFCs) to bed sediments from an urban reservoir. PFCs investigated include C4, C6, C8, C9 and C10 perfluoroalkanoate homologues (PFBA, PFHxA, PFOA, PFNA and PFDA, respectively) and perfluorooctane and hexane sulfonate (PFOS and PFHxS, respectively). Although sorption branches of the PFOS, PFNA and PFDA isotherms were nearly linear (implying a partitioning-like process), desorption experiments indicated that a fraction of the sorbed PFCs were entrapped and resistant to desorption. The hysteretic desorption branches were approximately linear. Irreversibility increased with chain length and was nearly complete for PFDA (thermodynamic irreversibility index (TII) 0.98). For the weakly sorbing PFOA and PFHxS, sorption was largely reversible. Data suggest that (1) for the strongly sorbing PFCs, e.g. PFNA, PFDA and PFOS, bed sediments acted predominantly as irreversible sinks, (2) aqueous concentrations of the moderately sorbing PFCs (PFOA and PFHxS) are buffered by reversibly sorbing suspended solids, and (3) the short-chain PFCs (PFBA and PFHxA) are not significantly sorbed and therefore not expected to be significantly influenced by sediment transport. Situations in which highly contaminated particles entering relatively clean water bodies, equilibrium is approached from the reverse (desorption) direction. For irreversibly sorbed contaminants field-based K-D values will be higher than the K-D values derived from laboratory sorption data obtained from forward sorption experiments.	1	1	1					B	-		
D269	ばく露	Sun, JC; Cheng, YC; Song, ZT; Ma, SS; Xing, LL; Wang, K; Huang, CJ; Li, DL; Chu, JS; Liu, Y	Large-scale assessment of exposure to legacy and emerging per- and polyfluoroalkyl substances in China's shorebirds	2023	Environ. Res. 2023 Jul:229:115946. doi: 10.1016/j.envres.2023.115946.	Emerging per-and polyfluoroalkyl substances (PFAS) have become more widely applied, whereas legacy PFAS such as PFOS continue to distribute ubiquitously in the environment. Large-scale assessment of wildlife exposure to both emerging and legacy PFAS plays a key role in effective biomonitoring to better discriminate regional contamination patterns and provide early warnings. Using eggs of two closely-related shorebird species collected across China during the breeding season in 2021, we constructed contrasting PFAS levels and profiles in coastal versus inland populations. The highest n-ary sumation PFAS concentrations were found in two Kentish plover (Charadrius alexandrinus) populations from the Bohai Sea, a semi-enclosed shallow bay located in northeast China. These two populations showed exceptionally high PFOA concentrations (mean: 94 and 121 ng/g wet weight; West and North Bohai Sea, respectively) dominating the overall PFAS profile (66% for both). This pattern is characteristic, compared to that of other seabird eggs worldwide. By comparison, PFAS profile in the white-faced plover (Charadrius dealbatus) population at the South China Sea coast was dominated by PFOS (46%), which showed similar levels to those at the North Bohai Sea coast (mean: 29 and 20 ng/g, respectively). PFAS concentrations of Kentish plovers from the remote Qinghai Lake were lower compared to the three coastal populations, and were dominated by PFNA (mean: 2.6 ng/g, 29%) and PFOS (mean: 2.5 ng/g, 27%). None of the eggs analyzed in the present study exceeded estimated toxicity reference values for PFOS or PFOA. Additionally, the emerging 6:2 Cl-PFESA was detected in eggs from all regions, while its concentrations were highest in the Bohai Sea populations, and short-chain PFBS was only detected in the North Bohai Sea population. Our results indicate intensive local emissions of PFOA and emerging PFAS at the Bohai Sea region, and warrant further investigation and monitoring.			1	1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D270	ばく露	Yamada, A; Bemrah, N; Veyrand, B; Pollono, C; Merlo, M; Desvignes, V; Sirot, V; Marchand, P; Berrebi, A; Cariou, R; Antignac, J; Le Bizec, B; Leblanc, JC	Dietary exposure to perfluoroalkyl acids of specific French adult sub-populations: High seafood consumers, high freshwater fish consumers and pregnant women	2014	Sci. Total Environ. 2014 Sep:491:170-175. doi: 10.1016/j.scitotenv.2014.01.089	Perfluoroalkyl acids (PFAAs) are globally found in various media, including food and especially fishery products. In the present study, the dietary exposure to 15 perfluoroalkyl acids was assessed for 3 French adult populations, namely high seafood consumers, high freshwater fish consumers, and pregnant women. Purified food extracts were analysed by LC-MS/MS and PFBA, PFPA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFTrDA, PFTeDA, PFBS, PFHxS, PFHpS, PFOS and PFDS were monitored and quantified according to the isotope dilution principle. Under lower bound (LB) hypothesis (i.e. contamination values < LOD considered as 0), high freshwater fish consumers appear as the most exposed to PFOS (7.5 ng.kg(-1) bw.d(-1)), PFUnA (1.3 ng.kg(-1) bw.d(-1)), PFDA (0.4 ng.kg(-1) bw.d(-1)) and PFHpS (0.03 ng.kg(-1) bw.d(-1)) while high seafood consumers appear as the most exposed to PFOA (1.2 ng.kg(-1) bw.d(-1)),PFNA (0.2 ng.kg(-1) bw.d(-1)) and PFHxS (0.06 ng.kg(-1) bw.d(-1)). For all considered populations, the major exposure contributors are fish, seafood and water under LB hypothesis, while dairy products, bread and crispbread are the main contributors under upper bound CUB) hypothesis. Besides this food exposure assessment, further studies are needed to assess the more global PFAA exposure, taking into account indoor and outdoor air, dust and cutaneous contact, which could be other important contributors for this particular class of chemicals.	1	1	1	1			1	A	-	2014年と少し古い論文、フランスのデータ、特定の集団を対象ではあるが、食事によるPFASばく露評価について有用な情報を提供していると考えられた。	
D271	ばく露	Li, XM; Dong, SJ; Zhang, W; Fan, X; Wang, RG; Wang, PL; Su, XO	The occurrence of perfluoroalkyl acids in an important feed material (fishmeal) and its potential risk through the farm-to-fork pathway to humans	2019	J. Hazard. Mater. 2019 Apr:367:559-567. doi: 10.1016/j.jhazmat.2018.12.103	Few studies have attempted to elucidate the occurrence of perfluoroalkyl acids (PFAAs) in animal feeds and how they play a role in human ingestion. Fishmeal was the most important animal-derived feed in global husbandry and may have been subjected to PFAA contamination considering the PFAAs' ubiquitous distribution in aquatic ecosystems. We collected ninety-two commercial fishmeal from the most important fishmeal-producing countries and found that Sigma(16)PFAAs ranged from 0.65 to 85.5 ng/g (average: 18.2 ng/g, 12% moisture). PFOS still predominated, with unexpected high detection of PFUnDA. The wide occurrence of short-chain PFAAs (e.g., PFBA, PFBS) in fishmeal were found for the first time. From a geographical view, PFAA levels in fishmeal that originated from the Northern Hemisphere were significantly higher than those from the Southern Hemisphere ($p < 0.01$). Higher levels of under-studied long-chain PFAAs (PFNA, PFDA, PFUnDA, PFDoDA and PFTrDA) weighted more in industrialized areas than less industrialized areas, whereas the legacy PFAAs (PFOS, PFOA and PFHxS) were comparable among all regions. The estimated daily intake was calculated from animal feed to humans (via cultured fish) from 20 Chinese provinces by the Monte Carlo Simulation. A proportion of 29.8% of residents from the Fujian Province exceeded the EFSA's suggestion for PFOS ingestion.	1		1	1				B	-		
D272	ばく露	Chen, ZA; Ren, GB; Ma, XD; Ding, Y; Hui, YM; Qin, PP; Xu, ZQ; Gu, XJ; Yuan, F; Liu, YH	Perfluoroalkyl substances in the Lingang hybrid constructed wetland, Tianjin, China: occurrence, distribution characteristics, and ecological risks	2020	Environ. Sci. Pollut. Res. 2020 Nov:27(31):38580-38590. doi: 10.1007/s11356-020-09921-8.	In this study, the occurrence, spatial distribution, sources, and ecological risks of perfluoroalkyl substances (PFASs) in the surface waters of the Lingang hybrid constructed wetland were systematically investigated. Twenty-three PFASs were analyzed from 7 representative sampling zones. The obtained results indicated that PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFOS, and HFPO-DA were frequently detected; and PFBA, PFOA, and PFOS were the dominant PFASs with the relative abundances in ranges of 26.91 to 52.26%, 11.79 to 28.79%, and 0 to 31.98%, respectively. The total concentrations of 8 PFASs (sigma(8)PFASs) ranged from 25.9 to 56.6 ng/L, and the highest concentration was observed in subsurface flow wetland. Moreover, HFPO-DA with high toxicity was detected in wetlands for the first time. Based on the principal component analysis-multiple linear regression (PCA-MLR) analysis, three sources and their contributions were fluoropolymer processing aids (67.6%), fluororesin coatings and metal plating (17.9%), and food packaging materials and atmospheric precipitation (14.5%), respectively. According to the risk quotients (RQs), the ecological risk of 8 PFASs was low to the aquatic organisms.	1	1		1	1			B	-		
D273	ばく露	Villagomez-Marquez, N; Abrell, L; Foley, T; Ramirez-Andreotta, MD	Organic micropollutants measured in roof-harvested rainwater from rural and urban environmental justice communities in Arizona	2023	Sci. Total Environ. 2023 Jun:876:162662. doi: 10.1016/j.scitotenv.2023.162662.	Due to global water scarcity and population growth, multiple solutions are needed to conserve and collect water, es-pecially in arid and semi-arid regions of the planet. As the practice of harvesting rainwater grows, it is important to assess the quality of roof-harvested rainwater (RHRW). This study measured twelve organic micropollutants (OMPs) in RHRW samples collected between 2017 and 2020 by community scientists, with approximately two hundred RHRW samples and corresponding field blank analyzed annually. The OMPs analyzed were atrazine, pentachlorophe-nol (PCP), chlorpyrifos, 2,4-dichlorophenoxyacetic acid (2,4-D), prometon, simazine, carbaryl, nonylphenol (NP), perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorobutane sulfonic acid (PFBS), and perfluorononanoic acid (PFNA). OMP concentrations measured in RHRW were below the following existing standards: US EPA Primary Drinking Water Standard, Arizona Department of Environmental Quality (ADEQ) Partial Body Con-tact for Surface Waters, and ADEQ Full Body Contact for Surface Waters for analytes in this study. At the time the study was conducted, 28 % of RHRW samples exceeded the non-enforceable US EPA Lifetime Health Advisory (HA) of 70 ng L-1 for the combined sum of PFOS and PFOA with a mean exceedance concentration of 189 ng L-1. When comparing PFOA and PFOS to the June 15, 2022 interim updated HAs of 0.004 ng L-1 and 0.02 ng L-1, respectively, all samples exceeded these values. No RHRW samples exceeded the final proposed HA of 2000 ng L-1 for PFBS. The limited number of state and federal standards established for the contaminants highlighted in this study indicate potential regulatory gaps and that users need to be aware that OMPs may be present in RHRW. Based on these concen-trations, domestic activities and intended uses should be carefully considered.			1	1				B	-		
D274	ばく露	Barbosa, MO; Ratola, N; Homem, V; Pereira, MFR; Silva, AMT; Ribeiro, ARL; Llorca, M; Farre, M	Per- and Poly-Fluoroalkyl Substances in Portuguese Rivers: Spatial-Temporal Monitoring	2023	Molecules. 2023 Feb;28(3):1209. doi: 10.3390/molecules28031209.	Eighteen per-and polyfluoroalkyl substances (PFASs) were investigated in surface waters of four river basins in Portugal (Ave, Leca, Antua, and Certima) during the dry and wet seasons. All sampling sites showed contamination in at least one of the seasons. In the dry season, perfluorooctanoate acid (PFOA) and perfluoro-octane sulfonate (PFOS), were the most frequent PFASs, while during the wet season these were PFOA and perfluobutane-sulfonic acid (PFBS). Compounds detected at higher concentrations were PFOS (22.6 ng L-1) and perfluoro-butanoic acid (PFBA) (22.6 ng L-1) in the dry and wet seasons, respectively. Moreover, the prospective environmental risks of PFASs, detected at higher concentrations, were evaluated based on the Risk Quotient (RQ) classification, which comprises acute and chronic toxicity. The results show that the RQ values of eight out of the nine PFASs were below 0.01, indicating low risk to organisms at different trophic levels in the four rivers in both seasons, wet and dry. Nevertheless, in the specific case of perfluoro-tetradecanoic acid (PFTeA), the RQ values calculated exceeded 1 for fish (96 h) and daphnids (48 h), indicating a high risk for these organisms. Furthermore, the RQ values were higher than 0.1, indicating a medium risk for fish, daphnids and green algae (96 h).	1			1				B	-		
D275	ばく露	Chen, S; Jiao, XC; Gai, N; Li, XJ; Wang, XC; Lu, GH; Piao, HT; Rao, Z; Yang, YL	Perfluorinated compounds in soil, surface water, and groundwater from rural areas in eastern China	2016	Environ. Pollut. 2016 Apr:211:124-131. doi: 10.1016/j.envpol.2015.12.024	Little research on perfluorinated compounds (PFCs) has been conducted in rural areas, although rural PFC sources are less complicated than in urban and industrial areas. To determine the levels and geographical distribution of 17 PFC compounds, samples of soil, surface water, and groundwater were collected from eight rural areas in eastern China. The total PFC concentrations (Sigma PFC5) in soils ranged from 034 to 65.8 ngig Sigma PFC5 in surface waters ranged from 7.0 to 489 ng/L and Sigma PFC5 in groundwater ranged from 53 to 615 ng/L. Ratios of perfluorononanoic acid/perfluorooctanoic acid (PFNA/PFOA), perfluoro-n-butyric acid/perfluorooctanoic acid (PFBA/PFOA), and perfluoroheptanoic acid/perfluorooctanoic acid (PFHpA/PFOA) in rainwater increased due to the fluorine chemical plants in the surrounding rural and urban areas, suggesting that atmospheric precipitation may carry PFCs and their precursors from the fluorochemical industrial area to the adjacent rural areas.	1		1					B	-		
D276	ばく露	Hu, HT; Hao, MM; Wang, HB; Hao, HT; Lu, ZL; Shi, BY	Occurrence of metals, phthalate esters, and perfluoroalkyl substances in cellar water and their relationship with bacterial community in rural areas of China	2023	Sci. Total Environ. 2023 Nov:900:165876. doi: 10.1016/j.scitotenv.2023.165876.	Water cellars are traditional rainwater harvesting facilities that have been widely used in rural areas of northwest China. However, there are few reports about the water quality and health risk caused by the cellar water, especially phthalate esters (PAEs) and perfluoroalkyl substances (PFASs). This study investigated and assessed the health risks caused by the metals, PAEs, PFASs and bacterial communities in cellar water. The results showed that the turbidity and total number of bacterial colonies ranged from 4.7 to 58.5 NTU and 5-557 CFU/mL, respectively. The turbidity and total number of bacterial colonies were the main water quality problems. Due to high concentration of Tl (0.005-0.171 & mu;g/L), the samples reached a high level of metal pollution. PAEs showed no non-carcinogenic and carcinogenic risk. The perfluorobutanoic acid (PFBA), perfluorobutanesulfonic acid (PFBS), perfluorooctanoic acid (PFOA), and perfluorooctane sulfonate (PFOS) were the main components of PFASs. PFOA and PFOS reached a moderate risk level in many cellar water samples. Moreover, Tl, Pb, As, PFBA and PFBS could change the bacterial community composition and induce the enrichment of bacterial functions related to human diseases. Besides these parameters, dissolved oxygen (DO) also affected the bacterial functions related to human diseases. Therefore, more attention should be paid to turbidity, DO, Tl, Pb, As, PFOA, PFOS, PFBA and PFBS in the cellar water. These results are meaningful for the water quality guarantee and health protection in rural areas of China.	1			1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D277	ばく露	Clara, M; Scheffknecht, C; Scharf, S; Weiss, S; Gans, O	Emissions of perfluorinated alkylated substances (PFAS) from point sources - identification of relevant branches	2008	Water Sci. Technol. 2008 :58(1):59-66. doi: 10.2166/wst.2008.641	Effluents of wastewater treatment plants are relevant point sources for the emission of hazardous xenobiotic substances to the aquatic environment. One group of substances, which recently entered scientific and political discussions, is the group of the perfluorinated alkylated substances (PFAS). The most studied compounds from this group are perfluorooctanoic acid (PFOA) and perfluorooctane sulphonate (PFOS), which are the most important degradation products of PFAS. These two substances are known to be persistent, bioaccumulative and toxic (PBT). In the present study, eleven PFAS were investigated in effluents of municipal wastewater treatment plants (WWTP) and in industrial wastewaters. PFOS and PFOA proved to be the dominant compounds in all sampled wastewaters. Concentrations of up to 340 ng/L of PFOS and up to 220 ng/L of PFOA were observed. Besides these two compounds, perfluorohexanoic acid (PFHxA) was also present in nearly all effluents and maximum concentrations of up to 280 ng/L werde measured. Only N-ethylperfluorooctane sulphonamide (N-EtPFOSA) and its degradation/metabolisation product perfluorooctane sulphonamide (PFOSA) were either detected below the limit of quantification or were not even detected at all. Beside the effluents of the municipal WWTPs, nine industrial wastewaters from six different industrial branches were also investigated. Significantly, the highest emissions or PFOS were observed from metal industry whereas paper industry showed the highest PFOA emission. Several PFAS, especially perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluorododecanoic acid (PFDoA) and PFOS are predominantly emitted from industrial sources, with concentrations being a factor of 10 higher than those observed in the municipal WWTP effluents. Perfluorodecane sulphonate (PFDS), N-Et-PFOSA and PFOSA were not detected in any of the sampled industrial point sources.								B	-		
D278	ばく露	Zhu, ZY; Wang, TY; Meng, J; Wang, P; Li, QF; Lu, YL	Perfluoroalkyl substances in the Daling River with concentrated fluorine industries in China: seasonal variation, mass flow, and risk assessment	2015	Environ. Sci. Pollut. Res. 2015 Jul:22(13):10009-10018. doi: 10.1007/s11356-015-4189-0.	In the present study, we investigated concentrations and composition profiles of perfluoroalkyl substances (PFASs) in surface water from the Daling River in different seasons. The highest concentration of Sigma PFASs (9540 ng L-1) and dominant homologues were found in surface water collected in summer. Perfluorobutanoic acid (PFBA), perfluorobutane sulfonate (PFBS), and perfluorooctanoic acid (PFOA) were the dominant PFASs in four seasons with a total contribution of over 90 %. The discharge of two fluorine chemical industry parks was predicted to be the main contamination source of PFASs in the study area. The daily and annual mass flows were calculated according to data of detected PFAS concentrations and water discharge, and the annual mass loading of PFASs into the Bohai Sea from the Daling River reached to 461 kg year(-1). Hazard assessment indicated that concentrations of PFASs in study area had little risk to aquatic organisms and wildlife. However, the multiple health risk would be relatively high if the water was served as drinking water in the study area.		1	1					B	-		
D279	ばく露	Barreca, S; Busetto, M; Colzani, L; Clerici, L; Marchesi, V; Tremolada, L; Daverio, D; Dellavedova, P	Hyphenated High Performance Liquid Chromatography-Tandem Mass Spectrometry Techniques for the Determination of Perfluorinated Alkylated Substances in Lombardia Region in Italy, Profile Levels and Assessment: One Year of Monitoring Activities During 2018	2020	Separations. 2020 Mar;7(1):17. doi: 10.3390/separations7010017.	In this research paper, we report a hyphenated technique based on ultra-high performance liquid chromatography-tandem mass spectrometry for the determination of twelve Perfluorinated Alkylated Substances in surface and groundwater samples from Lombardia Region during the monitoring activities in 2018 as new emerging and toxic pollutants. A green analytic method, developed by using an online Solid Phase Extraction coupled with UHPLC-MS/MS and previously validated, was applied for 4992 determinations conducted on 416 samples from 109 different sampling stations. Among the results, PFOS, PFOA, PFBA, PFBS, PFPeA and PFHxA were identified as the most abundant analytes detected. PFASs concentrations, in most cases, were below the limits of quantification and, in the cases where the limits of quantification have been exceeded, the values found were lower than Italy directive. PFOS is an exception and in fact this compound was detected in 76% of analyzed samples (surface and ground waters). Solid phase extraction with high performance liquid chromatography-tandem Mass Spectrometry has proved to be a very good Hyphenated techniques able to detect low concentrations of pollutants in surface and groundwater samples.	1	1		1				B	-		
D280	ばく露	Lott, DJ; Robey, NM; Fonseca, R; Bowden, JA; Townsend, TG	Behavior of Per- and polyfluoroalkyl substances (PFAS) in Pilot-Scale vertical flow constructed wetlands treating landfill leachate	2023	Waste Manage. 2023 Apr:161:187-192. doi: 10.1016/j.wasman.2023.03.001	This study investigated the behavior of per- and polyfluoroalkyl substances (PFAS) in multiple pilot-scale vertical flow constructed wetlands (VFCW) treating landfill leachate. Eight pilot-scale VFCW columns planted with Typha latifolia or Scirpus Californicus were fed untreated municipal solid waste (MSW) landfill leachate that was diluted with potable water at a 1:10 ratio (1 part leachate to 10 parts total) at a fixed daily hydraulic loading rate of 0.525 m d-1. Ninety-two PFAS were examined and 18 PFAS were detected at quantifiable concentrations (7 precursor species and 11 terminal species). The average concentration of sigma 92 PFAS in the influent was 3,100 ng L1, which corresponded with minimal reduction in the effluents from the four VFCW (decreases ranged from 1% to 12% on average for sigma 18 PFAS); however, precursors 6:3 FTCA, 7:3 FTCA, N-MeFOSAA, and N-EtFOSAA concentrations decreased significantly in the VFCW effluents, and significant decreases in the concentrations of these PFAA-precursors were concurrent with a significant increase in concentrations of five PFAAs (PFBA, PFNA, PFBS, PFOS, and PFOSI). This trend indicates that from a regulatory perspective, standalone VFCWs are likely to produce an apparent PFAS increase, which may also be true for many other leachate treatment processes incorporating aerobic biological treatment. Additional treatment to address PFAS should be integrated prior to the use of any system, including VFCWs, for the treatment of constituents of concern in MSW landfill leachate.	1		1	1				B	-		
D281	ばく露	Huang, XY; Wei, XX; Liu, HZ; Li, W; Shi, DZ; Qian, SH; Sun, WJ; Yue, DB; Wang, XM	Occurrence of per- and polyfluoroalkyl substances (PFAS) in municipal solid waste landfill leachates from western China	2022	Environ. Sci. Pollut. Res. 2022 Oct:29(46):69588-69598. doi: 10.1007/s11356-022-20754-5.	Landfill leachate has been documented as a significant source of trace organic pollutants, comprising an expansive family of per- and polyfluoroalkyl substances (PFAS). This study presents the findings on the distribution of 13 perfluoroalkyl carboxylates (PFCAs) and 4 perfluoroalkyl sulfonates (PFSAs) in leachates from 6 municipal solid waste (MSW) landfills in western China. The total concentrations of 17 PFAS in sampled leachates ranged from 1805 to 43,310 ng/L, and 15 compounds were detected in all samples. The short-chain compounds perfluorobutane sulfonate (PFBS, mean mass fraction 23.1%) and perfluorobutyric acid (PFBA, mean mass fraction 20.6%) were dominant. There were higher PFAS concentrations in leachates from operating landfills (mean: 12,194 ng/L) compared to closed landfills (mean: 2747 ng/L), but there was no significant difference between young (<10 years) and old landfills (> 10 years). Moderate to weak correlations were observed between PFAS concentrations and leachate properties, e.g., TN, NH4+-N, TOC, and pH. This is the first report on the distribution of PFAS in landfill leachates from western China. The results have identified landfill leachate as an underestimated source of PFAS in the environment and have contributed to a more comprehensive evaluation on PFAS presence across China.	1			1				B	-		
D282	ばく露	Tang, JX; Zhu, YL; Xiang, B; Li, Y; Tan, T; Xu, Y; Li, MX	Multiple pollutants in groundwater near an abandoned Chinese fluorine chemical park: concentrations, correlations and health risk assessments	2022	Sci Rep. 2022 Mar;12(1):3370. doi: 10.1038/s41598-022-07201-8.	Contamination and adverse effects from various pollutants often appear in abandoned industrial regions. Thus, nine groundwater samples were collected from the vicinity of the fluorochemical industry in Fuxin City, Liaoning Province, to determine concentrations of the ten heavy metals arsenic (As), chromium (Cr), cadmium (Cd), lead (Pb), nickel (Ni), copper (Cu), manganese (Mn), zinc (Zn), iron (Fe) and mercury(Hg), as well as those of fluorine (F-) and eighteen poly- and perfluorinated substances (PFASs), analyse correlation relationships, and assess the health risks for different age groups. The results showed that the levels of fluorine (F-) (0.92-4.42 mg center dot L-1), Mn (0.0005-4.91 mg center dot L-1) and Fe (1.45-5.61 mg center dot L-1) exceeded the standard limits for drinking water. Short chain perfluorobutanoic acid (PFBA) (4.14-2501.42 ng center dot L-1), perfluorobutane sulfonate (PFBS) (17.07-51,818.61 ng center dot L-1) and perfluorohexanoic acid (PFHxA) (0.47-936.32 ng center dot L-1) were the predominant substances from the PFASs group. No individual PFASs levels had significant relationships with F- or heavy metal contents. There was a positive relationship between short chain PFASs concentrations and water depth and a negative relationship between long chain PFASs concentration and water depth. The hazard quotient (HQ) decreased in the order F- > heavy metals > PFASs and also decreased for older age groups. In addition, As, Fe, Mn and perfluorooctanoic acid (PFOA) were the main sources of risk from the heavy metal and PFASs groups, respectively.	1	1		1				B	-		
D283	ばく露	Li, YN; Li, JF; Zhang, LF; Huang, ZP; Liu, YQ; Wu, N; He, JH; Zhang, ZZ; Zhang, Y; Niu, ZG	Perfluoroalkyl acids in drinking water of China in 2017: Distribution characteristics, influencing factors and potential risks	2019	Environ. Int. 2019 Feb:123:87-95. doi: 10.1016/j.envint.2018.11.036	Perfluoroalkyl acids (PFAAs) are a group of emerging persistent organic pollutants (POPs), which have been ubiquitously detected in the environmental media. However, national scale investigations on their occurrence and distribution in drinking water are still insufficient. In this study, we detected the 17 priority PFAAs in drinking water from 79 cities of 31 provincial-level administrative regions throughout China, and investigated their occurrence and distribution. Additionally, we also analyzed the influencing factors on their profiles, such as the existence of industrial sources, socioeconomic factors (population density and GDP), and assessed levels of risk associated with contaminated drinking water. On the national scale, the sum concentrations of the 17 PFAAs (Sigma(17)PFAAs) in drinking water was in a range of 4.49-174.93 ng/L with a mean value of 35.13 ng/L. Among the 17 individual PFAAs, perfluorobutanoic acids (PFBA) was the most abundant individual PFAAs with the median concentration of 17.87 ng/L, followed by perfluorooctanoic acid (PFOA, 0.74 ng/L), perfluorononanoic acid (PFNA, 0.40 ng/L) and perfluorooctane sulfonic acid (PFOS, 0.25 ng/L). The geographic distribution characteristic of Sigma(17)PFAAs in drinking water was in a descending order of Southwestern China (57.67 ng/L) > Eastern coastal China (32.85 ng/L) > Middle China (29.89 ng/L) > Northwestern China (28.49 ng/L) > Northeastern China (22.03 ng/L), and in general, the existence of the industrial sources could positively affect the contamination levels of PFAAs in drinking water. The pollution level of PFAAs in drinking water also varied among the three different city levels (medium-sized city > big city > town). In towns, the positive correlations were observed between the population density and the Sigma(17)PFAAs (R-2 = 0.45, p < 0.01), and the individual concentration of PFHxA, PFBS, and PFOA (p < 0.01). Moreover, besides PFAAs in Yunnan, Jiangsu, and Jiangxi, concentrations of related PFAAs in drinking water from 28 provinces were less than the suggested drinking water advisories. The relatively higher concentrations of PFAAs in Yunnan, Jiangsu, and Jiangxi suggest that further studies focusing on their sources and potential health risk to humans are needed.	1	1	1	1			1	A	-	中国の飲料水中のPFASを大規模に調査しており、水由来の曝露の情報として有用	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D284	ばく露	Dong, WH; Xie, W; Su, XS; Wen, CL; Cao, ZP; Wan, YY	Review: Micro-organic contaminants in groundwater in China	2018	Hydrogeol. J. 2018 Aug:26(5):1351-1369. doi: 10.1007/s10040-018-1760-z.	Micro-organic contaminants (MOs) in groundwater, which may have adverse effects on human health and ecosystems worldwide, are gaining increased attention in China. A great deal of research has been conducted to investigate their sources, occurrences and behavior in aquifers. This paper reviews the main sources, distribution, concentrations and behavior of a wide range of MOs in groundwater in China. These MOs include well-established persistent organic pollutants-polycyclic aromatic hydrocarbons (PAHs), hexachlorocyclohexanes (HCHs), polychlorinated biphenyls (PCBs), endocrine disrupting chemicals (poly brominated diphenyl ethers (PBDEs), phthalic acid esters (PAEs), bisphenol A (BPA)-and some contaminants of emerging concern such as pharmaceutical and personal care products (antibiotics, caffeine, shampoos) and perfluorinated compounds (PFCs). The results reveal that the main MOs in groundwater are PAHs, organochlorine pesticides (OCPs), PBDEs, PAEs, and antibiotics. Moreover, some PFCs such as perfluorobutane sulfonic acid (PFBS), perfluorobutanoic acid (PFBA) and perfluorooctanoic acid (PFOA) have only recently been observed in groundwater as emerging organic contaminants. Additionally, most MOs are distributed in populated and industrialized areas such as the southeast coast of China. Finally, industrial emissions, wastewater treatment plant effluents and agricultural wastewater are found to be dominant sources of MOs in groundwater. Based on the existing pollution levels, regulation and amelioration of MOs are warranted.	1			1				B	-	総説	
D285	ばく露	Johnson, T; Obereiner, J; Khire, MV	Longer-term temporal trends in PFAS concentrations in Midwestern landfill leachate	2023	Waste Manage. Res. 2023 Sep:41(9):1445-1452. doi: 10.1177/0734242X231160087.	It is well documented that per- and polyfluoroalkyl substances (PFAS) are routinely detected in leachate from municipal solid waste (MSW) landfills. PFAS-containing products are ubiquitous in society and in end-of-life discarded materials. While considerable data have been generated in recent years for PFAS concentrations in landfill leachate, little published information exists concerning longer-term trends in leachate concentrations. In this study, we examine a ten-year dataset for three MSW landfills located in the upper Midwestern United States where leachate PFAS testing has been performed on a quarterly basis. The significance of these data are considered in light of phase-out initiatives implemented in the US manufacturing companies for longer-chain PFAS including perfluorooctanoic acid (PFOA), perfluorooctane sulphonate (PFOS) and perfluorononanoic acid (PFNA). Findings from this study indicate that the average concentration of longer-chain PFOA in the three landfills decreased from 2400 to 1900 ng/L and the average PFOS concentrations decreased from 1000 to 370 ng/L. This may be indicative of reduced domestic production and use of these compounds. The phase-out of long-chain PFAS has also led to the introduction of shorter-chain replacement compounds such as perfluorobutanoic acid, perfluorobutane sulphonate and perfluorohexanoic acid, and this paper also examines long-term trends in leachate concentrations of these compounds.	1	1	1					B	-		
D286	ばく露	Jiao, EM; Zhu, ZL; Yin, DQ; Qiu, YL; Karrman, A; Yeung, LWY	A pilot study on extractable organofluorine and per- and polyfluoroalkyl substances (PFAS) in water from drinking water treatment plants around Taihu Lake, China: what is missed by target PFAS analysis?	2022	Environ. Sci.-Process Impacts 2022 Jul:24(7):1060-1070. doi: 10.1039/d2em00073c.	Per- and polyfluoroalkyl substances (PFAS) have raised concerns due to their worldwide occurrence and adverse effects on both the environment and humans as well as posing challenges for monitoring. Further collection of information is required for a better understanding of their occurrence and the unknown fractions of the extractable organofluorine (EOF) not explained by commonly monitored target PFAS. In this study, eight pairs of raw and treated water were collected from drinking water treatment plants (DWTPs) around Taihu Lake in China and analyzed for EOF and 34 target PFAS. Mass balance analysis of organofluorine revealed that at least 68% of EOF could not be explained by target PFAS. Relatively higher total target concentrations were observed in 4 DWTPs (D1 to D4) when compared to other samples with the highest sum concentration up to 189 ng L-1. PFOA, PFOS and PFHxS were the abundant compounds. Suspect screening analysis identified 10 emerging PFAS (e.g., H-PFAAs, H-PFESAs and OBS) in addition to target PFAS in raw or treated water. The ratios PFBA/PFOA and PFBS/PFOS between previous and current studies showed significant replacements of short-chain to long-chain PFAS. The ratios of the measured PFAS concentrations to the guideline values showed that some of the treated drinking water exceeds guideline values, appealing for efforts on drinking water safety guarantee.	1			1				B	-		
D287	ばく露	Lesch, V; Bouwman, H; Kinoshita, A; Shibata, Y	First report of perfluoroalkyl substances in South African Odonata	2017	Chemosphere 2017 May:175:153-160. doi: 10.1016/j.chemosphere.2017.02.020	Perfluorinated substances are global and ubiquitous pollutants. However, very little is known about these substances in invertebrates, and even less in terrestrial invertebrates in particular. We analysed adult male dragonflies from six sites in South Africa for perfluoroalkyl substances (PFASs), including perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluro-n-undecanoic acid (PFUnA), perfluoro-n-dodecanoic acid (PFDoA), perfluorohexanoic acid (PFHxA), and perfluorohexane sulfonic acid (PFHxS). PFOS was detected in all individuals, with less quantifiable occurrences of the other substances. The dragonflies from the three northern sites located in farming areas had significantly lower Sigma PFASs concentrations than the southern sites located closer to industrial areas (median PFASs of 0.32 ng/g wm (wet mass) for North, and 9.3 ng/g wm for South). All substances except PFOS occurred at similar concentrations at all six sites when quantifiable, but PFOS dominated in the Southern sites. The highest median concentration was from Bloemhof Dam (Sigma PFASs = 21 ng/g wm), which is known to be polluted by PFOS. Perfluorinated substances are not known to be manufactured in South Africa, therefore the residues detected are likely to have been derived from imported products. Odonata play a significant role in freshwater ecology. Any impacts on these aquatic and aerial predators are likely to have effects on aquatic and associated ecosystems. Further studies are required over a much larger geographic region and to investigate sources.		1	1					B	-		
D288	ばく露	Zhang, CH; He, XD; Li, Z; Zhang, SH; Li, HR; Jin, MY; Li, YQ	Perfluorinated Compounds (PFCs) in Ambient Air Particulates (PM2.5, PM10, TSP) in Beijing	2016	Pol. J. Environ. Stud. 2016;25(1):459-464. doi: 10.15244/pjoes/60176.	The presence of perfluorinated compounds (PFCs) in ambient air particulates (PM2.5, PM10, and TSP) in Beijing was investigated in the current study. The results showed that PFBA, PFPeA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA, and PFOS, were detected in all sizes of ambient air particulates. The concentrations of PFCs in TSP were slightly higher than those in PM10 and PM2.5. The concentrations of PFCs in PM2.5 were the lowest. The Sigma PFCs contents in PM2.5, PM10 and TSP were 87.03-96.77, 99.82-101.41, and 118.69-141.87 ng/g, respectively. PFBA, PFPeA, and PFOA were the dominating class of PFCs in ambient air particulates.	1		1					B	-		
D289	ばく露	Li, XR; Fatowe, M; Cui, DN; Quinete, N	Assessment of per- and polyfluoroalkyl substances in Biscayne Bay surface waters and tap waters from South Florida	2022	Sci. Total Environ.2022 Feb;806(Pt 1):150393. doi: 10.1016/j.scitotenv.2021.150393.	Per- and polyfluoroalkyl substances (PFAS) are persistent anthropogenic pollutants present in many environmental media worldwide due to their extensive uses in many industrial and commercial products combined with their high thermal and chemical stabilities. Its ubiquitous presence in surface and drinking water supply and significant adverse health effects observed in wildlife and humans, associated with its bioaccumulation potential, pose big concerns. In this study, we have developed and validated a semi-automated solid phase extraction (SPE) followed by liquid chromatography-mass spectrometry (LC-MS/MS) for the determination of legacy and emerging short-chain PFAS substitutes in surface and tap water at low parts-per-trillion (ppt) levels in South Florida environments. Surface waters from Biscayne Bay and adjacent canals (n = 15) and tap waters from different counties (Miami-Dade, Broward, and Palm Beach County) (n = 21) were collected between October 2020 (wet season) and February 2021 (dry season). Total PFAS concentrations up to 242 ng L-1 (average of 168 ng L-1) were found in tap water from Grapeland Heights, which is the closest location to the Miami international airport that was sampled. The highest average total PFAS level of 106 ng L-1 was observed in surface water from the Biscayne Canal C-8 for the wet and dry season. In general, average total PFAS was higher in tap water (86.3 ng L-1) than in surface waters (46.3 ng L-1), whereas the most predominant and frequently detected PFAS were PFBA, PFBS, PFPeA, PFHxA, PFHxS, PFOA and PFOS. PFAS levels found could represent a high human health risk, and ecological risk based on PFOS levels above recommended thresholds are also noted. Such knowledge on PFAS occurrence, distribution and sources in South Florida will provide essential information for local and regional regulatory agencies related to water quality, further facilitating the development of guidelines and procedures for PFAS pollution control and reduction in Florida.	1	1		1				B	-		
D290	ばく露	Castellani, F; Galletti, M; Charavgis, F; Cingolani, A; Renzi, S; Nucci, M; Protano, C; Vitali, M	Perfluorinated Compounds (PFCs) in River Waters of Central Italy: Monthly Variation and Ecological Risk Assessment (ERA)	2023	Arch Environ Contam Toxicol. 2023 Apr;84(3):332-346. doi: 10.1007/s00244-023-00993-4.	Perfluorinated compounds (PFCs) are a wide class of emerging pollutants. In this study, we applied the US EPA method 533 for the determination of 21 PFCs in river water samples. In particular, this method was used to investigate the presence of the target PFCs in six rivers in central Italy during a 4-month-long monitoring campaign. In 73% of the analyzed samples, at least some of the target PFCs were detected at concentrations higher than the limit of detection (LOD). The sum of the 21 target analytes (n-ary sumation 21PFCs) ranged from 4.3 to 68.5 ng L-1, with the highest concentrations measured in the month of June, probably due to a minor river streamflow occurring in the warmer summer months. Considering the individual congeners, PFBA and PFPeA, followed by PFHxA and PFOA, were the predominantly detected compounds. Short- and medium-chain PFCs (C4-C9) prevail over the long-chain PFCs (C10-C18), likely due to the increased industrial use and the higher solubility of short-chain PFCs compared to long-chain PFCs. The ecological risk assessment, conducted by using the risk quotient method, highlighted that the risk for aquatic environments associated with PFBA, PFPeA, PFBS, PFHxA and PFOA was low or negligible. Only for PFOA, there was a medium level of risk in two rivers in the month of June. With regard to PFOS, 54% of the river water samples were classified as high risk for the aquatic environment. The remaining 46% of the samples were classified as medium risk.	1	1		1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D291	ばく露	Pan, CG; Yu, KF; Wang, YH; Zhang, W; Zhang, J; Guo, J	Perfluoroalkyl substances in the riverine and coastal water of the Beibu Gulf, South China: Spatiotemporal distribution and source identification	2019	Sci. Total Environ. 2019 Apr:660:297-305. doi: 10.1016/j.scitotenv.2019.01.019	Few studies have examined the perfluoroalkyl substances (PFASs) contamination in less-developed coastal regions. In the present study, we collected 19 riverine and 21 coastal surface water samples in the summer and winter of 2017 to investigate PFASs contamination in the Beibu Gulf, South China. The results show that eleven and twelve target PFASs were detected in the summer and winter, respectively. The total PFASs (Sigma PFASs) concentrations in the water of the Beibu Gulf were in the range of 1609-4727 pg/L and 610-4920 pg/L in summer and winter, respectively. Perfluoropentanoic acid (PFPeA), perfluorobutanoic acid (PFBA) and perfluorobutane sulfonate (PFBS) were the predominantly detected PFASs in both seasons with maximum concentrations of 2968 pg/L, 1771 pg/L, and 1764 pg/L, respectively. Strong positive correlations between some PFASs were observed (e.g., PFBA and PFBS, PFOS and PFBS, $p < 0.05$), suggesting these correlated pollutants may share similar sources. PFASs contamination in the Beibu Gulf was strongly affected by ocean currents, and their concentrations were lower than most coastal waters around the world. Risk assessment indicates a low risk associated with target PFASs to aquatic organisms in the Beibu Gulf. The results of the present research provided a baseline and good overview of the spatial distribution of PFASs along the Beibu Gulf.	1			1				B	-		
D292	ばく露	Joerss, H; Schramm, TR; Sun, LT; Guo, C; Tang, JH; Ebinghaus, R	Per- and polyfluoroalkyl substances in Chinese and German river water - Point source- and country-specific fingerprints including unknown precursors	2020	Environ. Pollut. 2020 Dec:267:115567. doi: 10.1016/j.envpol.2020.115567.	This study aimed at comparing source-specific fingerprints of per- and polyfluoroalkyl substances (PFASs) in river water from China and Germany, selected as countries with different histories of PFAS production. Samples were collected from up- and downstream of seven suspected point sources in autumn 2018. Amongst the 29 analyzed legacy and emerging PFASs, 24 were detected, with a sum ranging from 2.7 ng/L (Alz River) to 420,000 ng/L (Xiaoqing River). While mass flow estimates for the Xiaoqing River and Yangtze River (mean: 20 and 43 t/y, respectively) indicated ongoing high emissions of the legacy compound PFOA in China, its ether-based replacements HFPO-DA and DONA showed the highest contribution downstream of a German fluoropolymer manufacturing site (50% and 40% of Sigma PFASs measured, respectively). In river water impacted by manufacturing sites for pharmaceutical and pesticide intermediates, the short-chain compound PFBS was the most prevalent substance in both countries. The German Ruhr River, receiving discharges from the electroplating industry, was characterized by the PFOS replacement 6:2 FTSA. Isomer profiling revealed a higher proportion of branched isomers in the Chinese Xi River and Xiaoqing River than in other rivers. This points to different synthesis routes and underlines the importance of differentiating between linear and branched isomers in risks assessments. Upon oxidative conversion in the total oxidizable precursor (TOP) assay, the increase of the short-chain compound PFBA was higher in German samples than in Chinese samples (88 +/- 30% versus 12 +/- 14%), suggesting the presence of a higher proportion of unknown precursors to PFBA in the German environment. Amongst the ether-based replacements, DONA and 6:2 Cl-PFESA were fully or partially degraded to non-targeted oxidation products, whereas HFPO- DA showed no degradation. This indicates that the inclusion of ether-based PFASs and their oxidation products in the TOP assay can help in capturing a larger amount of the unknown PFAS fraction.	1			1	1			B	-		
D293	ばく露	Zhang, B; He, Y; Huang, YY; Hong, DH; Yao, YM; Wang, L; Sun, WW; Yang, BQ; Huang, XF; Song, SM; Bai, XY; Guo, YK; Zhang, T; Sun, HW	Novel and legacy poly- and perfluoroalkyl substances (PFASs) in indoor dust from urban, industrial, and e-waste dismantling areas: The emergence of PFAS alternatives in China	2020	Environ. Pollut.2020 Aug;263(Pt A):114461. doi: 10.1016/j.envpol.2020.114461.	With the phase out of perfluorooctanesulfonate (PFOS) and perfluorooctanoic acid (PFOA), the composition profiles of poly- and perfluoroalkyl substance (PFAS) in our living environment are unclear. In this study, 25 PFASs were analyzed in indoor dust samples collected from urban, industrial, and e-waste dismantling areas in China. PFOS alternatives, including 6:2 chlorinated polyfluorinated ether sulfonate (6:2 Cl-PFESA) (median: 5.52 ng/g) and 8:2 chlorinated polyfluorinated ether sulfonate (8:2 Cl-PFESA) (1.81 ng/g), were frequently detected. By contrast, PFOA alternatives, such as hexafluoropropylene oxide dimer acid (HPFO-DA, Gen-X) and ammonium 4,8-dioxa-3H-perfluorononanoate (ADONA), were not found in any of the dust samples. As expected, all legacy PFASs were widely observed in indoor dust, and 4 PFAS precursors were also detected. Dust concentrations of 6:2 Cl- PFESA were strongly correlated ($p < 0.05$) with those of 8:2 Cl-PFESA regardless of sampling sites. 6:2 Cl-PFESA was also significantly associated with that of PFOS in industrial and e-waste ($p < 0.01$) areas. Association analysis suggested that the sources of PFOS and its alternatives are common or related. Although Sigma Cl-PFESA concentration was lower than that of PFOS (17.4 ng/g), industrial areas had the highest 6:2 Cl-PFESA/PFOS ratio (0.63). Composition profiles of PFASs in the industrial area showed the forefront of fluorine change. Thus, the present findings suggested that Cl-PFESAs are widely used as PFOS alternatives in China, and high levels of human Cl-PFESA exposure are expected in the future. Short-chain PFASs (C4-C7) were the predominant PFASs found in dust samples, contributing to over 40% of Sigma total PFASs. Furthermore, perfluoro-1-butanesulfonate/PFOS and perfluoro-n-butanoic acid (PFBA)/PFOA ratios were 2.8 and 0.72, respectively. These findings suggested shifting to the short-chain PFASs in the environment in China. To the authors knowledge this is the first study to document the levels of 6:2 Cl-PFESA, 8:2 Cl-PFESA in indoor dust.	1		1		1			B	-		
D294	ばく露	Fuertes, I; Gomez-Lavin, S; Elizalde, MP; Urtiaga, A	Perfluorinated alkyl substances (PFASs) in northern Spain municipal solid waste landfill leachates	2017	Chemosphere 2017 Feb:168:399-407. doi: 10.1016/j.chemosphere.2016.10.072	Landfill leachates have been recognized as significant secondary sources of poly- and perfluoroalkyl substances (PFASs). This study presents data on the occurrence and concentration of 11 perfluoroalkyl carboxylates (PFCAs) and 5 perfluoroalkyl sulfonates (PFSAs) in leachates from 4 municipal solid waste landfill sites located across northern Spain. To the best of our knowledge, this is the first report of the presence of PFASs in Spanish landfill leachates. Two of the landfill sites applied on-site treatment using membrane bioreactors (MBR), and its effect on PFASs occurrence is also reported. Total PFASs (Sigma PFASs) in raw leachates reached 1378.9 ng/L, while in treated samples Sigma PFASs was approximately two-fold (3162.3 ng/L). PFCAs accounted for the majority of the detected PFASs and perfluorooctanoic acid (PFOA) was the dominant compound in raw leachates (42.6%), followed by shorter chain PFHxA (30.1%), PFPeA and PFBA. The age of the sites might explain the PFASs pattern found in raw leachates as all of them were stabilized leachates. However, PFASs profile was different in treated samples where the most abundant compound was PFHxA (26.5%), followed by linear perfiuorobutane sulfonate (L-PFBS) (18.7%) and PFOA (17.7%). The overall increase of the PFASs content as well as the change in the PFASs profile after the MBR treatment, could be explained by the possible degradation of PFASs precursors such as fluorotelomer alcohols or fluorotelomer sulfonates. Using the volume of leachates generated in the landfill sites, that served 1.8 million people, the discharge of 16 Sigma PFASs contained in the landfill leachates was estimated as 1209 g/year.	1	1	1	1				B	-		
D295	ばく露	Falandysz, J; Rostkowski, P; Jarzynska, G; Falandysz, JJ; Taniyasu, S; Yamashita, N	Determination of perfluorinated alkylated substances in sediments and sediment core from the Gulf of Gdansk, Baltic Sea	2012	J. Environ. Sci. Health Part A-Toxic/Hazard. Subst. Environ. Eng. 2012 Feb:47(3):428-434. doi: 10.1080/10934529.2012.646133.	Perfluorinated alkylated substances (PFAS) have been determined in surface sediments and sediment core from Gulf of Gdansk, Baltic Sea. Perfluorooctanesulphonate (PFOS), perfluorohexanesulphonate (PFHxS), perfluorodecanoate (PFDA), perfluorononanoate (PFNA), perfluorooctanoate (PFOA), perfluoroheptanoate (PFHpA), perfluoroundecanote (PFUnDA), perfluorododecanoate (PFDoDA) and perfluorohexanoate (PFHxA) were quantified after isotopic dilution (C-13(4) PFOS and C-13(4) PFOA), liquid-liquid extractions by methanol and acetonitrile, cleanup by Envi-Carb, OasisWAX and Envi-Carb and final measurement by HPLC MS/MS. PFOS, PFHxS, PFUnDA, PFDA, PFNA and PFOA were found in Baltic Sea sediments in concentrations exceeding the method limit of quantification (LOQ) of 2 pg/g. PFOS was detected in concentration up to 0.896 ng/g dry weight and PFHxS up to 0.326 ng/g dw, which shows on a weak pollution. PFOS (48-74%) or PFHxS (45-56%) dominated in PFAS composition of sediments surveyed. Supplemental materials are available for this article. Go to the publisher's online edition of the Journal of Environmental Science and Health, Part A to view the free supplemental file.		1	1					B	-		
D296	ばく露	Bai, XL; Son, Y	Perfluoroalkyl substances (PFAS) in surface water and sediments from two urban watersheds in Nevada, USA	2021	Sci. Total Environ. 2021 Jan:751:141622. doi: 10.1016/j.scitotenv.2020.141622.	This study measured 17 perfluoroalkyl substances (PFAS) in surface water and sediments collected from six locations along the Las Vegas Wash and Lake Mead and eight locations along the Truckee River, Lake Tahoe, and Pyramid Lake in Nevada, United States. Of the 17 PFAS analyzed, 12 were detected in the surface water ($n = 18$) and 14 were detected in the sediments ($n = 21$) of the two watersheds. The total concentration of PFAS in the Truckee River water was 441.7 ng/L and the PFAS detected in the Las Vegas Wash water was 2234.3 ng/L. The predominant PFAS species found in the water were perfluorohexanoic acid (PFHxA) (1.5-187.0 ng/L), followed by perfluoropentanoic acid (PFPeA) (below detection limit [BDL] to 169.9 ng/L), perfluorooctanoic acid (PFOA) (BDL to 65.5 ng/L), and perfluorobutane sulfonic acid (PFBS) (BDL to 44.7 ng/L). The total PFAS in the sediments was 272.9 mu g/kg (dry weight) for the Truckee River and 345.7 mu g/kg for the Las Vegas Wash. The predominant species in the sediments were perfluorodecane sulfonic acid (PFDS) (BDL to 88.2 mu g/kg), PFHxA (BDL to 20.3 mu g/kg), PFBS (BDL to 29.1 mu g/Kg), and perfluoroundecanoic acid (PFUA) (BDL to 22.9 mu g/kg). The results demonstrated that short-chain PFAS ($C <= 8$) were more prevalent in water, whereas long-chain PFAS ($C > 8$) were more detectable in sediments. The Las Vegas Wash water had much higher PFAS levels compared with the Truckee River water. The PFAS concentrations and detection frequencies also significantly decreased in summer compared with winter along the Las Vegas Wash.		1		1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D297	ばく露	Pan, CG; Ying, GG; Zhao, JL; Liu, YS; Jiang, YX; Zhang, QQ	Spatiotemporal distribution and mass loadings of perfluoroalkyl substances in the Yangtze River of China	2014	Sci. Total Environ. 2014 Sep:493:580-587. doi: 10.1016/j.scitotenv.2014.06.033	A systematic investigation into contamination profiles of eighteen perfluoroalkyl substances (PFASs) in both surface water and sediments of Yangtze River was carried out by using high performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS) in summer and winter of 2013. The total concentrations of the PFASs in the water and sediment of Yangtze River ranged from 2.2 to 74.56 ng/L and 0.05 to 1.44 ng/g dry weights (dw), respectively. The PFAS concentrations were correlated to some selected water quality parameters such as pH, total phosphorus (TP), total nitrogen (TN) and conductivity in water, and some sediment properties, such as total organic carbon (TOC), TP, and TN in sediment. The monitoring results for the water and sediment samples showed no obvious seasonal variations. Among the selected 18 PFASs, perfluorooctanoic acid (PFOA) was the dominant PFAS compound found both in water and sediment for the two seasons with its maximum concentration of 18.03 ng/L in water and 0.72 ng/g in sediment, followed by perfluorobutane sulfonic acid (PFBS) with its maximum concentration of 41.9 ng/L in water in Wuhan, whereas the lowest concentrations of PFASs were observed at Poyang lake. The annual loadings of PFOA, perfluorohexanoic acid (PFHxA), PFBS, perfluorooctane sulfonic acid (PFOS) and the total PFASs in the Yangtze River were 6.8 tons, 2.2 tons, 8.2 tons, 0.88 tons, and 20.7 tons, respectively. Wuhan and Er'zhou of Hubei contributed the most amounts of PFASs into the Yangtze River. A correlation was found between some PFASs, for example PFBS and PFOS, which suggests that both of these PFASs originate from common sources in the region.		1		1				B	-		
D298	ばく露	Zhang, SY; Li, XQ; He, D; Zhang, DJ; Zhao, Z; Si, HT; Wang, FW	Per- and poly-fluoroalkyl substances in sediments from the water-level-fluctuation zone of the Three Gorges Reservoir, China: Contamination characteristics, source apportionment, and mass inventory and loadings	2022	Environ. Pollut. 2022 Apr:299:118895. doi: 10.1016/j.envpol.2022.118895.	Sixteen paired surface sediment samples (0-5 cm, n = 32) covering upstream to downstream of water-level-fluctuation zone of Three Gorges Reservoir, China were collected in March 2018 (following six months of submergence) and September 2018 (after six months of exposure). Seventeen per- and poly-fluoroalkyl substances (PFASs) were quantified to evaluate contamination characteristics, apportion source categories and estimate mass inventory and loadings. The concentration of Sigma PFASs ranged from 0.26 to 0.82 ng.g(-1) at high water-level (HWL) and 0.46-1.53 ng.g(-1) at low water-level (LWL). Perfluorooctanoic acid (PFOA, mean: 0.32 ng.g(-1)) and perfluorooctane sulfonate (PFOS, mean: 0.12 ng.g(-1)) dominated, accounting 44.9% and 16.3% of the total PFASs, respectively. The distribution of PFASs was more influenced by anthropogenic activities than physicochemical parameters of the sediments. Positive matrix factorization (PMF) identified PFOA-based products was the major sources (40.1% and 38.6%, respectively). Besides, the direct sources of PFOA-, PFOS-, PFNA-and PFBA-based products played the predominant role, while the indirect degradation of precursors contributed relatively little. The sediment (0-5 cm) mass inventory of PFASs at LWL (57.5 kg) was higher than HWL (39.3 kg). The annual mass loadings of the total PFASs, PFOA, PFOS, perfluoroundecanoic acid (PFUdA) and perfluorononanoic acid (PFNA) from the upstream to the middle-lower reaches of Yangtze River were 27.4 kg, 11.1 kg, 4.63 kg, 2.89 kg and 2.57 kg, respectively. This study could provide the basic datasets of PFASs in surface sediments of the TGR, and also indicate an important transport of PFASs from upstream to the lower reaches, which should be further studied as well.	1		1				B	-		
D299	ばく露	Riaz, R; Junaid, M; Rehman, MYA; Iqbal, T; Khan, JA; Dong, YR; Yue, LX; Chen, YP; Xu, N; Malik, RN	Spatial distribution, compositional profile, sources, ecological and human health risks of legacy and emerging per- and polyfluoroalkyl substances (PFASs) in freshwater reservoirs of Punjab, Pakistan	2023	Sci. Total Environ.2023 Jan;856(Pt 2):159144. doi: 10.1016/j.scitotenv.2022.159144.	Per- and polyfluoroalkyl substances (PFASs) are a large group of chemicals reported in global environment and are responsible for various adverse impacts on humans and environment. We report a comprehensive study on occurrence of PFASs, including legacy, substitute and emerging ones, from Pakistan. Surface water samples were collected from five ecologically important freshwater reservoirs in Pakistan, namely, Head Panjnad (HP), Head Trimmu (HT), Chashma Barrage (CB), Head Blloki (HB), and Head Qadirabad (HQ). The detection frequencies of PFASs ranged between 37 %-100 %. The highest concentration of n-ary sumation 15PFASs was detected at HP (114.1 ng L-1), whereas the lowest at HQ (19.9 ng L-1). Among the analyzed PFASs, 6:2 fluorotelomer sulfonic acid (6:2 FTS) and perfluorooctanoic acid (PFOA) showed maximum mean concentrations of 9.1 ng L-1 and 7 ng L-1 at HP, followed by Perfluorooctane sul-fonic acid (PFOS) with level of 0.99 ng L-1 at HT. The ecological risk assessment for selected species i.e., daphnid, mysid, fish and green algae showed that PFOS, perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA) exhib-ited moderate risk i.e., Hazard Quotients (HQs) < 1 to the modeled organisms, whereas perfluorobutane sulfonic acid (PFBS) showed the high risk to green algae (HQs = 8.6) and PFOA presented a high risk to all the organisms (HQs ranged between 1.04 and 7.38). The level of n-ary sumation PFASs at HP (114.1 ng L-1) exceed the EU guideline value of n-ary sumation PFASs in water (100 ng L-1), however the risk quotient (RQmix) values of all age groups were < 1 implying that the detected PFASs in water do not pose risk to human health. Source apportionment through Positive Matrix Factorization (PMF)showed that industrial effluent is the main source of PFASs in freshwater reservoirs. Comparable concentrations of legacy and substitute PFASs in this study indicate that legacy PFASs are still in use adjacent to ecologically important water reservoirs.			1	1				B	-		
D300	ばく露	Rodriguez-Varela, M; Duran-Alvarez, JC; Jimenez-Cisneros, B; Zamora, O; Prado, B	Occurrence of perfluorinated carboxylic acids in Mexico City's wastewater: A monitoring study in the sewerage and a mega wastewater treatment plant	2021	Sci. Total Environ. 2021 Jun:774:145060. doi: 10.1016/j.scitotenv.2021.145060.	An analytical method based on liquid chromatography coupled to mass spectrometry was validated to quantify five perfluorinated carboxylic acids (PFCA) namely, perfluorobutanoic acid (PFBA), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), and perfluoroundecanoic acid (PFUnA), inwastewater produced in amegacity. Sampling was performed on amonthly basis, obtaining samples from the undergrounded sewerage system and the main open-air canal transporting wastewater out the city. Steady levels of the sum of the target PFCA (.PFCA) were determined on both sites through the study: 419.4 +/- 24.3 ng L-1 in undergrounded sewage and 591.1 +/- 39 ng L-1 in the open-air canal. Short-chain PFCA (PFBA, PFHxA, and PFHpA) were abundant, while concentrations of PFOA and PFUnA remained lower in both sampling sites. The open-air canal was transected in four sampling points, which were sampled throughout the monitoring campaign, finding that furtive discharges of municipal and industrial wastewater increased the levels of short-chain PFCA, while those of PFOA and PFUnA were depleted. Relevant concentrations of PFBA (176.9 +/- 3.3 ng L-1), PFHxA (133.4 +/- 2.5 ng L-1), PFHpA (116.6 +/- 3.9 ng L-1), PFOA (133.1 +/- 3.5 ng L-1), and PFUnA (23.5 +/- 6.5 ng L-1) were found 60 km downstream, where the wastewater transported by the open-air canal is used in irrigation. A fraction of sewage is treated in a conventional wastewater treatment plant. The concentration of short-chain PFCA increased in effluent, adding extra loads of PFBA, PFHxA, and PFHpA to the environment.	1	1					B	-		
D301	ばく露	Chai, JF; Lei, PH; Xia, XY; Xu, G; Wang, DJ; Sun, R; Gu, JZ; Tang, L	Pollution patterns and characteristics of perfluorinated compounds in surface water adjacent potential industrial emission categories of Shanghai, China	2017	Ecotox. Environ. Safe. 2017 Nov:145:659-664. doi: 10.1016/j.ecoenv.2017.08.011	Perfluorinated compounds (PFCs) have received increasing attention worldwide recently because of potential risk to aquatic environment and living organisms. Herein, occurrence and spatial distributions of 17 selected PFCs were investigated in surface water adjacent to potential industrial emission categories in Shanghai. The results showed the distributions of PFCs in the ambient rivers were greatly affected by those industrial sources. Perfluorooctanoic acid (PFOA) and other short-chain PFCs such as perfluoropentanoic acid (PFPeA) and perfluorooctanesulfonate (PFBS) were detected as the predominant species in all samples. Specifically, the total concentrations of PFCs (EPFCs) near the airport ranged from 142 to 264 ng L-1, with PFOA, PFPeA, and PFBS as most prevalent. While near the fluorochemical plant and metal plating, concentrations of EPFCs ranged from 200 to 2143 ng L-1 and 211 ng L-1 to 705 ng L-1; and PFOA was the predominant individual PFCs, with the highest concentration of 1985 ng L-1. However, concentrations of PFOS were found at relatively low level, which ranged from < 0.06 to 4.44 ng L-1. The Spearman correlation analysis of concentration of individual PFCs showed that PFOA and perfluorohexanoic acid (PFHxA) was positive, while the correlation between PFOA and perfluorohexansulfonate (PFHxS) was negative near the airport, indicating PFOA and PFHxA may share common sources. Preliminary ecological risk evaluation of PFCs in adjacent water of the industrial emission areas suggested these emission categories posed higher risks than other area, although the risk level was still relatively safe.		1		1				B	-		
D302	ばく露	Vestergren, R; Berger, U; Glynn, A; Cousins, IT	Dietary exposure to perfluoroalkyl acids for the Swedish population in 1999, 2005 and 2010	2012	Environ. Int. 2012 Nov:49:120-127. doi: 10.1016/j.envint.2012.08.016	Dietary intake has been hypothesized to be the major pathway of human exposure to perfluoroalkyl acids (PFAAs). However, difficulties associated with the analysis of PFAAs at ultra trace levels in food samples have prevented the confirmation of this hypothesis. In this study, the dietary intake of PFAAs for the general Swedish population was estimated by applying a highly sensitive analytical method to a set of archived food market basket samples from 1999, 2005 and 2010. Dietary exposure to perfluorooctane sulfonic acid (PFOS) (860-1440 pg kg(-1) day(-1)), perfluoroundecanoic acid (PFUnDA) (90-210 pg kg(-1) day(-1)), perfluorodecanoic acid (PFDA) (50-110 pg kg(-1) day(-1)) and perfluorononanoic acid (PFNA) (70-80 pg kg(-1) day(-1)) was dominated by the consumption of fish and meat. In contrast, dietary exposure to PFOA (350-690 pg kg(-1) day(-1)) originated from low levels (8-62 pg g(-1)) found in several high consumption food categories including cereals, dairy products, vegetables and fruit. The dietary intakes of PFOS and PFOA estimated in this study were 4 to 10 times lower compared to previous exposure modeling studies. Nevertheless, the dietary intake of PFOS and PFOA was still a factor of 6 to 10 higher than exposure through ingestion of household dust and drinking water estimated for the general Swedish population. For perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA) and perfluorohexane sulfonic acid (PFHxS) drinking water intake was the major exposure pathway (36-53% of the total exposure) whereas dust ingestion made a significant contribution (27-49%) to the total exposure for PFHxA, PFHpA, PFNA, perfluorotridecanoic acid (PFTrDA) and perfluorotetradecanoic acid (PFTeDA). Dietary intakes varied by less than a factor of three for all PFAAs during the different sampling years which demonstrates that dietary intake has been fairly constant over the past decade when many manufacturing changes occurred.		1	1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D303	ばく露	Wang, SQ; Ma, LY; Chen, C; Li, YY; Wu, YL; Liu, YH; Dou, ZY; Yamazaki, E; Yamashita, N; Lin, BL; Wang, XH	Occurrence and partitioning behavior of per- and polyfluoroalkyl substances (PFASs) in water and sediment from the Jiulong Estuary-Xiamen Bay, China	2020	Chemosphere. 2020 Jan:238:124578. doi: 10.1016/j.chemosphere.2019.124578.	Twenty-four per- and polyfluoroalkyl substances (PFASs) were analyzed in water and sediment from the Jiulong Estuary-Xiamen Bay to study their seasonal variations, transport, partitioning behavior and ecological risks. The total concentration of PFASs in water ranged from 11 to 98 ng L-1 (average 45 ng L-1) during the dry season, 0.19-5.7 ng L-1 (average 1.5 ng L-1) during the wet season, and 3.0-5.4 ng g(-1) dw (average 3.9 ng g(-1) dw) in sediment. In water samples, short-chain PFASs were dominated by perfluorooctanoic acid (PFBA) in the dry season and perfluorobutane sulfonate (PFBS) in the wet season, while long chain PFASs, such as perfiuorooctane sulfonate (PFOS), dominated in the sediment. The highest concentration of PFASs in water were found in the estuary; in contrast, the highest level of PFASs in sediment were found in Xiamen Bay. These spatial distributions of PFASs indicate that river discharge is the main source of PFASs in estuarine water, while the harbor, airport and wastewater treatment plant near Xiamen Bay may be responsible for the high PFBS and PFOS concentrations in water and sediment. The partition coefficients (log K-d) of PFASs between sediment and water (range from 1.64 to 4.14) increased with carbon chain length (R-2 = 0.99) and also showed a positive relationship with salinity. A preliminary environmental risk assessment indicated that PFOS and perfluorooctanoic acid (PFOA) in water and sediment pose no significant ecological risk to organisms.	1			1				B	-		
D304	ばく露	Zushi, Y; Takeda, T; Masunaga, S	Existence of nonpoint source of perfluorinated compounds and their loads in the Tsurumi River basin, Japan	2008	Chemosphere. 2008 Apr:71(8):1566-1573. doi: 10.1016/j.chemosphere.2007.11.055.	Products containing perfluorinated compounds (PFCs) have been widely used during the last 50 years. As a result, worldwide environmental pollution by PFCs has been reported. The sources of PFC pollution in the aquatic environment have been poorly understood. In this study, river water and sewage treatment plant (STP) effluent were sampled along the stretch of the Tsurumi River and also at a fixed station in the river. The concentrations of perfluorooctanesulfonate (PFOS), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) were measured. With an increase in river flow rate, it was observed that the PFC concentrations in the river water at fixed station were remained the same or increased for PFOS (179.9 +/- 34.4-179.6 +/- 69.5 ng l(-1)), PFHxA (5.5 +/- 0.8-9.0 +/- 2.6 ng l(-1)), PFHpA (3.1 +/- 0.3-4.4 +/- 1.0 ng l(-1)), and PFOA (15.9 +/- 0.3-13.4 +/- 2.5 ng l(-1)) whereas the concentration of PFNA (38.0 +/- 3.3-15.4 +/- 3.0 ng l(-1)) and PFDA (3.9 +/- 0.3-2.1 +/- 0.3 ng l(-1)) were decreased. On the other hand, the loads of every PFC increased with an increase in river flow rate. The loads of PFCs in rain runoff were estimated to be 2-11 times greater than those in STP effluents that are discharged into the river. These results indicate the existence of a PFC nonpoint source (NPS) and its impact to the total PFC load of river is significant.		1	1					B	-		
D305	ばく露	Zushi, Y; Masunaga, S	First-flush loads of perfluorinated compounds in stormwater runoff from Hayabuchi River basin, Japan served by separated sewerage system	2009	Chemosphere. 2009 Aug:76(6):833-840. doi: 10.1016/j.chemosphere.2009.04.004.	Worldwide environmental pollution by perfluorinated compounds (PFCs) has been reported. PFCs have also been reported to have nonpoint sources (NPSs). A fixed-point hourly monitoring in the river was conducted during a storm event using an automatic sampler to estimate the impact of the first-flush of PFCs from NPS in this study. Perfluorocarboxylates (PFCAs) and perfluoroalkyl sulfonates (PFASs) with different chain lengths were monitored. The concentrations of short- to medium-chain-length FFCAs such as PFHpA, PFOA and PFNA, and PFASs such as PFBS, PFPeS, PFHxS, PFHpS and PFOS showed no marked increase with the storm-runoff event. However, in contrast to this, concentrations of long-chain-length PFCAs such as PFDA and PFUnA increased markedly. The concentrations of PFDA and PFUnA increased 3.4 (1.5-5.0 ng L-1)- and 2.0 (3.3-6.7 ng L-1)-fold, respectively. This study demonstrates that large loads of long-chain-length PFCAs are discharged to the Hayabuchi River during the first-flush after the rain event.			1	1				B	-		
D306	ばく露	Li, JF; He, JH; Niu, ZG; Zhang, Y	Legacy per- and polyfluoroalkyl substances (PFASs) and alternatives (short-chain analogues, F-53B, GenX and FC-98) in residential soils of China: Present implications of replacing legacy PFASs	2020	Environ. Int. 2020 Feb:135:105419. doi: 10.1016/j.envint.2019.105419.	With the worldwide regulation of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), the alternatives (short chain analogues and emerging per- and polyfluoroalkyl substances, PFASs) have gradually attracted global attention. This study analysed the replacing of legacy PFASs in China using PFASs data from residential soils, which might be good environmental indicators of their present usage. The total concentrations of 21 PFASs ranged from 244 to 13564 pg/g, and PFOA was the dominant compound among the studied PFASs, with a concentration of 354 +/- 439 pg/g. Serious PFASs pollution in residential soils mainly occurred in Eastern Coastal China as a result of locally developed industry and economies. Weak but significant correlations were found between PFASs and environmental and socioeconomic factors, suggesting that various factors determine PFASs contamination in residential soils. The concentration and detection frequency (DF) of short-chain analogues (C < 8) (375 +/- 509 pg/g and 100%), and F-53B (216 +/- 306 pg/g and 98.9%) were higher than those for PFOS (193 +/- 502 pg/g and 85.4%), indicating that these compounds have been widely used as PFOS alternatives and their consumption has already exceeded that of PFOS in China. In addition, GenX (the PFOA alternative) had a concentration and DF of 19.1 +/- 104 pg/g and 40.5%, respectively. These values were much lower than those for PFOA (354 +/- 439 pg/g and 96.6%), indicating GenX consumption is still limited at the national scale of China, despite its use as a PFOA replacement. Moreover, the low concentration and DF of FC-98 (2.31 +/- 11.1 pg/g and 27.0%) indicate that its consumption might be negligible. Our study demonstrated that short chain analogues and emerging alternatives have become the dominant PFAS pollutants in Chinese residential soils, and further studies need to be conducted to understand their toxicity and environmental risks.					1			B	-		
D307	ばく露	Yamada, A; Bemrah, N; Veyrand, B; Pollono, C; Merlo, M; Desvignes, V; Sirot, V; Oseredczuk, M; Marchand, P; Cariou, R; Antignac, JP; Le Bizec, B; Leblanc, JC	Perfluoroalkyl Acid Contamination and Polyunsaturated Fatty Acid Composition of French Freshwater and Marine Fishes	2014	J. Agric. Food Chem. 2014 Jul:62(30):7593-7603. doi: 10.1021/jf501113j.	In this study, French marine and freshwater fish perfluoroalkyl acid (PFAA) contamination are presented along with their fatty acid (FA) composition to provide further elements for a risk/benefit balance of fish consumption to be assessed. The 29 most consumed marine fish species were collected in four metropolitan French coastal areas in 2004 to constitute composite samples. Geographical differences in terms of consumed species and contamination level were taken into account. Three hundred and eighty-seven composite samples corresponding to 16 freshwater fish species collected between 2008 and 2010 in the six major French rivers or their tributaries were selected among the French national agency for water and aquatic environments freshwater fish sample library. The raw edible parts were analyzed for FA composition and PFAA contamination. Results show that freshwater fishes are more contaminated by PFAAs than marine fishes and do not share the same contamination profile. Freshwater fish contamination is mostly driven by perfluorooctane sulfonate (PFOS) (7596), whereas marine fish contamination is split between perfluorooctanoic acid (PFOA) (24%), PFOS (20%), perfluorohexanoic acid (PFHxA) (15%), perfluoropentanoic acid (PFHpA) (11%), and perfluorobutanoic acid (PFBA) (1196). Common carp, pike-perch, European perch, thicklip grey mullet, and common roach presented the most unfavorable balance profile due to their high level of PFAAs and low level of n-3 long-chain polyunsaturated fatty acids (LC-PUFAs). These data could be used, if needed, in an updated opinion on fish consumption that takes into account PFAA contamination.	1	1						B	-		
D308	ばく露	Semerad, J; Hatasova, N; Grasserova, A; Cerna, T; Filipova, A; Hanc, A; Innemanova, P; Pivokonsky, M; Cajthaml, T	Screening for 32 per- and polyfluoroalkyl substances (PFAS) including GenX in sludges from 43 WWTPs located in the Czech Republic - Evaluation of potential accumulation in vegetables after application of biosolids	2020	Chemosphere. 2020 Dec:261:128018. doi: 10.1016/j.chemosphere.2020.128018.	Highly persistent, toxic and bioaccumulative per - and polyfluoroalkyl substances (PFAS) represents a serious problem for the environment and their concentrations and fate remain largely unknown. The present study consists of a PFAS screening in sludges originating from 43 wastewater treatment plants (WWTPs) in the Czech Republic. To analyze an extended group of PFAS consisting of 32 PFAS, including GenX and other new replacements of older and restricted PFAS in sludge, a new method was optimized and validated using pressurized solvent extraction, followed by the SPE clean-up step to eliminate the observed matrix effects and LC-MS/MS. The results revealed high PFAS contamination of sewage sludge, reaching values from 5.6 to 963.2 ng g(-1). The results showed that in the majority of the samples (about 60%), PFOS was the most abundant among the targeted PFAS, reaching 932.9 ng g(-1). Approximately 20% of the analyzed samples contained more short-chain PFAS, suggesting the replacement of long-chain PFAS (especially restricted PFOA and PFOS). GenX was detected in 9 samples, confirming the trend in the use of new PFAS. The results revealed that significantly higher contamination was detected in the samples from large WWTPs (population equivalent > 50,000; p-value <0.05). Concerning the application of sludge in agriculture, our prediction using the respective PFAS bioconcentration factors, the observed concentrations, and the legislatively permitted management of biosolids in Czech Republic agriculture revealed that PFAS can cause serious contamination of cereals and vegetables (oat, celery shoots and lettuce leaves), as well as general secondary contamination of the environment.					1			B	-		
D309	ばく露	Zhang, YQ; Zhou, YQ; Zhang, AG; Li, JY; Yu, J; Dou, YZ; He, J; Kong, DY	Perfluoroalkyl substances in drinking water sources along the Yangtze River in Jiangsu Province, China: Human health and ecological risk assessment	2021	Ecotox. Environ. Safe. 2021 Jul:218:112289. doi: 10.1016/j.ecoenv.2021.112289.	Perfluoroalkyl substances (PFASs) in source water is of growing concern for its adverse effects on human health and wildlife as well. The Yangtze River is the vital drinking water source in Jiangsu Province of China, but little attention has been paid on PFASs. The occurrence, spatial distribution and temporal trend of PFASs in 21 water sources along the Jiangsu section of the Yangtze River was investigated with sampling from 2018 to 2020. Moreover, health risk of PFASs was assessed by estimated intake dose and derived tolerable intake dose, while ecological risk was assessed by selected effect concentration and environmental exposure. PFASs concentrations in source water ranged from 12.0 to 128 ng/L, with perfluorooctanoic acid (PFOA) as the dominated congener. Fluorine chemical industry lead to a great increase of perfluorohexanoic acid (PFHxA) in its nearest water source. The estimated daily intake of PFASs through drinking was 0.54 and 0.82 ng/kg bw/day for adults and children. The major health risk was from perfluorooctane sulfonate (PFOS) and PFOA for their toxicity on liver, reproduction, development and immunity, with the maximum hazard quotient of 0.029 and 0.043 for adults and children in the worst scenario. The ecological risks from PFASs on nine species groups ranged from 2.7 x 10-10 to 5.2. PFOA and Perfluorobutane sulfonate (PFBS) were causing significant risk on wildlife, particularly on worms, mussels, and fish, which may further influence the structure and processes in the foodweb. Overall, PFASs, especially PFOS, PFOA and PFBS, induced considerable risk on human health and aquatic species in some hotspot area. It would be necessary to include them into monitoring in China and develop standards for different protection purposes.		1		1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D310	ばく露	Lu, YT; Gao, JF; Nguyen, HT; Vijayasarathy, S; Du, P; Li, XQ; Yao, H; Mueller, JF; Thai, PK	Occurrence of per- and polyfluoroalkyl substances (PFASs) in wastewater of major cities across China in 2014 and 2016	2021	Chemosphere. 2021 Sep:279:130590. doi: 10.1016/j.chemosphere.2021.130590.	China produced and consumed a large amount of per- and polyfluoroalkyl substances (PFASs). whose persistency and possible toxicity to organisms have raised public health concerns. Analyzing influent wastewater could help to assess the composition and mass load of PFASs discharged into a wastewater treatment plant (WWTP) from its catchment. In this study, we analyzed 27 PFASs in wastewater samples collected from 42 WWTPs across China in 2014 and 2016. Results indicated that perfluorobutanoic acid (PFBA), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) were the most common PFASs in wastewater. Population normalized mass loads of PFOA and PFOS were higher in Eastern China than in the other three regions, possibly due to their higher usage. Although the concentrations of PFASs in Central and West areas were showed lower than in East area, Wuhan (in Central area) and Lanzhou (in West area) were hotspots of PFASs pollution because of their industry structure. Population density and per capita Gross Domestic Product (GDP) have positive correlations with the concentration of PFBA, PFOA, PFHxA, and Sigma PFASs in wastewater. The estimated annual release of PFASs to WWTPs in our study is much lower than the total emission to the environment. Our results suggest that although there was some reduction in the production volume, certain legacy PFASs were still released into wastewater and their composition and concentration vary among WWTPs.	1	1						B	-		
D311	ばく露	Han, DM; Ma, YG; Huang, C; Zhang, XF; Xu, H; Zhou, Y; Liang, S; Chen, XJ; Huang, XQ; Liao, HX; Fu, S; Hu, X; Cheng, JP	Occurrence and source apportionment of perfluoroalkyl acids (PFAAs) in the atmosphere in China	2019	Atmos. Chem. Phys. 2019 Nov:19(22):14107-14117. doi: 10.5194/acp-19-14107-2019.	Perfluoroalkyl acids (PFAAs) are a form of toxic pollutant that can be transported across the globe and accumulated in the bodies of wildlife and humans. A nationwide geographical investigation considering atmospheric PFAAs via a passive air sampler (PAS) based on XAD (a styrene-divinylbenzene copolymer) was conducted in 23 different provinces/municipalities/autonomous regions in China, which provides an excellent chance to investigate their occurrences, spatial trends, and potential sources. The total atmospheric concentrations of 13 PFAAs (n = 268) were 6.19-292.57 pgm(-3), with an average value of 39.84 +/- 28.08 pg m(-3), which were higher than other urban levels but lower than point source measurements. Perfluorooctanoic acid (PFOA) was the dominant PFAA (20.6 %), followed by perfluorohexanoic acid (PFHxA), perfluorooctane sulfonate (PFOS), and perfluoroheptanoic acid (PFPeA). An increasing seasonal trend of PFAA concentrations was shown as summer < autumn < spring < winter, which may be initiated by stagnant meteorological conditions. Spatially, the content of PFAAs displayed a declining gradient trend of central China > northern China > eastern China > north-eastern China > southwestern China > north-western China > southern China, and Henan contributed the largest proportion of PFAAs. Four sources of PFAAs were identified using a positive matrix factorization (PMF) model, including PFOS-based products (26.1 %), products based on PFOA and perfluorononanoic acid (PFNA; 36.6 %), degradation products of fluorotelomer-based products (15.5 %), and an unknown source (21.8 %).		1	1					B	-		
D312	ばく露	Eriksson, U; Karrman, A; Rotander, A; Mikkelsen, B; Dam, M	Perfluoroalkyl substances (PFASs) in food and water from Faroe Islands	2013	Environ. Sci. Pollut. Res. 2013 Nov:20(11):7940-7948. doi: 10.1007/s11356-013-1700-3.	Diet and drinking water are suggested to be major exposure pathways for perfluoroalkyl substances (PFASs). In this study, food items and water from Faroe Islands sampled in 2011/2012 were analyzed for 11 perfluoroalkyl carboxylic acids (PFCAs) and 4 perfluoroalkane sulfonic acids (PFSAs). The food samples included milk, yoghurt, crSme fraiche, potatoes, fish, and fish feed, and the water samples included surface water and purified drinking water. In total, nine PFCAs and four PFSAs were detected. Generally, the levels of PFAS were in the lower picogram per gram range. Perfluorobutanoic acid was a major contributor to the total PFASs concentration in water samples and had a mean concentration of 750 pg/L. Perfluoroundecanoic acid (PFUnDA) was predominating in milk and wild fish with mean concentrations of 170 pg/g. Perfluorooctane sulfonic acid (PFOS) was most frequently detected in food items followed by PFUnDA, perfluorononanoic acid, and perfluorooctanoic acid (PFOA). Levels of PFUnDA and PFOA exceeded those of PFOS in milk and fish samples. Prevalence of long-chain PFCAs in Faroese food items and water is confirming earlier observations of their increase in Arctic biota. Predominance of short-chain and long-chain homologues indicates exposure from PFOS and PFOA replacement compounds.	1		1					B	-		
D313	ばく露	Lai, WWP; Lin, YC; Wang, YH; Guo, YL; Lin, AYC	Occurrence of Emerging Contaminants in Aquaculture Waters: Cross-Contamination between Aquaculture Systems and Surrounding Waters	2018	Water Air Soil Pollut. 2018 AUG;229(8):249. doi: 10.1007/s11270-018-3901-3.	This study aimed to perform a preliminary screen of various waters for pollution by emerging contaminants and identifying potential cross-contamination problems in aquaculture systems. Specifically, the occurrence and distribution of 110 emerging contaminants (49 antibiotics, 49 other pharmaceuticals, and 12 industrial/household compounds) in 14 aquaculture sites (fish, shrimp, and shellfish ponds) and three surrounding aquatic environments in Taiwan were investigated. All the detected compounds were at nanogram per liter to sub-microgram per liter levels. Six pharmaceuticals that occurred at high concentrations and frequencies were ibuprofen (788 ng/L), lincomycin (624 ng/L), flumequine (331 ng/L), caffeine (276 ng/L), ifosfamide (220 ng/L), and cephalexin (172 ng/L). Other commonly detected emerging contaminants (with detection frequencies > 70%) were sulfamethoxazole, erythromycin-H2O, atenolol, methadone, benzotriazole, tolyltriazole, perfluorobutane sulfonate (PFBS), perfluoroheptanoic acid (PFHpA), perfluorooctanoate (PFOA), and perfluorononanoic acid (PFNA). This work demonstrated the impact of aquaculture activities (i.e., usage of antibiotics) on the surrounding aquatic environments and, at the same time, how the surrounding anthropogenic activities impact aquaculture waters. Cross-contamination was observed between these two aquatic systems; emerging contaminants resulting from human activities, such as perfluorinated chemicals, anticorrosive substances, and anticancer and abused drugs, from the surrounding waters were found to be introduced into the aquaculture systems.			1	1				B	-		
D314	ばく露	Guo, CS; Zhang, Y; Zhao, X; Du, P; Liu, SS; Lv, JP; Xu, FX; Meng, W; Xu, J	Distribution, source characterization and inventory of perfluoroalkyl substances in Taihu Lake, China	2015	Chemosphere 2015 May:127:201-207. doi: 10.1016/j.chemosphere.2015.01.053	The levels, distribution, possible sources, and inventory of perfluoroalkyl acids (PFAAs) in the eutrophic freshwater Taihu Lake, East China were investigated in this study. Among the target 11 PFAAs, perfluorooctanoic acid (PFOA) (2.15-73.9 ng L-1) and perfluorohexanoic acid (PFHxA) (<1.0Q-22.2 ng L-1) were the dominant components in surface water, followed by perfluorooctanesulfonic acid (PFOS) with the maximum concentration of 10.5 ng L-1. PFOS was also dominant (0.13-6.95 ng g(-1) dw) in the sediments, accounting for 15-85% of Sigma PFAAs concentrations in 70% of the sediment samples. Sediment-water partitioning coefficients showed that logK(oc) increased linearly with the increasing chain length, with the logK(oc) values increased by 0.1-0.4log unit with each CF2 moiety from C8 to C12 perfluorinated carboxylic acids. Three specific molecular ratios, PFOS/PFOA, PFOA/PFNA and PFHpA/PFOA were used to characterize the potential sources. It indicated that the majority of pollutants was from direct emissions from manufacturing processes. The PFOA/PFNA ratios between 1.7 and 56.8 in surface water suggested the influence of secondary sources such as the degradation of volatile precursor substances. Given the high ratios of PFHpA/PFOA (0.05-7.93), it also indicated the influence from atmospheric deposition to the epilimnion. The predicted environmental concentrations were calculated from European Union system for the evaluation of substances model (EUSES). As expected, the predicted environmental concentration (PEC) of PFOS in sediment fit well to the monitored level of PFOS in this region, and the inventory of Sigma PFCA and PFOS were estimated to be 989 kg and 646 kg in Taihu Lake.		1	1					B	-		
D315	ばく露	Garnett, J; Halsall, C; Winton, H; Joerss, H; Mulvaney, R; Ebinghaus, R; Frey, M; Jones, A; Leeson, A; Wynn, P	Increasing Accumulation of Perfluorocarboxylate Contaminants Revealed in an Antarctic Firn Core (1958-2017)	2022	Environ Sci Technol. 2022 Aug 16;56(16):11246-11255. doi: 10.1021/acs.est.2c02592.	Perfluoroalkyl acids (PFAAs) are synthetic chemicals with a variety of industrial and consumer applications that are now widely distributed in the global environment. Here, we report the measurement of six perfluorocarboxylates (PFCA, C-4-C-9) in a firn (granular compressed snow) core collected from a non-coastal, high-altitude site in Dronning Maud Land in Eastern Antarctica. Snow accumulation of the extracted core dated from 1958 to 2017, a period coinciding with the advent, use, and geographical shift in the global industrial production of poly/ perfluoroalkylated substances, including PFAA. We observed increasing PFCA accumulation in snow over this time period, with chemical fluxes peaking in 2009-2013 for perfluorooctanoate (PFOA, C-8) and nonanoate (PFNA, C-9) with little evidence of a decline in these chemicals despite supposed recent global curtailments in their production. In contrast, the levels of perfluorobutanoate (PFBA, C-4) increased markedly since 2000, with the highest fluxes in the uppermost snow layers. These findings are consistent with those previously made in the Arctic and can be attributed to chlorofluorocarbon replacements (e.g., hydrofluoroethers) as an inadvertent consequence of global regulation.	1		1					B	-		
D316	ばく露	Li, PY; Oyang, XH; Zhao, YL; Tu, TQ; Tian, XJ; Li, L; Zhao, Y; Li, JY; Xiao, ZY	Occurrence of perfluorinated compounds in agricultural environment, vegetables, and fruits in regions influenced by a fluorine-chemical industrial park in China	2019	Chemosphere 2019 Jun:225:659-667. doi: 10.1016/j.chemosphere.2019.03.045	The occurrence of perfluorinated compounds (PFCs) in vegetables and fruits, as well as agricultural environment, was investigated in the downstream regions of Changshu fluorine-chemical industrial park (CFCIP) in China. Twenty-one PFCs were analyzed in irrigation water, agricultural soil, typical vegetables, and fruits, with the maximum total PFC concentrations of 369.9 ng/L, 64.7 ng/g dw, 11.5 ng/g ww, and 10.5 ng/g ww, respectively. Short-chained perfluoroalkyl carboxylic acids (PFCAs) such as perfluorooctanoic acid (PFOA), perfluorobutanoic acid (PFBA), and perfluorohexanoic acid were the dominant PFCs in terms of their concentrations and detection frequency. PFCs in irrigation water and agricultural soils showed a decreasing trend with increasing distance from CFCIP, while this pattern was not observed in agricultural products. The predominant compounds varied in different vegetables and fruits. Simultaneous bioaccumulation of PFBA and PFOA was found in melons and solanaceous species and pears. Leafy vegetables and grapes exhibited high bioaccumulation of PFOA and PFBA, respectively. Health risk assessment by calculating estimated daily intake showed that no direct risk was caused by the consumption of vegetables and fruits for the residents in the investigated regions. However, the tolerable weekly intake of PFOA exceeded the established thresholds for the adult residents. A comprehensive health assessment of the dietary exposure of PFCs, including all exposure pathways, in fluorine-chemical industrial park-impacted regions is needed.	1	1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D317	ばく露	Du, D; Lu, YL; Zhou, YQ; Zhang, M; Wang, CC; Yu, MZ; Song, S; Cui, HT; Chen, CC	Perfluoroalkyl acids (PFAAs) in water along the entire coastal line of China: Spatial distribution, mass loadings, and worldwide comparisons	2022	Environ. Int. 2022 Nov:169:107506. doi: 10.1016/j.envint.2022.107506.	Perfluoroalkyl acids (PFAAs) have been ubiquitously distributed in water environment worldwide for a long time, especially in the estuaries and coastal areas. In this study, the distribution characteristics of 12 PFAAs in 91 main river estuaries along the entire coast of China were analyzed for the first time, and the riverine PFAAs fluxes into the coastal marine environment were estimated. Based on a mini-review, the PFAAs pollution in the coast of China at a global scale was evaluated, which was intended to reveal the overall level of PFAAs and to provide a science basis for strengthening environmental management along the coast of China. The results showed that perfluorooctanoic acid (PFOA), perfluorobutanoic acid (PFBA), and perfluorobutane sulfonic acid (PFBS) were dominant in the whole coastal region, which indicated the usage of PFAAs was changing from long-chain PFAAs to short-chain substitutes in China. With regard to the spatial distribution, the high PFAAs concentrations were found in the coastal areas of south Bohai Sea, Shandong Province from the north while those in the south were generally lower when taking the Qinling Mountain and Huaihe River as a dividing line. The estimated PFAAs riverine mass loading in the whole coastal region was 131 tons per year, and the discharge flux of the Yangtze River accounted for more than half (73.5 tons). In comparison with global data, PFAAs concentrations in the coast of China was at a moderate level, and the detected hotspots of high levels were strongly influenced by fluorochemical industries. However, the mass loading of PFAAs was diversified due to geographical differences and abundant river discharges.	1			1				B	-		
D318	ばく露	Codling, G; Sturchio, NC; Rockne, KJ; Li, A; Peng, H; Tse, TJ; Jones, PD; Giesy, JP	Spatial and temporal trends in poly- and per-fluorinated compounds in the Laurentian Great Lakes Erie, Ontario and St. Clair	2018	Environ. Pollut. 2018 Jun:237:396-405. doi: 10.1016/j.envpol.2018.02.013	The temporal and spatial trends in sediment of 22 poly- and perfluorinated (PFAS) compounds were investigated in the southern Great Lakes Erie and Ontario as well as Lake St. Clair. Surface concentrations measured by Ponar grab samples indicated a trend for greater concentrations near to urban sites. Mean concentrations Sigma(22)PFAS were 15.6, 18.2 and 19 ng g(-1) dm for Lakes St. Clair, Erie and Ontario, respectively. Perfluoro-n-butanoic acid (PFBA) and Perfluoro-n-hexanoic acid (PFHxA) were frequently determined in surface sediment and upper core samples indicating a shift in use patterns. Where PFBA was identified it was at relatively great concentrations typically >10 ng g(-1) dm. However as PFBA and PFHxA are less likely to bind to sediment they may be indicative of pore water concentrations Sedimentation rates between Lake Erie and Lake Ontario differ greatly with greater rates observed in Lake Erie. In Lake Ontario, in general concentrations of PFAS observed in core samples closely follow the increase in use along with an observable change due to regulation implementation in the 1970s for water protection. However some of the more water soluble PFAS were observed in deeper core layers than the time of production could account for, indicating potential diffusion within the sediment. Given the greater sedimentation rates in Lake Erie, it was hoped to observe in greater resolution changes since the mid 1990s. However, though some decrease was observed at some locations the results are not clear. Many cores in Lake Erie had clearly observable gas voids, indicative of gas ebullition activity due to biogenic production, there were also observable mussel beds that could indicate mixing by bioturbation of core layers.	1	1						B	-		
D319	ばく露	Kirchgeorg, T; Weinberg, I; Dreyer, A; Ebinghaus, R	Perfluorinated compounds in marine surface waters: data from the Baltic Sea and methodological challenges for future studies	2010	Environ. Chem. 2010;7(5):429-434. doi: 10.1071/EN10039.	Poly- and perfluorinated compounds (PFCs) are chemicals of emerging environmental concern. Except for very few coastal sites, PFC contamination of the Baltic Sea has not been investigated. In order to assess the PFC contamination of Baltic Sea water and evaluate the spatial distribution of PFCs, 74 surface water samples from the entire Baltic Sea were taken during two sampling campaigns in the summer of 2008 and analysed for PFCs. Of 40 analysed PFCs, 13 were detected at concentrations below 1 ng L-1, which indicates a rather low PFC contamination of Baltic Sea surface water. Usually, PFOA was the analyte observed in highest concentrations followed by PFNA, PFBS, and PFOS. PFC concentrations decreased from the Kattegat to the Bothnian Bay and the Gulf of Finland, reflecting the decreasing population density and thus the potential contamination in corresponding catchments or the decreasing influence of potentially contaminated North Sea water.			1	1				B	-		
D320	ばく露	Padilla-Sanchez, JA; Papadopoulou, E; Poothong, S; Haug, LS	Investigation of the Best Approach for Assessing Human Exposure to Poly- and Perfluoroalkyl Substances through Indoor Air	2017	Environ. Sci. Technol. 2017 Nov:51(21):12836-12843. doi: 10.1021/acs.est.7b03516.	Per- and polyfluoroalkyl substances (PFASs), including fluorotelomer alcohols (FTOHs), perfluoroalkyl sulfonamidoethanols (FOSEs), and perfluoroalkyl sulfonamides (FOSAs), were assessed in 61 residential indoor air and 15 personal air samples collected in Oslo area, Norway. FTOHs were detected in all samples, and the median concentrations in residential indoor air were 2970, 10400, and 3120 pg m(-3) for 6:2, 8:2, and 10:2 FTOH, respectively. This is similar to or higher than previously reported in studies from the same geographical area and worldwide. FOSEs and FOSAs were detected in 49-70% and 7-13% of the residential indoor air samples, respectively. The median FTOH concentrations observed in personal air were 1970, 7170, and 1590 pg m(-3) for 6:2, 8:2, and 10:2 FTOH, respectively, which is 30 to 50% lower than the median concentrations in residential indoor air. No FOSEs or FOSAs were detected above the method detection limit (MDL) in the personal air samples. Intakes of perfluorohexanoate (PFHxA), perfluoroheptanoate (PFHpA), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorodecanoate (PFDA), perfluoroundecanoate (PFUnDA), and perfluorooctyl sulfonate (PFOS) through inhalation and biotransformation of PFAS precursors in air were estimated. Median intakes of 1.7, 0.17, 5.7, 0.57, 1.8, 0.18, and 2.3 pg kg bw(-1) day(-1) were obtained in residential indoor air, while 1.0, 0.10, 3.3, 0.33, 0.88, and 0.09 pg kg bw(-1) day(-1) were found in personal air for PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, and PFOS, respectively. The median PFOA intakes from residential indoor air (5.7 pg kg bw(-1) day(-1)) and personal air (3.3 pg kg bw(-1) day(-1)) were both around 5 orders of magnitude lower than the tolerable daily intake (TDI) reported by the European Food Safety Authority (EFSA).		1	1				B	-		
D321	ばく露	Wang, F; Zhuang, YR; Dong, BQ; Wu, J	Review on Per- and Poly-Fluoroalkyl Substances' (PFASs') Pollution Characteristics and Possible Sources in Surface Water and Precipitation of China	2022	Water. 2022 Mar;14(5):812. doi: 10.3390/w14050812.	In recent years, due to the production and use of per- and poly-fluoroalkyl substances (PFASs), the research on the pollution characteristics and sources of PFASs in surface water and precipitation in China has attracted increasing attention. In this study, the related published articles with sampling years from 2010 to 2020 were reviewed, and the concentration levels, composition characteristics and possible sources of PFASs in surface water (rivers and lakes) and precipitation in China were summarized, including those in the Tibetan Plateau region. The results show that the concentrations of PFASs in surface water in different areas of China vary greatly, ranging from 0.775 to 1.06 x 10(6) ng/L. The production processes of fluorinated manufacturing facilities (FMFs) and sewage discharge from wastewater treatment plants (WWTPS) were the main sources of PFASs in surface water in China, and the concentrations of PFASs in water flowing through cities with high urbanization increased significantly compared with those before water flowed through cities with high urbanization. The compositions of PFASs in surface water gradually changed from long-chain PFASs, such as per-fluoro-octanoic acid (PFOA) and per-fluoro-octanesulfonic acid (PFOS) to short-chain PFASs, such as per-fluorobutanoic acid (PFBA), per-fluorobutanesulfonic acid (PFBS), perfluorohexanoic acid (PFHxA) and per-fluoropentanoic acid (PFPeA). The concentrations of PFASs in precipitation in China ranged from 4.2 to 191 ng/L, which were lower than those of surface water. The precipitation concentrations were relatively high around a fluorination factory and in areas with high urbanization levels. PFASs were detected in the surface water and precipitation in the Tibetan Plateau (TP), which is the global roof of the world, but the concentrations were low (0.115-6.34 ng/L and 0.115-1.24 ng/L, respectively). Local human activities and surface runoff were the main sources of PFASs in the surface water of the Tibetan Plateau. In addition, under the influence of the Southeast Asian monsoon in summers, marine aerosols from the Indian Ocean and air pollutants from human activities in Southeast Asia and South Asia will also enter the water bodies through dry and wet depositions. With the melting of glaciers caused by global warming, the concentration of PFASs in the surface water of the TP was higher than that before the melting of glaciers flowed into the surface water of the TP. Generally, this study summarized the existing research progress of PFAS studies on surface water and precipitation in China and identified the research gaps, which deepened the researchers' understanding of this field and provided scientific support for related research in the future. The concentrations of PFASs in the water bodies after flowing through FMFs were significantly higher than those before water flowed through FMFs, so the discharge of the FMF production process was one of the main sources of PFASs in surface water.	1	1		1				B	-		
D322	ばく露	Chiesa, LM; Pavlovic, R; Arioli, F; Nobile, M; Di Cesare, F; Mosconi, G; Falletta, E; Malandra, R; Panseri, S	Presence of perfluoroalkyl substances in Mediterranean sea and North Italian lake fish addressed to Italian consumer	2022	Int. J. Food Sci. Technol. 2022 Feb:57(2):1303-1316. doi: 10.1111/ijfs.15532.	The primary source of perfluoroalkyl substances (PFASs) exposure is the diet, mainly fish. Seabass (Dicentrarchus labrax) and seabream (Sparus aurata) are among the most consumed sea fish in Italy. Fish from Northern Italy lakes like perch (Perca fluviatilis) is of particular importance in terms of consumption volume, while Mediterranean shad (Alosa agone) and European whitefish (Coregonus lavaretus) represent niche consumption. These species too could be a cause of consumer exposure to PFAS. The study investigated the presence of PFASs in the above-mentioned fish species through LC-HRMS analysis. Only PFBA and PFOS were found both in lake and sea fish while PFBS was found only in lake fish. The found concentrations were used to estimate intake of PFOS, the only detected molecule of the four discussed in the last EFSA report. The Tolerable Weekly Intake of 4.4 ng kg(-1) b.w. per week was never exceeded also for the 99th percentile consumers.	1			1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D323	ばく露	Huang, CS; Zhang, JJ; Hu, GC; Zhang, LJ; Chen, HB; Wei, DY; Cai, D; Yu, YJ; Li, X; Ding, P; Li, J	Characterization of the distribution, source, and potential ecological risk of perfluorinated alkyl substances (PFASs) in the inland river basin of Longgang District, South China	2021	Environ. Pollut. 2021 Oct:287:117642. doi: 10.1016/j.envpol.2021.117642.	Previous studies of perfluorinated alkyl substances (PFASs) in receiving water bodies of typical industrial parks under the low-carbon development mode are scarce. In the present study, 18 PFASs were analyzed in surface water and sediment samples of the inland river basin in Longgang District in 2017. The sigma PFAS concentrations in surface water (drought and rainy periods) and sediment ranged from 15.17 to 948.50 ng/L, 11.56-561.14 ng/L, and 1.07-28.94 ng/g dw, respectively. Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorobutane sulfonate (PFBS) were the dominant pollutants in surface water, with maximum concentrations of 867.68 ng/L, 288.28 ng/L, and 245.09 ng/L, respectively. Meanwhile, PFOS, perfluoroundecanoic acid (PFUdA), PFBS, and perfluorodecanoic acid (PFDA) were the major PFASs in the sediment samples, with maximum concentrations of 9.83 ng/g dw, 11.86 ng/g dw, 5.30 ng/g dw, and 5.23 ng/g dw, respectively. In addition, PFOA and PFOS resulted from similar sources in sediment and surface water samples ($P < 0.05$). The risk quotient value (RQ) results showed that the control of PFOS in the treatment of pollutants in the inland river basin of Longgang District deserves more attention.				1				B	-		
D324	ばく露	Desgens-Martin, V; Li, WW; Medina, T; Keller, AA	Estimated Influent PFAS Loads to Wastewater Treatment Plants and Ambient Concentrations in Downstream Waterbodies: Case Study in Southern and Central California	2023	ACS ES&T Wat. 2023 Jun:3(8):2219-2228. doi: 10.1021/acsestwater.3c00022.	Roleof modeling and field sampling for quickly assessingPFAS sources and ecological and public health risks. Per- and polyfluoroalkyl substances (PFAS) have receivedincreasedscrutiny from environmental and public health protection agencies,with focus placed on phased-out legacy PFAS such asperfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA).However, recent studies highlight the need to also evaluate the risksof replacement and breakdown products such as perfluorobutanesulfonicacid (PFBS) and hexafluoropropylene oxide dimer acid (HFPO-DA). Thus,the objective was to evaluate the ecological risks of legacy and newerPFAS, using monitoring and predictive models. Here, PFBS, PFOA, PFOS,and other PFAS were detected in samples collected downstream from16 Southern and Central California wastewater treatment plants (WWTPs).PFBS, PFOA, and PFOS were sometimes detected at concentrations aboveexperimentally determined lowest observed effect concentrations. Additionally,ChemFate, a fate and transport model, was used to estimate daily loadsto the upstream WWTPs. Population size and urban land use were thebest predictors of PFAS loads to WWTPs. The sum of influent loadsof selected PFAS was estimated to be 61,000 & PLUSMN; 40,000 kg/yearfor California. Additionally, the sum of PFAS totaled annually inevaluated regions correlated well with the overall pollution burden.Here, the practicality of using predictive models in conjunction withfield sampling to predict PFAS inputs and their ecological risks tothe environment was demonstrated.				1	1			B	-		
D325	ばく露	Bedi, M; Sapozhnikova, Y; Taylor, RB; Ng, C	Per- and polyfluoroalkyl substances (PFAS) measured in seafood from a cross-section of retail stores in the United States	2023	J. Hazard. Mater. 2023 Oct:459:132062. doi: 10.1016/j.jhazmat.2023.132062.	Seafood is a dominant source of human exposure to per-and polyfluoroalkyl substances (PFAS). Existing studies on foodborne PFAS exposure have focused on only a subset of these compounds. Here, we conducted a pilot study to screen 33 PFAS in 46 seafood samples from a cross-section of national and local stores in the US. Low levels of 8 PFAS were measured in 74% of the samples, predominated by PFHxS (59%). Total PFAS ranged between 0.12 and 20 ng/g; highest levels were measured in Estonia-sourced smelt. The highest median levels were of PFOA (0.84 ng/g) with elevated concentrations found in Chinese clams (2.4 ng/g), which exceeds the EU established maximum limits (MLs). Measured levels of PFHxS, PFOA, and PFNA also exceeded MLs in 24%, 7%, and 5% of the samples, respectively. For average consumption levels, exposures were below the EU established tolerable weekly intakes (TWIs). However, for more frequent consumption of flounder, catfish, and cod, exposures exceeded regulations, which warrants identifying vulnerable high seafood consuming populations. Accidental PFBS cross contamination from sample storage bags resulted in 100% detection in samples, highlighting the problem with post-purchase food handling practices such as storage and cooking that could also have a sub-stantial impact on human exposure, potentially in larger amounts than the (sea)food itself.			1	1				B	-		
D326	ばく露	Taylor, S; Terkildsen, M; Stevenson, G; de Araujo, J; Yu, CH; Yates, A; McIntosh, RR; Gray, R	Per and polyfluoroalkyl substances (PFAS) at high concentrations in neonatal Australian pinnipeds	2021	Sci. Total Environ. 2021 Sep:786:147446. doi: 10.1016/j.scitotenv.2021.147446.	Per and polyfluorinated substances (PFAS) exposure was investigated in Australian pinnipeds. Concentrations of 16 PFAS were measured in the livers of Australian sea lion (Neophoca cinerea), Australian fur seal (Arctocephalus pusillus doriferus) and a long-nosed Fur Seal (Arctocephalus forsteri) pup sampled between 2017 and 2020 from colonies in South Australia and Victoria. Findings reported in this study are the first documented PFAS concentrations in Australian pinnipeds. Median and observed range of values in ng/g wet weight were highest for perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) in the liver of N. cinerea (PFOS = 7.14, 1.00-16.9; PFOA = 2.73, 0.32-11.2; PFNA = 2.96, 0.61-8.22; n = 28), A. forsteri (PFOS = 15.98, PFOA = 2.02, PFNA = 7.86; n = 1) and A. p. doriferus (PFOS = 27.4, 10.5-2119; PFOA = 0.98, 0.32-52.2; PFNA = 2.50, 0.91-44.2; n = 20). PFAS concentrations in A. p. doriferus pups were significantly greater ($p < 0.05$) than in N. cinerea pups for all PFAS except PFOA and were of similar magnitude to those reported in northern hemisphere marine animals. These results demonstrate exposure differences in both magnitude and PFAS profiles for N. cinerea in South Australia and A. p. doriferus in Victoria. This study reports detectable PFAS concentrations in Australian pinniped pups indicating the importance of maternal transfer of these toxicants. As N. cinerea are endangered and recent declines in pup production has been reported for A. p. doriferus at the colony sampled, investigation of potential health impacts of these toxicants on Australian pinnipeds is recommended.			1					B	-		
D327	ばく露	Morales-McDevitt, ME; Dunn, M; Habib, A; Vojta, S; Becanova, J; Lohmann, R	Poly- and Perfluorinated Alkyl Substances in Air and Water from Dhaka, Bangladesh	2022	Environ. Toxicol. Chem. 2022 Feb:41(2):334-342. doi: 10.1002/etc.5255.	Bangladesh hosts extensive textile manufacturing, for some of which per- and polyfluorinated alkyl substances (PFAS) have been used to impart water and dirt repellency, among other things. Textile waste emissions to the atmosphere and discharge into rivers and other bodies of water could present a significant concern for human and ecosystem health, but there is little information on PFAS in Bangladesh. To assess the presence of ionic PFAS and their precursors in air and water from Dhaka, Bangladesh, polyethylene sheets were deployed for 28 days as passive samplers for neutral PFAS in outdoor air and water, while ionic PFAS were measured from discrete water grabs. Fluorotelomer alcohols (FTOHs) were detected at almost all sites in air and water; the most frequently detected compound was 6:2 FTOH, ranging from below instrumental detection limits (<IDL) to 70 ng m-3 in air and from <IDL to -19 ng L-1 in water. Of the ionic PFAS, perfluorobutanoic acid (PFBA), perfluorohexanoic acid, perfluorooctanoic acid, perfluorohexane sulfonic acid, and perfluorooctane sulfonic acid dominated in frequency of detection and magnitude, with concentrations ranging from 1.8 to 19.0 ng L-1 in surface waters. The prevalence of 6:2 FTOH and PFBA across sites probably reflects their use in textile manufacturing and could indicate the industry's switch to shorter-chain PFAS alternatives.								B	-		
D328	ばく露	Wang, Q; Tsui, MMP; Ruan, YF; Lin, HJ; Zhao, Z; Ku, JPH; Sun, HW; Lam, PKS	Occurrence and distribution of per- and polyfluoroalkyl substances (PFASs) in the seawater and sediment of the South China sea coastal region	2019	Chemosphere 2019 Sep:231:468-477. doi: 10.1016/j.chemosphere.2019.05.162	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are anthropogenic chemicals widely used in industrial and consumer products. PFASs can be readily transported by water due to their relatively high solubility and polarity, and oceans are believed to be their final global sink. The heavily industrialized and urbanized Pearl River Delta in South China represents a major source of PFASs. In the present study, samples of surface waters, bottom waters, and sediments of the South China Sea (SCS) were collected during summer 2017 and 2018 to determine the level, distribution, and potential regional risk of PFASs. The PFAS concentrations in surface seawater, bottom seawater, and sediment were 125-1015 pg/L, 38 -779 pg/L, and 7.5-84.2 pg/g dry weight, respectively. Perfluorobutanoic acid (PFBA) and perfluorooctanoic acid (PFOA) were the dominant PFASs in seawater, while perfluorooctanesulfonic acid (PFOS) was dominant in sediment. The PFAS alternatives 6:2 and -8:2 Cl-polyfluorinated ether sulfonate (6:2 and 8:2 Cl-PFESA) as well as hexafluoropropylene oxide dimer (HFPO-DA) were detected in the SCS for the first time. The spatial distribution of PFASs in seawater and sediment were impacted by river outflows and sea currents, and concentrations decreased from the estuaries to the offshore regions due to the dilution effect. PFAS concentrations were relatively low compared to other coastal regions worldwide, and a preliminary environmental hazard assessment showed that PFASs posed minimal risk to marine organisms in the coastal region of the SCS, with the exception of PFOS.	1				1			B	-		
D329	ばく露	Si, YY; Huang, JK; Liang, ZH; Liu, GQ; Chen, D; Guo, Y; Wang, F	Occurrence and Ecological Risk Assessment of Perfluoroalkyl Substances (PFASs) in Water and Sediment from an Urban River in South China	2021	Arch. Environ. Contam. Toxicol. 2021 Jul:81(1):133-141. doi: 10.1007/s00244-021-00855-x.	The chemical substances in urban rivers influence municipal water systems and reflect the recent use of these chemicals by humans or industries around the urban center. In this study, seven perfluoroalkyl substances (PFASs)-perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), 2-perfluorohexyl ethanol (6:2 FTOH), 2-perfluorooctyl ethanol (8:2 FTOH), and 6:2 chlorinated polyfluoroalkyl ether sulfonic acids (F-53B)-could be detected and quantified in river water and sediment samples collected from one tributary of the Liuxi River, which is part of Pearl River near Guangzhou in Guangdong province, South China. The fluxes of target PFASs into Liuxi River and their related ecological risks were further estimated. The total concentrations of PFASs (sigma PFASs) ranged from 506 to 3.16 x 10(3) ng/L in water samples and 9.13 to 850 ng/L in sediment samples. The two dominant PFAS compounds were 6:2 FTOH and PFHpA, which accounted for more than 90.0% of sigma PFASs in river water and sediment. Correlation analysis showed that there was significant positive correlation ($p < 0.01$) between two selected PFASs (e.g., between 6:2 FTOH and PFHpA). Correlation analysis of PFASs in river water and sediment indicated most PFASs in sediment were partitioned from river water. The ecological risk assessment indicated that the detected PFASs have a low risk (HQ < 0.1) in river water and sediment to Daphnia magna in the Liuxi River.		1	1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D330	ばく露	Hepburn, E; Madden, C; Szabo, D; Coggan, TL; Clarke, B; Currell, M	Contamination of groundwater with per- and polyfluoroalkyl substances (PFAS) from legacy landfills in an urban re-development precinct	2019	Environ. Pollut. 2019 May:248:101-113. doi: 10.1016/j.envpol.2019.02.018	The extent of per- and polyfluoroalkyl substances (PFAS) in groundwater surrounding legacy landfills is currently poorly constrained. Seventeen PFAS were analysed in groundwater surrounding legacy landfills in a major Australian urban re-development precinct. Sampling locations (n = 13) included sites installed directly in waste material and down-gradient from landfills, some of which exhibited evidence of leachate contamination including elevated concentrations of ammonia-N (<= 106 mg/L), bicarbonate (<= 1,740 mg/L) and dissolved methane (<= 10.4 mg/L). Between one and fourteen PFAS were detected at all sites and PFOS, PFHxS, PFOA and PFBS were detected in all samples. The sum of detected PFAS (Sigma(14)PFAS) varied from 26 ng/L at an ambient background site to 5,200 ng/L near a potential industrial point-source. PFHxS had the highest median concentration (34 ng/L; range: 2.6-280 ng/L) followed by PFOS (26 ng/L; range: 1.3-4,800 ng/L), PFHxA (19 ng/L; range:		1		1				B	-		
D331	ばく露	Masunaga, S; Zushi, Y	Status and Trends of Perfluoroalkyl Substances in Japan with Special Emphasis on the Tokyo Bay Basin	2016	ACS Symp. Ser. 2016:1244:157-179. doi: 10.1021/bk-2016-1244.ch007	Existing information on the occurrence and distribution of perfluoroalkyl substances (PFASs) in the Tokyo Bay basin was reviewed and reconstructed to show their temporal trends. The monitoring of river water in the basin showed that levels of perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) decreased during 2004-2013. The monitoring of homologue profiles of perfluoroalkyl acids (PFAAs) in Tama River water in 2009-2014 showed a significant change. In 2009, perfluorononanoic acid (PFNA) was identified as the most abundant PFAS, followed by PFOA and PFOS. While levels of these three acids decreased in 2009-2014, perfluorocarboxylic acids (PFCAs) with perfluoro carbon chains C-6, C-8 and C-9, and perfluoroalkyl sulfonates (PFSAs) with carbon chains C-6 and C-8, were contributing equally to the total level of PFAAs in 2014. Analysis of a dated sediment core from the center of Tokyo Bay indicated that the input of C8-13 PFCAs to the bay increased in 1977-2005 while PFOS increased from the 1970s to around 1993 and decreased gradually thereafter. These results indicate that the gradual decrease of PFOS emissions `in the basin started in the early 1990s, while the decrease of PFOA and PFNA emissions started slightly later, after 2006. Furthermore, a study on PFAA precursors in Tama River water showed that the total amount of potential precursors in PFAA equivalents was as much as 50% of the total PFAAs present in the same sample and was not negligibly small, suggesting a need for further studies on PFAA precursors.			1				B	-		
D332	ばく露	Wang, FW; Wang, WR; Zhao, DY; Liu, JX; Lu, PL; Rose, NL; Zhang, G	Source apportionment and wet deposition of atmospheric poly- and per-fluoroalkyl substances in a metropolitan city centre of southwest China	2022	Atmos. Environ. 2022 Mar:273:118983. doi: 10.1016/j.atmosenv.2022.118983.	Sixty rainwater samples were collected covering four seasons from July 2020 to April 2021 from the center of Chongqing, a metropolitan city of southwest China, using automatic deposition sampler. The samples were analysed for 17 targeted poly-and per-fluoroalkyl substances (PFASs) by HPLC-MS/MS. The concentration of PFASs ranged from 3.31 ng/L to 196.14 ng/L and dominated by perfluoro-n-octanoic acid (PFOA), perfluoro-nhexanoic acid (PFHxA), perfluoro-n-butanoic acid (PFBA) and sodium perfluoro-1-octanesulfonate (PFOS). The seasonal variations of dissolved and particulate PFAS were distinct, with the highest level in summer and autumn, respectively. Positive matrix factorization (PMF) and a wet deposition model were performed to apportion the sources and estimate the wet deposition flux of the 17 PFASs, respectively. PMF analysis indicated that, based on yearly average, paper packaging production (37.4%) and aqueous film forming foam (AFFF) usage (29.8%) were the two major sources, followed by textile production (16.7%) and electronic product manufacturing (16.1%). The highest source contributor for PFASs in winter was AFFF usage (47.0%); while in the other three seasons, it was paper packaging production that contributed the most (50.1%, 39.8% and 34.8% respectively). Seasonal average wet deposition flux of PFASs was estimated to be 13.9 ng/m2/day. The dry deposition of PFASs was estimated to account for 15.8% of the total atmospheric deposition flux, suggesting a more important role for wet deposition. The results of this study provide important information for understanding of PFASs occurrence and atmospheric wet deposition in Chongqing, and other urban centers across China.	1	1					B	-		
D333	ばく露	Liu, ZY; Xu, C; Johnson, AC; Sun, XY; Wang, MX; Xiong, J; Chen, C; Wan, X; Ding, XY; Ding, MY	Exploring the source, migration and environmental risk of perfluoroalkyl acids and novel alternatives in groundwater beneath fluorochemical industries along the Yangtze River, China	2022	Sci. Total Environ. 2022 Jun:827:154413. doi: 10.1016/j.scitotenv.2022.154413.	The widely used legacy perfluoroalkyl acids (PFAAs) with serious environmental hazards are gradually restricted and being replaced by novel alternatives. Here, for an efficient control of emerging environmental risks in groundwater, we systematically studied the source apportionment, spatial attenuation, composition change and risk zoning of 12 PFAAs and five novel alternatives within a region of similar to 200 km(2) around a mega fluorochemical industrial park (FIP) along the Yangtze River, and in-depth explored potential association between groundwater and soil pollution as well as influencing factors on contaminant migration and risk distribution in the aquifer. Short-chain PFAAs and novel alternatives together accounted for over 70% in groundwater, revealing their prevalence in replacing legacy perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). Novel alternatives for PFOA were mainly hexafluoropropylene oxide dimer acid (GenX) and hexafluoropropylene oxide (rimer acid (HFPO-TA), while those for PFOS were 6:2 chlorinated polyfluorinated ether sulfonic acid (6:2 Cl-Pi:ESA) and 6:2 fluorotelomer sulfonic acid (6:2 FTS). PFAAs (maximum total: 1339 ng/L) and novel alternatives (maximum total: 208 ng/L) in groundwater were mostly derived from the FIP, and exhibited an exponentially decreasing trend with increasing distance. Compared with those in groundwater, more diverse sources of PFAAs and novel alternatives in surface soil were identified. The transport of these chemicals may be retarded by claycd surface soils with high organic matter contents. High aquifer permeability could generally promote the dilution and migration of PFAAs and novel alternatives in groundwater, as well as reduce the differences in their spatial distribution. Shorter-chain components with smaller molecules and higher hydrophilicity exhibited greater migration capacities in the aquifer. In addition, different levels of health risk from PFOS and PFOA were zoned based on drinking groundwater, and high risks tended to be distributed in areas with relatively poor aquifer water yield due to higher pollutant accumulation.					1		B	-		
D334	ばく露	Kim, SK	Watershed-based riverine discharge loads and emission factor of perfluorinated surfactants in Korean peninsula	2012	Chemosphere. 2012 Nov:89(8):995-1002. doi: 10.1016/j.chemosphere.2012.07.016.	Long-range transport of and exposure to perfluorinated substances (PFSs) strongly depend on their emission mode. In the present study, watershed-based riverine discharge loads and emission factors are estimated for perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorohexylsulfonate (PFHxS), and perfluorooctylsulfonate (PFOS) by using spatially distributed data of chemical concentrations together with water flows and a geographic information system (GIS). Average per capita emissions (emission factor, mu g capita(-1) d(-1)) are 75 for PFOA, 36 for PFNA, 17 for PFHxS, and 43 for PFOS, which are several times lower than the estimates for Japan and the European continent. A relatively uniform distribution is observed for PFHxS and PFOS emission factors, while elevated values of PFOA and PFNA predominate in one of eight river basins. This may indicate the leading contribution of diffusive sources (e.g. nonpoint source) for PFHxS and PFOS versus the presence of localized point sources for PFOA and PFNA. The lower-upper bound of total riverine loads discharged annually from the Korean peninsula are in the range of 0.53-1.3 tons for PFOA, 0.09-0.60 tons for PFNA, 0.07-0.29 tons for PFHxS, and 0.19-0.73 tons for PFOS, accounting for <1% of global annual emissions. Furthermore, these riverine discharge loads are significantly greater than the discharge loads from a wastewater treatment plant, indicating the necessity of further study of nonpoint sources.			1				B	-		
D335	ばく露	Sanchez-Avila, J; Meyer, J; Lacorte, S	Spatial distribution and sources of perfluorochemicals in the NW Mediterranean coastal waters (Catalonia, Spain)	2010	Environ. Pollut. 2010 Sep:158(9):2833-2840. doi: 10.1016/j.envpol.2010.06.022.	This study provides the first evidence of the sources and loads of perfluorochemicals (PFCs) to the NW Mediterranean Sea. Five PFCs were analyzed in 45 seawater samples collected along the Catalan coast. Total PFCs ranged from 0.07 to 13.0 ng/l, being the levels higher in ports than in coastal waters. To determine the sources of PFCs, 8 wastewater treatment plants (WWTPs) effluents and 6 rivers discharging to the sea were also analyzed. WWTP effluents contained total PFCs levels ranging from 3.47 to 132 ng/l but due to the relatively low discharge flows, they contributed to 34.7 g/d to the sea. Total PFCs in rivers ranged from 2.24 to 21.9 ng/l and were the principal PFCs contributors to the sea. Overall, a total load of 190 g/d of PFCs are discharged to the NW Mediterranean coast. The effects and risk of PFCs discharges to the Mediterranean basin are discussed.							B	-		
D336	ばく露	Boone, JS; Vigo, C; Boone, T; Byrne, C; Ferrario, J; Benson, R; Donohue, J; Simmons, JE; Kolpin, DW; Furlong, ET; Glassmeyer, ST	Per- and polyfluoroalkyl substances in source and treated drinking waters of the United States	2019	Sci. Total Environ. 2019 Feb:653:359-369. doi: 10.1016/j.scitotenv.2018.10.245	Contaminants of emerging concern (CECs), including per- and polyfluoroalkyl substances (PFAS), are of interest to regulators, water treatment utilities, the general public and scientists. This study measured 17 PFAS in source and treated water from 25 drinking water treatment plants (DWTPs) as part of a broader study of CECs in drinkingwater across the United States. PFASwere quantitatively detected in all 50 samples, with summed concentrations of the 17 PFAS ranging from <1 ng/L to 1102 ng/L. Themedian total PFAS concentrationwas 21.4 ng/L in the source water and 19.5 ng/L in the treated drinking water. Comparing the total PFAS concentration in source and treated water at each location, only five locations demonstrated statistically significant differences (i. e. P < 0.05) between the source and treated water. When the perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) concentrations in the treated drinking water are compared to the existing US Environmental Protection Agency's PFOA and PFOS drinkingwater heath advisory of 70 ng/L for each chemical or their sumone DWTP exceeded the threshold. Six of the 25 DWTPs were along twolarge rivers. The DWTPswithin each of the river systems had specific PFAS profiles, with the three DWTPs from one river being dominated by PFOA, while three DWTPs on the second river were dominated by perfluorobutyric acid (PFBA). Published by Elsevier B. V. This is an open access article under the CC BY-NC-ND license.	1						A	-	全米の浄水場の浄水中のPFAS濃度が示されており、情報として有用	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D337	ばく露	Sun, R; Wu, MH; Tang, L; Li, JJ; Qian, ZQ; Han, T; Xu, G	Perfluorinated compounds in surface waters of Shanghai, China: Source analysis and risk assessment	2018	Ecotox. Environ. Safe. 2018 Mar:149:88-95. doi: 10.1016/j.ecoenv.2017.11.012	17 perfluorinated compounds (PFCs) were systematically investigated in the surface water from principal watersheds of Shanghai, China. 10 PFCs were above the detection limit (0.08-0.28 ng/L) in 39 surface water samples. The perfluorooctanoic acid (PFOA) and perfluorobutanesulfonate (PFBS) were the two dominant compounds with a median concentration 50.67 ng/L and 29.84 ng/L, respectively. Concentrations of perfluorooctanesulfonate (PFOS) were generally less than PFBS, which might result from the global phase-out of PFOS production and the use of PFBS as a substitute for PFOS-based products. There were three major polluted areas of PFOA along the Huangpu River. The PFOA concentration in groundwater samples collected from one of the three areas indicated that chemical industry might be the possible source. The perfluoroalkane sulfonates (PFSAs) level had a spatial trend that indicated northwest had higher concentrations than the southeast. The distribution of PFCs was not much affected by atmospheric deposition. Mass loading analysis in the surface water revealed that the Huangpu River exhibited relatively large mass loading of total PFCs of 1742.43 kg/year to Yangtze River Estuary. The predominant of the PFC species was PFOA with 652.65 kg/year. The current concentrations of PFOA and PFOS were at middle level comparing to other studies in China and worldwide. Risk assessment of 6 PFCs showed that there is no risk to the aquatic organisms in Shanghai. PFOS and PFBS had low risk to the avian. Furthermore, the adults living in Shanghai were at low risk to exposure to PFCs through water consumption.				1				B	-		
D338	ばく露	Murakami, M; Shinohara, H; Takada, H	Evaluation of wastewater and street runoff as sources of perfluorinated surfactants (PFSs)	2009	Chemosphere. 2009 Jan:74(4):487-493. doi: 10.1016/j.chemosphere.2008.10.018.	Perfluorinated surfactants (PFSs) in wastewater and street runoff in Japan were measured to determine their pathways of travel and utility as indicators of each to water environments. Among PFS species, perfluorooctanesulfonate (PFOS), perfluorooctanoate (PFOA), and perfluorononanoate (PFNA) were dominant in wastewater. PFS concentrations were higher in secondary effluents than in influents. possibly because of biodegradation of their precursors. This was supported by a significant correlation between concentration increases of PFOA and PFNA. Biodegradation of the same precursors probably produced mainly PFOA and secondarily PFNA. Concentrations of perfluorocarboxylates (PFCAs), especially longer- and even-chain PFCAs, in street runoff were equal to or higher than those in wastewater influents and secondary effluents, but PFOS concentrations were lower in street runoff. This result suggests that street runoff potentially contaminates water environments with PFCAs. In street runoff, perfluorodecanoate (PFDA), perfluoroundecanoate (PFUA), and perfluorododecanoate (PFDDA) were abundant along with PFCA and PFNA. PFS profiles in street runoff were significantly different from those in wastewater samples, suggesting that relative proportions of PFSs can be useful as indicators. Four ratios - PFOA/PFOS, PFNA/PFOS, long-chain/(short-chain + long-chain), and even-chain/(even-chain + odd-chain) - were proposed to evaluate the contributions of PFSs from wastewater and street runoff to water environments.			1					B	-		
D339	ばく露	Lynch, KM; Fair, PA; Houde, M; Muir, DCG; Kannan, K; Bossart, GD; Bartell, SM; Gribble, MO	Temporal Trends in Per- and Polyfluoroalkyl Substances in Bottlenose Dolphins (Tursiops truncatus) of Indian River Lagoon, Florida and Charleston, South Carolina	2019	Environ. Sci. Technol. 2019 Dec:53(24):14194-14203. doi: 10.1021/acs.est.9b04585.	Temporal trends in plasma concentrations of per- and polyfluoroalkyl substances (PFAS) in free-ranging bottlenose dolphins (Tursiops truncatus) inhabiting two geographic areas: Indian River Lagoon, Florida over the years 2003-2015 and the waters surrounding Charleston, South Carolina over 2003-2013, were examined. Nine PFAS met the inclusion criteria for analysis based on percent of values below level of detection and sampling years. Proportionate percentiles parametric quantile regression assuming lognormal distributions was used to estimate the average ratio of PFAS concentrations per year for each chemical. Plasma concentrations decreased over time for perfluorodecanoate (PFDA), perfluorohexane sulfonate (PFHxS), perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), and perfluoroundecanoate (PFUnDA) in both locations. Perfluorononanoate (PFNA) decreased with time in Indian River Lagoon dolphins. Perfluorododecanoate (PFDoDA) concentrations significantly increased over time among female Indian River Lagoon dolphins. Regulation and phaseout of specific PFAS groups may have led to the decreasing levels of those PFAS and increasing levels of other replacement PFAS.			1					B	-		
D340	ばく露	Chropenova, M; Karaskova, P; Kallenborn, R; Greguskova, EK; Cupr, P	Pine Needles for the Screening of Perfluorinated Alkylated Substances (PFASs) along Ski Tracks	2016	Environ. Sci. Technol. 2016 Sep:50(17):9487-9496. doi: 10.1021/acs.est.6b02264.	Perfluorinated alkylated substances (PFASs) are today considered persistent, toxic, and bioaccumulative contaminants. Perfluorooctansulfonate (PFOS) and perfluorooctanoic acid (PFOA) are currently listed as priority substances under the UNEP global convention for the regulation of POPs. A previous study reported higher levels of PFASs in pine needles near ski areas. Their application as stain repellents in modern outdoor clothes and in ski waxes is assumed to be a potential source. Pine trees (Pinus mugo in Slovakia and Pinus sylvestris in Norway) were chosen for sampling in ski resorts. Relative distributions, overall concentrations, trend estimates, elevation patterns, and distance from primary sources were assessed. PFOA was the predominant PFAS constituent in pine needles from Slovakia (8-93%). In Norway, the most-abundant PFAS was perfluorobutanoic acid (PFBA: 3-66%). A difference in product composition (particularly in ski waxes) and differences in Norwegian and Slovakian regulations are considered to be the primary reason for these differences. Open application of PFOA in industry and products has been banned in Norway since 2011. The replacement of PFOA with short-chain substitutes is thus considered the reason for the observed pattern differences in the analyzed pine needles. Regular monitoring and screening programs are recommended.	1							B	-		
D341	ばく露	Kim, JW; Tue, NM; Isobe, T; Misaki, K; Takahashi, S; Viet, PH; Tanabe, S	Contamination by perfluorinated compounds in water near waste recycling and disposal sites in Vietnam	2013	Environ. Monit. Assess. 2013 Apr:185(4):2909-2919. doi: 10.1007/s10661-012-2759-x.	There are very few reports on the contamination by perfluorinated chemicals (PFCs) in the environment of developing countries, especially regarding their emission from waste recycling and disposal sites. This is the first study on the occurrence of a wide range of PFCs (17 compounds) in ambient water in Vietnam, including samples collected from a municipal dumping site (MD), an e-waste recycling site (ER), a battery recycling site (BR) and a rural control site. The highest PFC concentration was found in a leachate sample from MD (360 ng/L). The PFC concentrations in ER and BR (mean, 57 and 16 ng/L, respectively) were also significantly higher than those detected in the rural control site (mean, 9.4 ng/L), suggesting that municipal solid waste and waste electrical and electronic equipment are potential contamination sources of PFCs in Vietnam. In general, the most abundant PFCs were perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluoroundecanoic acid (PFUDA; < 1.4-100, < 1.2-100, and < 0.5-20 ng/L, respectively). Interestingly, there were specific PFC profiles: perfluoroheptanoic acid and perfluorohexanoic acid (88 and 77 ng/L, respectively) were almost as abundant as PFOA in MD leachate (100 ng/L), whereas PFNA was prevalent in ER and BR (mean, 17 and 6.2 ng/L, respectively) and PFUDA was the most abundant in municipal wastewater (mean, 5.6 ng/L), indicating differences in PFC contents in different waste materials.		1	1					B	-		
D342	ばく露	Gao, Y; Fu, JJ; Meng, M; Wang, YW; Chen, BW; Jiang, GB	Spatial distribution and fate of perfluoroalkyl substances in sediments from the Pearl River Estuary, South China	2015	Mar. Pollut. Bull. 2015 Jul:96(1-2):226-234. doi: 10.1016/j.marpolbul.2015.05.022.	In this study, 54 sediment samples were collected from the Pearl River Estuary (PRE) in Southern China to study the spatial distribution and patterns of PFASs in this region. PFAS concentrations in the sediment samples ranged from nd (below detection limit) to 2.41 ng g(-1) dw (dry weight) with an average value of 0.79 ng g(-1) dw. PFAS concentrations were higher at the nearshore sampling sites than in the others. Perfluorobutanesulfonate (PFBS) and perfluorohexanesulfonate (PFHxS) were the two dominant compounds among the target PFASs, which may be due to their production and use as PFOS substitutes in the Pearl River Delta (PRD) areas. Significant linear relationships were found between total PFAS concentrations and total organic carbon (TOC) ($R = 0.30$, $p < 0.05$). The preliminary environmental risk assessment indicated that PFOS and PFOA in the regional sediments posed no significant ecological risk to the benthic organisms at present levels.				1				B	-		
D343	ばく露	Zhang, YY; Lai, SC; Zhao, Z; Liu, FB; Chen, HW; Zou, SC; Xie, ZY; Ebinghaus, R	Spatial distribution of perfluoroalkyl acids in the Pearl River of Southern China	2013	Chemosphere. 2013 Nov:93(8):1519-1525. doi: 10.1016/j.chemosphere.2013.07.060.	An intensive campaign was conducted in September 2012 to collect surface water samples along the tributaries of the Pearl River in southern China. Thirteen perfluoroalkyl acids (PFAAs), including perfluorocarboxylates (PFCAs, C4-C11) and perfluorosulfonates (PFSAs, C4, C6-C8, and C10), were determined using high-performance liquid chromatography/negative electrospray ionization-tandem mass spectrometry (HPLC/(-)ESI-MS/MS). The concentrations of total PFAAs (Sigma PFAAs) ranged from 3.0 to 52 ng L-1, with an average of 19 12 ng L-1. The highest concentrations of Sigma PFAAs were detected in the surface water of the Dong Jiang tributary (17-52 ng L-1), followed by the main stream (13-26 ng L-1) and the Sha Wan stream (3.0-4.5 ng L-1). Perfluorooctanoate (PFOA), perfluorobutane sulfonate (PFBS), and perfluorooctane sulfonate (PFOS) were the three most abundant PFAAs and on average accounted for 20%, 24%, and 19% of EPFAAs, respectively. PFBS was the most abundant PFAA in the Dong Jiang tributary, and PFOA was the highest PFAA in the samples from the main stream of the Pearl River. A correlation was found between PFBS and PFOA, which suggests that both of these PFAAs originate from common source(s) in the region. Nevertheless, the slope of PFBS/PFOA was different in the different tributaries sampled, which indicates a spatial difference in the source profiles of the PFAAs.				1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D344	ばく露	Coggan, TL; Moodie, D; Kolobaric, A; Szabo, D; Shimeta, J; Crosbie, ND; Lee, E; Fernandes, M; Clarke, BO	An investigation into per- and polyfluoroalkyl substances (PFAS) in nineteen Australian wastewater treatment plants (WWTPs)	2019	Heliyon. 2019 Aug;5(8):e02316. doi: 10.1016/j.heliyon.2019.e02316.	Quantifying the emissions of per- and polyfluoroalkyl substances (PFAS) from Australian wastewater treatment plants (WWTP) is of high importance due to potential impacts on receiving aquatic ecosystems. The new Australian PFAS National Environmental Management Plan recommends 0.23 ng L-1 of PFOS as the guideline value for 99% species protection for aquatic systems. In this study, 21 PFAS from four classes were measured in WWTP solid and aqueous samples from 19 Australian WWTPs. The mean Sigma(21)PFAS was 110 ng L-1 (median: 80 ng L-1; range: 9.3-520 ng L-1) in aqueous samples and 34 ng g(-1) dw (median: 12 ng g(-1) dw; range: 2.0-130 ng g(-1) dw) in WWTP solids. Similar to WWTPs worldwide, perfluorocarboxylic acids were generally higher in effluent, compared to influent. Partitioning to solids within WWTPs increased with increasing fluoroalkyl chain length from 0.05 to 1.22 log units. Many PFAS were highly correlated, and PCA analysis showed strong associations between two groups: odd chained PFCAs, PFHxA and PFSAs; and 6:2 FTS with daily inflow volume and the proportion of trade waste accepted by WWTPs (as % of typical dry inflow). The compounds PFPeA, PFHxA, PFHpA, PFOA, PFNA, and PFDA increased significantly between influent and final effluent. The compounds 6:2 FTS and 8:2 FTS were quantified and F-53B detected and reported in Australian WWTP matrices. The compound 6:2 FTS was an important contributor to PFAS emissions in the studied Australian WWTPs, supporting the need for future research on its sources (including precursor degradation), environmental fate and impact in Australian aquatic environments receiving WWTP effluent.								B	-		
D345	ばく露	Gewurtz, SB; Bradley, LE; Backus, S; Dove, A; McGoldrick, D; Hung, H; Dryfhout-Clark, H	Perfluoroalkyl Acids in Great Lakes Precipitation and Surface Water (2006-2018) Indicate Response to Phase-outs, Regulatory Action, and Variability in Fate and Transport Processes	2019	Environ. Sci. Technol. 2019 Aug:53(15):8543-8552. doi: 10.1021/acs.est.9b01337.	The concentrations of perfluoroalkyl acids (PFAAs) were determined in precipitation from three locations across the Great Lakes between 2006 and 2018 and compared to those in surface water. Perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) concentrations generally decreased in precipitation, likely in response to phase-outs/regulatory actions. In comparison, concentrations of shorter-chained PFAA, which are not regulated in Canada did not decrease and those of perfluorohexanoate and perfluorobutanoate (PFBA) recently increased, which could be due to their use as replacements, as the longer-chained PFAAs are being phased-out by industry. PFOS and PFOA concentrations were greater in Lake Ontario precipitation than in precipitation from more remote locations. In comparison, PFBA concentrations were comparable across locations, suggesting greater atmospheric transport either through its more volatile precursors and/or directly in association with particles/aerosols. In Lake Ontario, the comparison of PFAAs in precipitation to those in surface water provides evidence of sources (e.g., street dust and wastewater effluent) in addition to wet deposition to surface water, whereas wet deposition appears to be dominant in Lakes Huron and Superior. Our results suggest that source control of shorter-chained PFAAs may be slow to be reflected in environmental concentrations due to emissions far from the location of detection and continued volatilization from existing in-use products and waste streams.	1	1						B	-		
D346	ばく露	Chen, H; Zhang, C; Han, JB; Sun, RJ; Kong, XY; Wang, XM; He, X	Levels and spatial distribution of perfluoroalkyl substances in China Liaodong Bay basin with concentrated fluorine industry parks	2015	Mar. Pollut. Bull. 2015 Dec:101(2):965-971. doi: 10.1016/j.marpolbul.2015.10.024.	Eighteen different perfluoroalkyl substances (PFASs) were investigated in 35 river water samples and 34 sediment samples collected from rivers in the Liaodong Bay basin containing two fluorine industry parks. Perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS) were the predominant PFASs in freshwater, with median concentrations of 26.5 ng/L and 1.87 ng/L, respectively. However, perfluorobutane sulfonate (PFBS) had the highest maximum concentration (up to 124.1 ng/L, approximately two orders of magnitude higher) in water at a site which is the nearest to the industrial source of PFASs. Total PFASs in water at this site were also the highest. In contrast, PFOA and perfluorooctadecanoate (PFOcDA) were the most abundant PFASs in sediment, with median concentrations of 1.19 ng/g and 035 ng/g, respectively. Total PFAS concentrations in sediment from the site near to the industrial park were significantly higher than the other rivers. Mass loading of total PFASs from the rivers flowing into Liaodong Bay was estimated to be 506 kg/year.				1				B	-		
D347	ばく露	Palmer, K; Bangma, JT; Reiner, JL; Bonde, RK; Korte, JE; Boggs, ASP; Bowden, JA	Per- and polyfluoroalkyl substances (PFAS) in plasma of the West Indian manatee (Trichechus manatus)	2019	Mar. Pollut. Bull. 2019 Mar:140:610-615. doi: 10.1016/j.marpolbul.2019.02.010	Per- and polyfluoroalkyl substances (PFAS) are ubiquitous, synthetic anthropogenic chemicals known to infiltrate and persist in biological systems as a result of their stability and bioaccumulation potential. This study investigated 15 PFAS, including short-chain carboxylic and sulfonic acids, and their presence in a threatened herbivore, the West Indian manatee (Trichechus mantas). Seven of the 15 PFAS examined were detected in manatee plasma. Perfluorooctanesulfonic acid (PFOS) (ranging from 0.13 to 166 ng/g ww) and perfluorononanoic acid (PFNA) (ranging from 0.038 to 3.52 ng/g ww) were detected in every manatee plasma sample examined (n = 69), with differing medians across sampling sites in Florida, Crystal River (n = 39), Brevard County (n = 18), Everglades National Park (n = 8), and four samples (n = 4) from Puerto Rico. With an herbivorous diet and long life-span, the manatee provides a new perspective to monitoring PFAS contamination.			1					B	-		
D348	ばく露	Taniyasu, S; Kannan, K; Horii, Y; Hanari, N; Yamashita, N	A survey of perfluorooctane sulfonate and related perfluorinated organic compounds in water, fish, birds, and humans from Japan	2003	Environ. Sci. Technol. 2003 Jun:37(12):2634-2639. doi: 10.1021/es0303440.	Occurrence of perfluorooctane sulfonate (PFOS) in the tissues of humans and wildlife is well documented. In this study, concentrations and distribution of PFOS, perfluorohexane sulfonate (PFHS), and perfluorobutane sulfonate (PFBS) were determined in samples of surface water, fish and bird blood and livers, and human blood collected in Japan. Notable concentrations of PFOS were found in surface water and fish from Tokyo Bay. PFOS was found in all of the 78 samples of fish blood and liver analyzed. Based on the concentrations of PFOS in water and in fish livers, bioconcentration factors were calculated to range from 274 to 41 600. Concentrations of PFOS in the blood of Japanese human volunteers ranged from 2.4 to 14 ng/mL. PFHS was detected in 33% of the fishes analyzed, at concentrations severalfold less than those of PFOS.				1				B	-		
D349	ばく露	MacGillivray, AR	Temporal Trends of Per- and Polyfluoroalkyl Substances in Delaware River Fish, USA	2021	Integr. Environ. Assess. Manag. 2021 Mar:17(2):411-421. doi: 10.1002/ieam.4342.	Per- and polyfluoroalkyl substances (PFAS) are found in a variety of industrial and household products. Human and wildlife exposure to PFAS is widespread. Increasing evidence suggests adverse effects of PFAS to human health and the environment. Human health risks from exposure through drinking water and fish consumption are areas of concern. Therefore, understanding occurrence and exposure risk is important to protect water resources. PFAS was investigated in fish fillet from the Delaware River over a 15-y period (2004-2018). The sample period coincided with actions to reduce or eliminate the release of certain PFAS to the environment. Elevated levels of perfluorononanoate (PFNA) and perfluoroundecanoate (PFUnA) were initially observed in tidal fish fillet. While significant decreases in PFNA and PFUnA concentrations were observed in fish fillet from the tidal river during the timeframe of the study, changes in concentrations of other PFAS in tidal and nontidal fish were less substantial. In 2018, fish fillet continued to be contaminated with perfluorooctanesulfonate (PFOS) at levels exceeding recommended regional risk advisory limits on fish consumption. Integr Environ Assess Manag 2020;00:1-11.			1					B	-		
D350	ばく露	Shivakoti, BR; Tanaka, S; Fujii, S; Nguyen, PHL; Nozoe, M; Kunacheva, C; Okamoto, R; Seneviratne, STMLD; Tanaka, H	Perfluorinated compounds (PFCs) in Yodo River system, Japan	2011	Water Sci. Technol. 2011 ;63:115-123. doi: 10.2166/wst.2011.020	There is increasing concern about occurrences of perfluorinated compounds (PFCs) in the environment due to their persistent, bioaccumulation, and potentially toxic effects. We investigated contamination of 11 PFCs (C4-C12) in the Yodo River system, which is a major source of drinking water for more than 11 million people of Kansai region in Japan. PFCs were detected in higher concentration even exceeding more than 1000 ng/L in some cases. Composition profile of total PFCs concentration showed that PFOS, PFHxA, PFOA, and PFNA were occurring dominantly in the river system. PFOS and PFOA concentration were nearly proportional to a previous study in the same river system, indicating continuous sink of the compounds into the river system. Although discharge of PFCs from wastewater effluents at upstream could be one of the major point sources, concentration did not exceed 29.4 ng/L at the downstream of main Yodo River, possibly, due to dilution effects. Total mass load of PFCs in mainstream of Yodo River was estimated 451.7 g/d based on observed river discharge and PFCs concentration. Results showed that Yodo River system could have a unique upstream-downstream linkage of PFCs contamination and the river could be a continuous pathway of PFCs exposure to the people of Kansai region.		1	1					B	-		
D351	ばく露	Buljovcic, MB; Antic, IS; Kadokami, K; Skrbic, BD	Temporal trend of perfluorinated compounds in untreated wastewater and surface water in the middle part of the Danube River belonging to the northern part of Serbia	2022	J. Serb. Chem. Soc. 2022;87(12):1425-1437. doi: 10.2298/JSC220427061B.	The occurrence and temporal variation of selected priority substances and contaminants of emerging concerns, i.e., eleven perfluorinated compounds (PFCs, belonging to perfluorosulphonates, perfluorocarboxylic acids, and perfluorinated sulphonamides) have been investigated in composite surface water samples of the Danube River at the upstream and downstream locations from the discharge point of wastewater. Among the analyzed compounds, six PFCs (PFOA, PFOS, PFHxA, PFNA, PFDA and PFUnA) were quantified. Overall, the detection frequency for most quantified compounds was very high (>90 %), only PFDA and PFUnA were quantified with less frequency, 33 and 67 %, respectively. The highest quantified concentrations of PFOA and PFOS were 14.9 ng/L (average 12.1 ng/L) and 14.2 ng/L (average 6.11 ng/L), respectively. These ones together with PFHxA (average 10.0 ng/L) were quantified at the highest concentrations in comparison to the other investigated compounds. However, the determined levels of PFOS during investigated sampling period, for all samples analyzed, were always lower than the maximum allowable concentration set for inland river waters but always higher than the environmental quality standard threshold value-AA-EQS of 0.65 ng/L sets by the Directive of European Parliament. Moreover, the levels of PFOA were always several times lower than the set AA-EQS value.		1	1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D352	ばく露	Wong, F; Shoeib, M; Katsoyiannis, A; Eckhardt, S; Stohl, A; Bohlin-Nizzetto, P; Li, H; Fellin, P; Su, YS; Hung, H	Assessing temporal trends and source regions of per- and polyfluoroalkyl substances (PFASs) in air under the Arctic Monitoring and Assessment Programme (AMAP)	2018	Atmos. Environ. 2018 Jan:172:65-73. doi: 10.1016/j.atmosenv.2017.10.028	Long-term Arctic air monitoring of per- and polyfluoroalkyl substances (PFASs) is essential in assessing their long-range transport and for evaluating the effectiveness of chemical control initiatives. We report for the first time temporal trends of neutral and ionic PFASs in air from three arctic stations: Alert (Canada, 2006-2014); Zeppelin (Svalbard, Norway, 2006-2014) and Andoya (Norway, 2010-2014). The most abundant PFASs were the perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorobutanoic acid (PFBA), and fluorotelomer alcohols (FTOHs). All of these chemicals exhibited increasing trends at Alert with doubling times (t(2)) of 3.7 years (y) for PFOA, 2.9 y for PFOS, 2.5 y for PFBA, 5.0 y for 8:2 FTOH and 7.0 y for 10:2 FTOH. In contrast, declining or non-changing trends, were observed for PFOA and PFOS at Zeppelin (PFOA, half-life, t(1/2) = 7.2 y; PFOS t(1/2) = 67 y), and Andoya (PFOA t(1/2) = 1.9 y; PFOS t(1/2) = 11 y). The differences in air concentrations and in time trends between the three sites may reflect the differences in regional regulations and source regions. We investigate the source region for particle associated compounds using the Lagrangian particle dispersion model FLEXPART. Model results showed that PFOA and PFOS are impacted by air masses originating from the ocean or land. For instance, PFOA at Alert and PFOS at Zeppelin were dominated by oceanic air masses whereas, PFOS at Alert and PFOA at Zeppelin were influenced by air masses transported from land.	1							B	-		
D353	ばく露	Draghi, S; Pavlovic, R; Pellegrini, A; Fidani, M; Riva, F; Brecchia, G; Agradi, S; Arioli, F; Vigo, D; Di Cesare, F; Curone, G	First Investigation of the Physiological Distribution of Legacy and Emerging Perfluoroalkyl Substances in Raw Bovine Milk According to the Component Fraction	2023	Foods. 2023 Jul;12(13):2449. doi: 10.3390/foods12132449.	Simple Summary Bovine milk is important for human nutrition, especially for infants. However, per-fluoroalkyl substances (PFASs) are harmful chemicals that can contaminate milk and pose a threat to both humans and animals. This study evaluated how 14 different PFASs were distributed within milk by analyzing the content of whole milk, skim milk, and cream. Samples were taken from 23 cows in Northern Italy that were not exposed to known sources of PFASs. The most common PFAS found in all three fractions was perfluorobutanoic acid (PFBA), followed by perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). PFOS was found in higher concentrations in cream compared to raw and skimmed milk. Multiparous cows had higher levels of PFASs in their milk. To fully understand the risks of consuming dairy products contaminated with PFASs and their potential impact on cattle health status, further investigation is necessary. Additionally, more studies are needed to uncover the mechanisms behind the excretion of these substances in milk. Bovine milk is a pillar of the human diet and plays a key role in the nutrition of infants. Perfluoroalkyl substances (PFASs) are well-recognized highly stable organic compounds that are able to pollute ecosystems persistently and threaten both human and animal health. The study aimed to analyze the distribution of 14 PFASs within the milk matrix by comparing their content in whole milk, and its skimmed and creamed fractions. Raw milk samples were individually collected from 23 healthy cows (10 primiparous and 13 multiparous) reared on a farm in Northern Italy not surrounded by known point sources of PFASs. Each sample was fractioned in whole, skim, and cream components to undergo PFAS analysis using liquid chromatography-high-resolution mass spectrometry. All samples contained at least one PFAS, with perfluorobutanoic acid (PFBA) being the primary contaminant in all three fractions, followed by perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). PFOS was shown to be significantly ($p < 0.001$) more concentrated in cream than in raw and skimmed milk. Multiparous cows showed a higher frequency of positive samples in all analyzed fractions. Further research is necessary to assess the risk of dairy diets and high-fat dairy products and to investigate the toxicological effects of PFASs on cattle, even in environments without known PFAS sources.	1							B	-		
D354	ばく露	Xu, HY; Zhu, JQ; Lei, C; Xu, XL; Wang, W; Lu, Y; Zhang, DY	The Investigation of Perfluorinated Compounds in Surface Waters of the Xixi Wetland, Hangzhou, China	2016	Bull. Environ. Contam. Toxicol. 2016 Dec:97(6):770-775. doi: 10.1007/s00128-016-1954-9.	The distribution patterns of perfluorinated compounds (PFCs) in the surface waters of Xixi wetland, China, were investigated for the first time. Among the eight PFCs investigated, only perfluorooctanoic acid (PFOA), perfluoroheptanoic acid (PFHpA) and perfluorononanoic acid (PFNA) were detected. PFOA was the most prominent PFC, and detected in all of the samples with higher PFOA concentrations (maximum: 197.8 ng L-1), followed by PFHpA (maximum: 3.97 ng L-1). Geographical differences in PFC levels were not observed among various sampling locations except for the YanShan River location, but seasonal changes have been observed for PFOA. The study suggested that the water diversion project from the Qiantang River to the Xixi Wetland may have significantly contributed to the increase of PFOA level, and that domestic sewage and farmland irrigation runoff are constant pollution sources to the Xixi Wetland.			1					B	-		
D355	ばく露	Zhang, C; Lei, M; Liu, XX; Zhou, ZJ; Liu, MY; Chen, H; Yang, WC; Wang, XM	Presence and inputs of legacy and novel per- and polyfluoroalkyl substances from rivers and drainage outlets to Liaodong Bay, China	2022	Reg. Stud. Mar. Sci. 2022 Nov:56:102684. doi: 10.1016/j.rsma.2022.102684.	Legacy and novel per-and polyfluoroalkyl substance (PFAS) concentrations were measured in 93 water samples from the rivers and drainage outlets to Liaodong Bay, China. The concentrations of Sigma 19PFASs in river water samples ranged from 7.75 ng/L to 750 ng/L. The concentration ranges for municipal wastewater and industrial wastewater samples were 13.9 to 360 ng/L and 30.6 to 73.1 ng/L, respectively. PFOA was the predominant PFAS along the coast of Liaodong Bay, but PFBA was also present in high concentrations in all samples. For the novel PFAS alternatives, the detection frequencies of 6:2 chlorinated polyfluorinated ether sulfonate (6:2 Cl-PFESA) and hexafluoropropylene oxide dimer acid (HFPO-DA) were 43.0% and 55.9%, respectively. The estimated total discharge of Sigma 19PFASs reached 1.7 ton/year in rivers and drainage outlets along Liaodong Bay. River water input accounted for 98.6% of the total input, suggesting that it made a major contribution to PFAS pollution in Liaodong Bay. Capsule: The occurrence of legacy and novel per-and polyfluoroalkyl substances from rivers and drainage outlets directly discharging to Liaodong Bay of China was investigated, and their mass discharges were estimated and compared.	1		1		1			B	-		
D356	ばく露	Kovarova, J; Marsalek, P; Blahova, J; Jurcikova, J; Kasikova, B; Svobodova, Z	Occurrence of Perfluoroalkyl Substances in Fish and Water from the Svitava and Svratka Rivers, Czech Republic	2012	Bull. Environ. Contam. Toxicol. 2012 Mar:88(3):456-460. doi: 10.1007/s00128-011-0484-8.	Perfluoroalkyl substances (PFHxS, FHUEA, PFOA, PFOS, FOSA, N-methyl FOSA and PFNA) from seven sites on the Svitava and Svratka rivers in the Brno conurbation (Czech Republic) were determined in fish blood plasma and water. Concentrations of PFHxS, FHUEA, FOSA, and N-methyl FOSA were below detection limits. Major compound in fish blood was PFOS (38.9-57.8 ng mL(-1)), followed by PFNA and PFOA. In water, the major compound detected was PFOA (1.7-178.0 ng mL(-1)), followed by PFOS and PFNA. A significant ($p < 0.05$) correlation for PFOA concentration in blood plasma and water was found ($r = 0.74$).			1					B	-		
D357	ばく露	Lynch, JM; Ragland, JM; Reagen, WK; Wolf, ST; Malinsky, MD; Ellisor, MB; Moors, AJ; Pugh, RS; Reiner, JL	Feasibility of using the National Marine Mammal Tissue Bank for retrospective exploratory studies of perfluorinated alkyl acids	2018	Sci. Total Environ. 2018 May:624:781-789. doi: 10.1016/j.scitotenv.2017.11.299	Perfluorinated alkyl acids (PFAAs) have been used for 50+ years in materials such as stain-resistant treatments for paper and clothing, lubricants, and foam fire extinguishers. PFAAs are characterized by a fully fluorinated alkyl chain with a terminal acid group. Their long half-lives and ubiquitous environmental distribution create considerable concern for wildlife and human exposure. There is interest in examining temporal trends of PFAAs using the National Marine Mammal Tissue Bank (NMMTB), but NMMTB tissues are frozen and cryohomogenized in polytetrafluoroethylene (PTFE)-based materials. Because PTFE supplies may leach PFAAs into samples, this study mimicked collection, processing and storage steps of NMMTB samples and measured PFAA leaching to determine the feasibility of using this sample archive for PFAA temporal trends. We also explored concentrations in Atlantic white-sided dolphin (Lagenorhynchus acutus, WSDs) and rough-toothed dolphin (Steno bredanensis, RTDs) blubber (n = 3 and 0) and liver (n = 48 and 12, respectively). The materials used in NMMTB protocols may add up to 0.968 ng/g perfluorooctanoic acid (PFOA), 0.090 ng/g perfluorononanoic acid (PNFA), and 0.221 ng/g perfluorooctane sulfonate (PFOS) to each archived sample. Leaching of PFNA and PFOS from supplies compared to dolphin levels was negligible, but PFOA contributions were substantially higher than levels found in most dolphin liver samples. Therefore, monitoring PFOA temporal trends from the NMMTB would require careful consideration. RTDs had significantly higher levels of PFOS and PFNA than WSDs. Both species have similar life history, trophic status, and foraging behaviors in deep pelagic waters, so differences could be from latitudinal variation in contamination. RTDs stranded in Florida; WSDs stranded farther north mostly in Massachusetts. Juveniles had significantly higher levels of PFOS and PFNA than adults in both species, suggesting growth dilution as they approach maturity. PFOS significantly decreased after 2001 in both species as expected based on changes in production. Published by Elsevier B.V.			1					B	-		
D358	ばく露	Barisci, S; Suri, R	Occurrence and removal of poly/perfluoroalkyl substances (PFAS) in municipal and industrial wastewater treatment plants	2021	Water Sci. Technol. 2021 Dec:84(12):3442-3468. doi: 10.2166/wst.2021.484.	The presence of poly- and perfluoroalkyl substances (PFAS) has caused serious problems for drinking water supplies especially at intake locations close to PFAS manufacturing facilities, wastewater treatment plants (WWTPs), and sites where PFAS containing firefighting foam was regularly used. Although monitoring is increasing, knowledge on PFAS occurrences particularly in municipal and industrial effluents is still relatively low. Even though the production of C8-based PFAS has been phased out, they are still being detected at many WWTPs. Emerging PFAS such as GenX and F-53B are also beginning to be reported in aquatic environments. This paper presents a broad review and discussion on the occurrence of PFAS in municipal and industrial wastewater which appear to be their main sources. Carbon adsorption and ion exchange are currently used treatment technologies for PFAS removal. However, these methods have been reported to be ineffective for the removal of short-chain PFAS. Several pioneering treatment technologies, such as electrooxidation, ultrasound, and plasma have been reported for PFAS degradation. Nevertheless, in-depth research should be performed for the applicability of emerging technologies for real-world applications. This paper examines different technologies and helps to understand the research needs to improve the development of treatment processes for PFAS in wastewater streams.					1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D359	ばく露	Gustafsson, A; Bergman, A; Weiss, JM	Estimated daily intake of per- and polyfluoroalkyl substances related to different particle size fractions of house dust	2022	Chemosphere. 2022 Sep;303(Pt 2):135061. doi: 10.1016/j.chemosphere.2022.135061.	Indoor environmental pollutants are a threat to human health. In the current study, we analysed 25 per- and polyfluoroalkyl substances (PFASs) in seven different size fraction of house dust including the two relevant for exposure via ingestion and inhalation. The highest PFAS concentration is found in the inhalable particulate fraction which is explained by the increased surface area as the particulate's sizes decrease. The estimated daily intake (EDI) of the individual PFAS and exposure pathways were calculated for children and adults. In addition, the total EDI for PFOA and its precursors was estimated. The polyfluoroalkyl phosphoric acid diesters (diPAP), followed by PFOA and PFHxA fluortelomer, showed the highest concentrations of PFAS analysed. The cumulative EDI of PFAS for children was 3.0 ng/kg bw per day, a worst-case scenario, which is 17 times higher than the calculated EDI for adults. For children, ingestion of dust was found to result in 800 times higher PFOA exposure than via inhalation. The contribution from PFOA precursors corresponded to only 1% of the EDI from dust indicating PFOA as the main source of exposure. The EDI's of PFOA and PFOS from dust were lower than the calculated EDI's from food ingestion reported by the Swedish Food Agency. Our data indicate that the EDI for the sum of four PFASs: PFOA, PFNA, PFHxS and PFOS from dust intake alone is close to the established tolerable weakly intake of 4.4 ng/kg bw in children, set by European Food Safety Authority (EFSA) in 2020. The combined EDI levels PFOA and PFOS from both dust and food exceeded the EFSA TWI for both children and adults. This study demonstrates that dust is a relevant exposure pathway for PFAS intake and that analysis of relevant particle size fractions is important for evaluation of dust as an exposure pathway.		1	1					B	-		
D360	ばく露	Kumar, E; Koponen, J; Rantakokko, P; Airaksinen, R; Ruokojarvi, P; Kiviranta, H; Vuorinen, PJ; Myllyla, T; Keina, M; Raitaniemi, J; Mannio, J; Junttila, V; Nieminen, J; Vena, ER; Jestoi, M	Distribution of perfluoroalkyl acids in fish species from the Baltic Sea and freshwaters in Finland	2022	Chemosphere. 2022 Mar;291(Pt 3):132688. doi: 10.1016/j.chemosphere.2021.132688.	Occurrence and distribution of perfluoroalkyl acids (PFAAs), a sub-category of per- and polyfluoroalkyl substances (PFASs), is widespread in the environment. Food, especially fish meat, is a major pathway via which humans are exposed to PFAAs. As fish is an integral part of Nordic diet, therefore, in this study, several fish species, caught in selected Baltic Sea basins and freshwater bodies of Finland, were analysed for PFAAs. Perfluorooctane sulfonate (PFOS) was detected in all Baltic Sea fish samples and in >80% fish samples from freshwaters. PFOS contributed between 46 and 100% to the total PFAA concentration in Baltic Sea fish samples and between 19 and 28% in fish samples from freshwaters. Geographically, concentration ratios of PFOS to other PFAAs differed between fish from the Baltic Sea and Finnish lakes suggesting that distribution of PFAAs differ in these environments. Results were compared with current safety thresholds - environmental quality standard for biota (EQSbiota) set by the European Commission and a group tolerable weekly intake (TWI) for the sum of four PFASs (n-ary sumation PFAS-4) i.e. perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS) and PFOS, recommended by the European Food Authority (EFSA). EQSbiota compliance was observed for PFOS in all species except smelt caught in the Baltic Sea and also in the River Aurajoki, where smelt had migrated from the Baltic Sea for spawning. Moderate consumption of most Baltic fishes (200 g week-1) results in an exceedance of the new TWI (4.4 ng kg- 1 body weight week-1) for n-ary sumation PFAS-4.			1					B	-		
D361	ばく露	Xu, FP; Chen, D; Liu, XT; Guan, QX; Tan, HL; Zhou, DM; Shi, YM; Liu, J; Hu, YX	Emerging and legacy per- and polyfluoroalkyl substances in house dust from South China: Contamination status and human exposure assessment	2021	Environ. Res. 2021 Jan:192:110243. doi: 10.1016/j.envres.2020.110243.	Our study investigated a large variety of perand polyfluoroalkyl substances (PFASs) in house dust collected from Guangzhou, South China during 2015-2018. The perfluorobutane sulfonic acid (PFBS) exhibited the highest median concentration (17.6 ng/g), followed by linear perfluorooctanoic acid (L-PFOA; 4.8 ng/g), linear perfluorooctane sulfonic acid (L-PFOS; 4.2 ng/g), 6:2 fluorotelomer phosphate diester (6:2 diPAP; 3.4 ng/g), perfluorodecanoic acid (PFDA; 1.2 ng/g) and perfluoroundecanoic acid (PFUdA; 1.2 ng/g), and 6:2 chlorinated perfluoroalkyl ether sulfonic acid (6:2 Cl-PFESA; 1.1 ng/g). Total concentrations of PFASs (median: 53 ng/g) were generally within the 25-50 percentile of the concentration range reported in global studies. However, our samples exhibited composition profiles different from those reported in many other regions. Analysis based on this and previous studies revealed that the compositions in house dust from East Asia, North America, and Europe exhibit a region-specific pattern. This may indicate region-specific market demands, application patterns, as well as associated human exposure risks. Exploration of dwelling characterizations suggested that renovation history appeared to be a significant factor influencing PFAS concentrations in house dust, although other factors may exist and play a role. Estimation of daily intakes via dust ingestion and dermal contact indicates low exposure risks from these two pathways. However, the PFAS chemical-specific biological effects, possible mixture effects, as well as additional exposure pathways, imply that the risk from indoor PFAS exposure should not be overlooked.				1				B	-		
D362	ばく露	Christensen, ER; Zhang, RJ; Codling, G; Giesy, JP; Li, A	Poly- and per-fluoroalkyl compounds in sediments of the Laurentian Great Lakes: Loadings, temporal trends, and sources determined by positive matrix factorization	2019	Environ. Pollut.2019 Dec;255(Pt 2):113166. doi: 10.1016/j.envpol.2019.113166.	A recent data set for 22 poly- and per-fluorinated compounds (PFASs) in Ponar grab samples of surface sediments and cores from the Great Lakes of North America was examined for concentrations, loads, correlations with geographical coordinates and depth (time), and for sources. Correlations were determined by multivariate regression analyses. Source apportionment of PFASs was carried out by positive matrix factorization (PMF) for two cores from Lake Ontario. For the five lakes together, the total load of PFASs in sediments was estimated to be 245 +/- 24 tonnes, which is about half the load for total PCBs. The recent annual loading was 1812 +/- 320 kg/yr. Concentrations and inventories of PFASs were greatest in Lakes Erie and Ontario. Since 1947, concentrations of perfluorooctane sulfonic acid (PFOS) in ten cores have increased exponentially as a function of time with doubling times between 10 and 54 yr and have leveled off in three cores since 2000. PMF demonstrated an effective grouping of two particle-associated factors, characterized mainly by longer-chain PFASs (C >= 8) and two other factors of mainly shorter-chain compounds (C <= 6). Two factors feature only one dominant compound: factor 1, PFOS, and factor 3, perfluorobutane sulfonic acid (PFBS). Of all factors, factor 3 with PFBS has the largest contribution (47.8%). Significant scores for perfluorohexane sulfonic acid (PFHxS) and PFBS, along with flat or decreasing PFOS contributions since 2003, indicate that the replacement of PFOS with these compounds is beginning to take effect in the environment.				1				B	-		
D363	ばく露	Wang, JM; Shi, YL; Pan, YY; Cai, YQ	Perfluorinated compounds in milk, milk powder and yoghurt purchased from markets in China	2010	Chin. Sci. Bull. 2010 Apr:55(11):1020-1025. doi: 10.1007/s11434-010-0055-0.	The exposure to perfluorinated compounds (PFCs) through the diet for humans is of great concern. Among the diet, dairy products are in great demand. This paper reports the study on the levels of 9 perfluorinated acids and 2 fluorotelomer acids in milk, milk powder and yoghurt purchased from Chinese markets from 2008 to 2009. The analytes were quantitated by high performance liquid chromatography/electrospray tandem mass spectrometry (HPLC-ESI-MS/MS). In milk samples, perfluoroheptanoic acid (PFHpA) and perfluorononanoic acid (PFNA) were detected frequently, both in 68% of samples. In milk powder samples, perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and PFNA were the only detected PFCs and none of them was observed in more than 35% of samples. In yoghurt, PFOA was the most frequently detected compound, found in 69% of samples. None of fluorotelomer acids was observed in any samples. The mean concentrations of total PFCs were 178 pg/g (wet weight) in milk, 98 pg/g (dry weight) in milk powder and 42 pg/g in yoghurt (wet weight). It is notable that the data of this study indicate significant differences ($P < 0.001$) among three kinds of packaging of milk in the concentration of total PFCs. A preliminary human health risk assessment of milk and dairy products consumption was conducted in this study. For adults, the mean daily intake of PFOS and total PFCs was equal to or lower than 23 and 167 pg kg(-1) d(-1) (body weight), respectively.			1					B	-		
D364	ばく露	Hoa, NTQ; Lieu, TT; Anh, HQ; Huong, NTA; Nghia, NT; Chuc, NT; Quang, PD; Vi, PT; Tuyen, LH	Perfluoroalkyl substances (PFAS) in freshwater fish from urban lakes in Hanoi, Vietnam: concentrations, tissue distribution, and implication for risk assessment	2022	Environ. Sci. Pollut. Res. 2022 Jul:29(34):52057-52069. doi: 10.1007/s11356-022-19532-0.	Concentrations and profiles of 17 perfluoroalkyl substances (PFAS) including 13 perfluorocarboxylic acids (PFA) and 4 perfluoroalkyl sulfonates (PFS) were determined in whole blood, muscle, and liver samples of four freshwater fish species in West Lake and Yen So Lake (Hanoi, Vietnam). Concentrations of total 17 PFAS in fish blood samples ranged from 5.2 to 29 (median 16) ng/mL. Total 17 PFAS levels in liver samples (4.5; 2.7-6.6 ng/g wet weight) were significantly higher than in muscle samples (1.0; 0.51-2.6 ng/g wet weight). More than 90% PFAS burdens in our fish samples were attributed to muscle and blood rather than liver, but contributions of individual compounds varied greatly. The most predominant substances were perfluorooctanesulfonate (PFOS) and PFA with chain lengths from C10 to C14 (i.e., PFDA, PFUnDA, PFDoDA, PFTrDA, and PFTeDA). There is no significant difference in PFAS concentrations between the studied species (i.e., bighead carp, common carp, rohu, and tilapia), but common carp showed specific PFAS profiles as compared to other species (e.g., higher proportions of PFOS and long-chain PFA such as PFTrDA, PFTeDA, and PFHxDA). Daily intake doses of PFOS and perfluorooctanoic acid (PFOA) through fish consumption were markedly lower than the US EPA reference dose of 20 ng/kg/day. Weekly intakes of the sum of PFHxS, PFOS, PFOA, and PFNA in our study were still lower than the EFSA tolerable weekly intake of 4.4 ng/kg/week.			1					B	-		
D365	ばく露	Surma, M; Sznajder-Katarzynska, K; Wiczkowski, W; Zielinski, H	Assessment of Bioactive Surfactant Levels in Selected Cereal Products	2022	Appl. Sci.-Basel. 2022 May;12(10):5242. doi: 10.3390/app12105242.	Per- and polyfluoroalkyl substances (PFASs) are bioactive surfactants that are widespread in the environment and living organisms. This study presents measurements of PFAS in selected food of plant origin that are part of the healthy eating pyramid, including bread, rolls, flour, bran, buckwheat, millet, rice, and noodles. A simple and reliable analytical method was developed for the simultaneous determination of seven perfluorocarboxylic acids (PFCAs) and three perfluoroalkane sulfonates (PFSAs) in cereal-based products. Out of the 10 PFASs, 5 PFASs were detected at levels above LOQ. The most frequently detected compound was perfluorooctanoic acid (PFOA), which was quantified in 65.2% of samples, while none of the others were present in more than 40.0% of tested products. Perfluorobutanoic acid (PFBA) was the predominant PFAS in cereal-based products, and its maximum measured concentration was 202.85 ng/g for wheat bran. The soil-root-shoot interactions in relation to PFAS transfer to the above-ground parts of plants and PFAS's ability to interfere with proteins are most likely the sources of these compounds in commonly consumed cereal products. As PFBA contributes greatly to total PFAS concentration, this food group should be included in future dietary exposure assessments.	1							B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D366	ばく露	He, XM; Li, AM; Wang, SY; Chen, H; Yang, ZX	Perfluorinated substance assessment in sediments of a large-scale reservoir in Danjiangkou, China	2018	Environ. Monit. Assess. 2018 FEB;190(2):66. doi: 10.1007/s10661-017-6439-8.	The occurrence of eight perfluorinated compounds (PFCs) in the surface sediments from 10 sampling sites spread across the Danjiangkou Reservoir was investigated by isotope dilution ultra-high-performance liquid chromatography-tandem mass spectrometry (UPLC-MS/MS) after solid-phase extraction (SPE). All the sediments from the 10 sites contained detectable levels of PFCs. The total concentration of the target PFCs in each sediment sample (C-Sigma PFCs) ranged from 0.270 to 0.395 ng g(-1) of dry weight, and the mean value of C-Sigma PFCs was 0.324 +/- 0.045 ng g(-1) of dry weight for the whole reservoir. For each perfluorinated compound in one sediment, perfluorooctane sulfonate (PFOS) or perfluoro-n-butanoic acid (PFBA) consistently had a higher concentration than the other six PFCs, while perfluoro-n-octanoic acid (PFOA) was always undetectable. In terms of spatial distribution, the total and individual concentrations of PFCs in sediment from downstream sites of the Danjiangkou Reservoir were higher than those from upstream sites. Factor analysis revealed that PFCs in the sediment samples originated from electroplating and anti-fog agents in industry, food/pharmaceutical packaging and the water/oil repellent paper coating, and the deposition process. The quotient method was utilized to assess the ecological risk of PFCs in the sediments of the Danjiangkou Reservoir, which showed that the concentrations of PFCs were not considered a risk. In this study, detailed information on the concentration level and distribution of PFCs in the sediments of the Danjiangkou Reservoir, which is the source of water for the Middle Route Project of the South-to-North Water Transfer Scheme in China, was reported and analyzed for the first time. These results can provide valuable information for water resource management and pollution control in the Danjiangkou Reservoir.	1							B	-		
D367	ばく露	Hu, XDC; Tokranov, AK; Liddie, J; Zhang, XM; Grandjean, P; Hart, JE; Laden, F; Sun, Q; Yeung, LWY; Sunderland, EM	Tap Water Contributions to Plasma Concentrations of Poly- and Perfluoroalkyl Substances (PFAS) in a Nationwide Prospective Cohort of US Women	2019	Environ. Health Perspect. 2019 Jun;127(6):67006. doi: 10.1289/EHP4093.	BACKGROUND: Between 2013 and 2015, concentrations of poly- and perfluoroalkyl substances (PFAS) in public drinking water supplies serving at least six million individuals exceeded the level set forth in the health advisory established by the U.S. Environmental Protection Agency. Other than data reported for contaminated sites, no systematic or prospective data exist on the relative source contribution (RSC) of drinking water to human PFAS exposures. OBJECTIVES: This study estimates the RSC of tap water to overall PFAS exposure among members of the general U.S. population. METHODS: We measured concentrations of 15 PFAS in home tap water samples collected in 1989-1990 from 225 participants in a nationwide prospective cohort of U.S. women: the Nurses' Health Study (NHS). We used a one-compartment toxicokinetic model to estimate plasma concentrations corresponding to tap water intake of PFAS. We compared modeled results with measured plasma PFAS concentrations among a subset of 110 NHS participants. RESULTS: Tap water perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) were statistically significant predictors of plasma concentrations among individuals who consumed >= 8 cups of tap water per day. Modeled median contributions of tap water to measured plasma concentrations were: PFOA 12% (95% probability interval 11%-14%), PFNA 13% (8.7%-21%), linear perfluorooctanesulfonic acid (nPFOS) 2.2% (2.0%-2.5%), branched perfluorooctanesulfonic acid (brPFOS) 3.0% (2.5%-3.2%), and perfluorohexanesulfonic acid (PFHxS) 34% (29%-39%). In live locations, comparisons of PFASs in community tap water collected in the period 2013-2016 with samples from 1989-1990 indicated increases in quantifiable PFAS and extractable organic fluorine (a proxy for unquantified PFAS). CONCLUSIONS: Our results for 1989-1990 compare well with the default RSC of 20% used in risk assessments for legacy PFAS by many agencies. Future evaluation of drinking water exposures should incorporate emerging PFAS.			1				1	A	-	幅広い調査により、血漿中のPFAS濃度への水道水の寄与を評価した論文で、有用な知見を提供していると考えられたため	
D368	ばく露	Lu, GH; Shao, PW; Zheng, Y; Yang, YL; Gai, N	Perfluoroalkyl Substances (PFASs) in Rivers and Drinking Waters from Qingdao, China	2022	Int. J. Environ. Res. Public Health. 2022 May;19(9):5722. doi: 10.3390/ijerph19095722.	Perfluoroalkyl substances (PFASs) in rivers; drinking water sources (reservoirs and groundwater); and various types of drinking waters (tap waters, barreled pure waters, and bottled mineral waters) in Qingdao, Eastern China were quantified by high-performance liquid chromatography tandem mass spectrometry (HPLC-MS/MS). The total concentrations of PFASs (sigma PFASs) in the river waters ranged from 28.3 to 292.2 ng/L, averaging 108 +/- 70.7 ng/L. PFBS was the most abundant compound, with a maximum concentration of 256.8 ng/L, followed by PFOA (maximum concentration: 72.4 ng/L) and PFBA (maximum concentration: 41.6 ng/L). High levels of PFASs were found in rivers in the suburban and rural areas. The estimated annual mass loading of the total PFASs to Jiaozhou Bay (JZB) was 5.9 tons. The PFASs in the drinking water reservoirs were relatively low. The sigma PFASs in the tap water ranged from 20.5 ng/L to 29.9 ng/L. Differences in the PFAS levels and composition profiles were found among barreled water at different market sites and for different brands of mineral water products. The sequence of the contamination levels of the waters related to drinking water was reservoir water > tap water > barrel water > groundwater > bottled mineral water. The PFASs in drinking water may not pose a serious risk to the drinking water consumers of Qingdao City.	1			1				B	-		
D369	ばく露	Cao, XZ; Xin, SH; Liu, XX; Wang, SL	Occurrence and behavior of per- and polyfluoroalkyl substances and conversion of oxidizable precursors in the waters of coastal tourist resorts in China	2023	Environ. Pollut.2023 Jan;316(Pt 1):120460. doi: 10.1016/j.envpol.2022.120460.	Per-and polyfluorolkyl substances (PFAS) were measured in the water and fish from 20 coastal tourist resorts in China, to investigate their sources, seasonal differences, and bioconcentration. An oxidative method with hy-droxyl radicals was used to extract potential perfluoroalkyl acid (PFAA) precursors in the water of resorts. The results indicated that the total concentrations of target chemicals (i.e., sigma PFAS) in the original water were 59.4-138, 32.7-77.2, and 14.6-29.9 ng L-1 in December, April, and August, respectively. C4-C10 per-fluorocarboxlate (PFCA) and perfluorooctane sulfonate (PFOS) accounted for 67%-92% of the sigma PFAS contents in all water samples. The PFAS concentrations in the muscles and liver of fish were 16.0-162 ng g(-1) ww and 186-1240 ng g(-1) ww, respectively. The dominant compounds were perfluorobutanoate acid (PFBA) and PFOS in the water, and perfluorooctanoic acid (PFOA) and PFOS in fish tissues. High bioconcentration were observed for PFCA (C >= 8) and perfluorosulfonate (PFSA, C >= 6). After oxidative conversion, the water exhibited a noticeable increase in the sigma PFAS value. Precursors that generated C4-C9 PFCA were more prevalent than precursors that generated other PFCA upon oxidation. The concentration of C8-based precursor was higher than that of C6-based precursor in wet and dry seasons. This study is the first to apply an oxidative method to investigate PFAS pollution in the water of coastal tourist resorts. The results verified that PFAA precursors exist in the water of coastal tourist resorts, and more attention should be given to the existence of PFAA precursors and the safety of water in coastal tourist resorts.	1							B	-		
D370	ばく露	Ren, J; Yu, MJ; Chen, F; Cui, L; Zhang, YZ; Li, JM; Chen, MK; Wang, XP; Fu, JJ	Occurrence, spatial heterogeneity, and risk assessment of perfluoroalkyl acids (PFAAs) in the major rivers of the Tibetan Plateau	2023	Sci. Total Environ.2023 Jan;856(Pt 1):159026. doi: 10.1016/j.scitotenv.2022.159026.	The Tibetan Plateau (TP) is home to the headwaters of major rivers in Asia, yet their water quality security on a large spatial scale is scarcely studied, especially in regard to emerging organic pollutants. In this study, a systematic field campaign was carried out along Yarlung Tsangpo River, Nu River, Lancang River and Jinsha River, and 13 perfluoroalkyl acids (PFAAs) were analyzed. The total concentrations of PFAAs in the river waters of the TP were in the range of 0.58-7.46 ng/L, containing a high proportion of perfluorobutanoic acid (PFBA) and perfluorobutane sulfonate (PFBS) with average values of 56.7 %. Elevated PFAA loadings were found for the midstream of Yarlung Tsangpo River in central Tibet. Geodetector results indicated that precipitation, solar radiation and vegetation type were the top three influential factors contributing to the observed spatial heterogeneity. When interactions with human activities were taken into account, the explanatory power was significantly enhanced and rose above 0.70, highlighting the increased risks for TP rivers from the combined effects of natural environments and anthropogenic activities. Risk assessments suggest a low risk is posed to the alpine aquatic ecosystems and human health. The discharge fluxes of PFAAs via riverine export were estimated at 94-425 kg/year, which is one to two orders of magnitude lower than their mass loadings in major rivers worldwide. Our study underlined the need for further attention to the increased risk of water resource quality on the central TP in the context of long-range transport, increased cryosphere melting and local emission.	1			1				B	-		
D371	ばく露	Zhou, JQ; Baumann, K; Surratt, JD; Turpin, BJ	Legacy and emerging airborne per- and polyfluoroalkyl substances (PFAS) collected on PM2.5 filters in close proximity to a fluoropolymer manufacturing facility	2022	Environ. Sci.-Process Impacts 2022 Dec:24(12):2272-2283. doi: 10.1039/d2em00358a.	Large fluoropolymer manufacturing facilities are major known sources of per- and polyfluoroalkyl substances (PFAS), many of which accumulate in groundwater, surface water, crops, wildlife, and people. Prior studies have measured high PFAS concentrations in groundwater, drinking water, soil, as well as dry and wet deposition near fluoropolymer facilities; however, much less is known about near-source PFAS air concentrations. We measured airborne PFAS on PM2.5 filters in close proximity to a major fluoropolymer manufacturing facility (Chemours' Fayetteville Works) located near Fayetteville, North Carolina, USA. Weekly PM2.5 filter samples collected over a six-month field campaign using high-volume air samplers at locations 3.7 km apart, north-northeast and south-southwest of the facility were analyzed for thirty-four targeted ionic PFAS species by liquid chromatography coupled to electrospray ionization tandem mass spectrometry. Twelve emerging and ten legacy PFAS compounds were detected. Thirteen PFAS were found at higher concentrations in these nearfield samples than at regional background sites, suggesting a local source for these compounds. Five emerging and five legacy PFAS compounds had maximum concentrations exceeding 1 pg m(-3). PFBA, PFHxA, PFHxDA, PFOS, PMPA, NVHOS, PFO5DoA, and Nafion BP1 contributed the most to the total (legacy + emerging) PFAS concentration (86%). Six PFAS, specifically PFBA, PFOS, PFO5DoA, Nafion BP1, Nafion BP2, and Nafion BP4, provide a consistent representative profile of elevated species across the two sites (with detection frequency >50%). To our knowledge, this is the first study to report both legacy and emerging ionic PFAS in air in close proximity to a U.S. fluoropolymer manufacturing facility.	1	1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D372	ばく露	Liu, S; Liu, ZY; Tan, WF; Johnson, AC; Sweetman, AJ; Sun, XY; Liu, Y; Chen, C; Guo, H; Liu, HY; Wan, X; Zhang, LM	Transport and transformation of perfluoroalkyl acids, isomer profiles, novel alternatives and unknown precursors from factories to dinner plates in China: New insights into crop bioaccumulation prediction and risk assessment	2023	Environ. Int. 2023 Feb:172:107795. doi: 10.1016/j.envint.2023.107795.	Perfluoroalkyl acids (PFAAs) are contaminants of global concern, and the inadvertent consumption of PFAA-contaminated crops may pose a threat to public health. Therefore, systematically studying their source tracing, bioaccumulation prediction and risk assessments in crops is an urgent priority. This study investigated the source apportionment and transport of PFAAs and novel fluorinated alternatives (collectively as per- and polyfluoroalkyl substances, PFASs) from factories to agricultural fields in a fluorochemical industrial region of China. Furthermore, bioaccumulation specificities and prediction of these chemicals in different vegetables were explored, followed by a comprehensive risk assessment from agricultural fields to dinner plates which considered precursor degradation. A positive matrix factorization model revealed that approximately 70 % of PFASs in agricultural soils were derived from fluorochemical manufacturing and metal processing. Alarming levels of n-ary sumation PFASs ranged 8.28-84.3 ng/g in soils and 163-7176 ng/g in vegetables. PFAS with short carbon chain or carboxylic acid group as well as branched isomers exhibited higher environmental transport potentials and bioaccumulation factors (BAFs) across a range of vegetables. The BAFs of different isomers of perfluorooctanoic acid (PFOA) decreased as the perfluoromethyl group moved further from the acid functional group. Hexafluoropropylene oxide dimer acid (GenX) showed relatively low BAFs, probably related to its ether bond with a high affinity to soil. Vegetables with fewer Casparian strips (e.g., carrot and radish), or more protein, possessed larger BAFs of PFASs. A bioaccumulation equation integrating critical parameters of PFASs, vegetables and soils, was built and corroborated with a good contamination prediction. After a total oxidizable precursors (TOP) assay, incremental perfluoroalkyl carboxylic acids (PFCAs) were massively found (325-5940 ng/g) in edible vegetable parts. Besides, precursor degradation and volatilization loss of PFASs was firstly confirmed during vegetable cooking. A risk assessment based on the TOP assay was developed to assist the protection of vegetable consumers.					1			B	-		
D373	ばく露	Arvaniti, OS; Ventouri, EI; Stasinakis, AS; Thomaidis, NS	Occurrence of different classes of perfluorinated compounds in Greek wastewater treatment plants and determination of their solid-water distribution coefficients	2012	J. Hazard. Mater. 2012 Nov:239:24-31. doi: 10.1016/j.jhazmat.2012.02.015	The concentrations of eighteen perfluorinated compounds (PFCs: C5-C14 carboxylates, C4, C6-C8 and C10 sulfonates and 3 sulfonamides) were determined in wastewater and sludge samples originating from two different wastewater treatment plants (WWTPs). The analytes were extracted by solid phase extraction (dissolved phase) or sonication followed by solid phase extraction (solid phase). Qualitative and quantitative analyses were performed by LC-MS/MS. According to the results, perfluoropentanoic acid (PFPeA), perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) were dominant in wastewater and sludge samples from both plants. The average concentrations in the raw and treated wastewater ranged up to 75.7 ng L-1 (perfluorotridecanoic acid, PFTrDA) and 76.0 ng L-1 (PFPeA), respectively. Concentrations of most PFCs were higher in effluents than in influents, indicating their formation during wastewater treatment processes. In sewage sludge, the average concentrations ranged up to 6.7 ng g(-1) dry weight (PFOS). No significant seasonal variations in PFCs concentrations were observed, while higher concentrations of PFOA, PFOS and perfluorononanoic acid (PFNA) were determined in the WWTP receiving municipal and industrial wastewater. Significantly different distribution coefficient (K-d) values were determined for different PFCs and different type of sludge, ranging between 169 L kg(-1) (PFHxS) to 12,922 L kg(-1) (PFDA).			1					B	-		
D374	ばく露	Cui, QQ; Shi, FL; Pan, YT; Zhang, HX; Dai, JY	Per- and polyfluoroalkyl substances (PFASs) in the blood of two colobine monkey species from China: Occurrence and exposure pathways	2019	Sci. Total Environ. 2019 Jul:674:524-531. doi: 10.1016/j.scitotenv.2019.04.118	Per-/polyfluoroalkyl substances (PFASs), which are widely used in industrial and commercial products, have been identified as global and ubiquitous pollutants. Despite this, limited data are available regarding the impacts of PFAS exposure and intake in non-human primates. Here, we report for the first time on the occurrence of PFASs in the blood and dietary sources of two rare and endangered primate species, namely, the golden snub-nosed monkey (Rhinopithecus roxellana) and Francois' leaf monkey (Trachypithecus francoisi). Results showed that perfluorooctanoate (PFOA) and perfluorononanoate (PFNA) were dominant and found at the highest proportions in the blood of both species at the four study sites. The Sigma PFAS levels in blood samples from captive golden snub-nosed monkeys in Tongling Zoo (mean: 2.51 ng/mL) and Shanghai Wild Zoo (3.52 ng/mL) near urbanized areas were one order of magnitude higher than the levels in wild monkeys from Shennongjia Nature Reserve (0.27 ng/mL). Furthermore, significant age positive relationships for perfluorodecanoic acid (PFDA), perfluorooctane sulfonate (PFOS), and 6:2 chlorinated polyfluorinated ether sulfonates (6:2 Cl-PFESA) were observed in both golden snub-nosed monkeys at Shanghai Wild Zoo and Francois' leaf monkeys at Wuzhou Breeding Center. In addition, PFAS levels in frequently consumed food and drinking water were analyzed for Francois' leaf monkeys. Results showed that tree leaves accounted for the highest percentage of total daily intake of PFASs, especially PFOA, thus highlighting tree leaf consumption as a primary PFAS exposure route for this species. Overall, however, dietary exposure to PFASs was of relatively low risk to Francois' leaf monkey health.			1					B	-		
D375	ばく露	Su, HQ; Shi, YJ; Lu, YL; Wang, P; Zhang, M; Sweetman, A; Jones, K; Johnson, A	Home produced eggs: An important pathway of human exposure to perfluorobutanoic acid (PFBA) and perfluorooctanoic acid (PFOA) around a fluorochemical industrial park in China	2017	Environ. Int. 2017 Apr:101:1-6. doi: 10.1016/j.envint.2017.01.016	Dietary intake is considered to be a major pathway of human exposure to perfluoroallcyl adds (PFAAs). Chicken egg is an important contributor to the Chinese diet. In the present study, PFAAs in home produced eggs (HPEs) and commercially produced eggs (CPEs) surrounding a fluorochemical industrial park (HP) in China were investigated. PFAAs in HPEs decreased with increasing distance from the FIP. HPEs were much more Contaminated than CPEs, with PFAAs in CPEs comparable to or lower than those in HPEs from 20 km away from the FIP. PFOA concentrations in HPEs were higher than the levels of PFOA in eggs from other studies reported so far. For the first time, PFBA was reported in eggs and detected in all egg samples. PFOA and PFBA were the predominant forms in HPEs, while PFOA, PFBA and PFOS dominated in CPEs. For PFOA, estimated daily intakts (EDI) were 233 ng/kg.bw/day for adults and 657 ng/kg.bw/day for children who consume HPEs at households about 2 km away from the FIP. The EDI of PFOA for children via HPEs exceeded the reference dose value (333 ng/kg.bw/day) proposed by the Environmental Working Group.	1							B	-		
D376	ばく露	Riget, F; Bossi, R; Sonne, C; Vorkamp, K; Dietz, R	Trends of perfluorochemicals in Greenland ringed seals and polar bears: Indications of shifts to decreasing trends	2013	Chemosphere. 2013 Nov:93(8):1607-1614. doi: 10.1016/j.chemosphere.2013.08.015.	Time-series of perfluorinated alkylated substances (PFASs) in East Greenland polar bears and East and West Greenland ringed seals were updated in order to deduce whether a response to the major reduction in perfluoroalkyl production in the early 2000s had occurred. Previous studies had documented an exponential increase of perfluorooctane sulphonate (PFOS) in liver tissue from both species. In the present study, PFOS was still the far most dominant compound constituting 92% (West Greenland ringed seals), 88% (East Greenland ringed seals) and 85% (East Greenland polar bears). The PFOS concentrations increased up to 2006 with doubling times of approximately 6 years for the ringed seal populations and 14 years in case of polar bears. Since then a rapid decrease has occurred with clearing half-lives of approximately 1, 2 and 4 years, respectively. In polar bears perfluorohexane sulphonate (PFHxS) and perfluorooctane sulphonamide (PFOSA) also showed decreasing trends in recent years as do perfluorodecanoic acid (PFDA) and perfluoroundecanoic acid (PFUnA). For the West Greenland ringed seal population perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), PFDA and PFUnA peaked in the mid 2000s, whereas PFNA, PFDA and PFUnA in the East Greenland population have been stable or increasing in recent years. The peak of PFASs in Greenland ringed seals and polar bears occurred at a later time than in Canadian seals and polar bears and considerably later than observed in seal species from more southern latitudes. We suggest that this could be explained by the distance to emission hot-spots and differences in long-range transport to the Arctic.			1					B	-		
D377	ばく露	Eze, CT; Otitoloju, AA; Eze, OO; Ugochukwu, TE; Onodugo, C; Ali, AM; Lyche, JL; Karlsen, OA; Goksoyr, A	West African e-waste-soil assessed with a battery of cell-based bioassays	2023	Sci. Total Environ.2023 Jan;856(Pt 1):159068. doi: 10.1016/j.scitotenv.2022.159068.	Soil samples randomly taken from major e-waste sites in West Africa (Nigeria, Benin and Ghana) were examined for an extensive range of organic contaminants. Cytotoxicity measurements and assessment of activation of xeno-sensing re-ceptors from fish (Atlantic cod) were employed as a battery of in vitro biological assays to explore the quality and tox-icity profile of West African e-waste soil. The concentrations of the measured contaminants of emerging concerns (CECs) and persistent organic pollutants (POPs) in the e-waste soil differs significantly from the reference soil with chemical profiles typically dominated by legacy polybrominated diphenyl ethers (PBDEs) (405.8 mu gkg-1) and emerg-ing organophosphate ester flame retardant tris (1-chloro-2-propyl) phosphate (TCPP) (404 mu gkg-1), in addition to the short chain perfluorobutane sulfonate (PFBS) (275.3 mu gkg-1) and perfluorobutanoate (PFBA) (16 mu gkg-1). The study revealed that perfluorooctanoic acid (PFOA) occurred only in e-waste soil from Ghana and ranged from 2.6 to 5.0 mu gkg-1. Overall, non-polar e-waste soil-derived extracts had a stronger effect on COS-7 cell viability than the polar ex-tracts and elutriates. The highest receptor activation was observed with single polar and non-polar extracts from the Nigeria and Benin sites, indicating hotspots with Er-, PPARa-and Ahr-agonist activities. Thus, the results obtained with our battery of in vitro biological assays underscored these e-waste sites as remarkably polluted spots with complex toxicity profiles of great concern for human and environmental health.	1				1			B	-		
D378	ばく露	Shiwaku, Y; Lee, P; Thepaksorn, P; Zheng, B; Koizumi, A; Harada, KH	Spatial and temporal trends in perfluorooctanoic and perfluorohexanoic acid in well, surface, and tap water around a fluoropolymer plant in Osaka, Japan	2016	Chemosphere 2016 Dec:164:603-610. doi: 10.1016/j.chemosphere.2016.09.006	This study was conducted to clarify the spatial distributions of perfluorooctanoic acid (PFOA) and perfluorohexanoic acid (PFHxA) in well, surface and tap water around a fluoropolymer plant in Osaka between 2003 and 2016 and to predict the fate of those chemicals in these aquatic environments. We analyzed 44 well, six surface and six tap water samples collected within a 5 km radius of the plant. The PFOA concentrations in well water ranged from 45.2 to 7440 ng/L. (median = 240 ng/L), while PFHxA concentrations ranged from 9.68 to 970 (median = 45.4 ng/L) in 2015-2016. The concentration of other perfluoroallcyl carboxylic acids were lower than PFOA and PFHxA in well water. Fixed-point observation showed that the levels of PFOA decreased greatly over the last few decades, whereas those of PFHxA increased in both well and surface water. Further monitoring and investigation are suggested to understand PFOA and PFHxA contamination and fate in the environment, as well as their potential for human exposure in this region.		1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D379	ばく露	He, S; Ren, NQ	Occurrence and Risk Assessment of per- and Polyfluoroalkyl Substances in Water Source Protection Area of Southeastern China	2022	Front. Environ. Sci. 2022 Jun:10:913997. doi: 10.3389/fenvs.2022.913997.	In order to clarify the pollution characteristics and human health risks of PFASs pollutants in typical drinking water sources in Zhejiang Province, this study relies on ultra -performance liquid chromatography-mass spectrometry (UPLC-MS/MS) technology to analyze the pollution of 26 PFASs in 7 reservoirs in Zhejiang Province. The detected concentrations of PFASs were evaluated to further assess the human health risks. Total PFASs concentrations in the seven reservoirs ranged from 1.30 ng L-1-24.90 ng L-1. Among the 26 PFASs pollutants analyzed, PFOA and PFBA were the main PFASs pollutants, the detected concentrations of PFOA and PFBS ranging from 0.50 ng L-1-13.70 ng L-1 and 0 ng L-1-1.70 ng L-1, respectively. Then we evaluated 15 PFASs and calculated the results of the HQ value of the reproductive toxicity and hepatotoxicity of the total PFASs in this study ranged from 2.30 x 10(-8) to 1.16 x 10(-4) and 9 x 10(-8) to 5.24 x 10(-4) respectively, which were both lower than 0.01, indicating that there is no significant risk to the human body.	1			1				B	-		
D380	ばく露	Dellatte, E; Brambilla, G; De Filippis, SP; di Domenico, A; Pulkrabova, J; Eschauzier, C; Klenow, S; Heinemeyer, G; de Voogt, P	Occurrence of selected perfluorinated alkyl acids in lunch meals served at school canteens in Italy and their relevance for children's intake	2013	Food Addit. Contam. Part A-Chem. 2013 Sep:30(9):1590-1597. doi: 10.1080/19440049.2013.813648.	Ready-to-eat servings may be more contaminated with perfluorinated alkyl acids (PFAAs) than the corresponding unprocessed foods due to the presence of PFAAs in and transfer from food contact materials (FCM) and cookware. Therefore, the presence of selected PFAAs in meals served weekly at lunch time in six Italian school canteens was assessed. Five towns were selected representing different areas with local water and food supply. Daily lunch menus were sampled and pooled to form a composite. Analyses were carried out on the weekly composite from each canteen. UPLC-MS/MS quantification limits were in the 6.0-12pgg(-1) range for the selected PFAAs (PFHxA, PFOA, PFNA, PFDA, PFUnDA, PFHxS, branched and non-branched PFOS). Non-branched PFOS was quantified in four out of six composites, with levels ranging from 14 to 25pgg(-1), while PFOA and PFDA were determined in two out of six in the range 6.5-8.2pgg(-1). Theoretical estimates and analytical results in the same order of magnitude indicate a negligible contribution from food processing and serving to meal contamination. When composite analytical data are transposed into dietary estimates, it is shown that Italian school-age children have intakes in the range of 0.3-1.1 and 0.5-1.4ngkg(-1)bwday(-1) for PFOA and PFOS respectively, well below the corresponding tolerable daily intakes (TDIs).		1	1					B	-		
D381	ばく露	Cao, YX; Cao, XZ; Wang, H; Wan, Y; Wang, SL	Assessment on the distribution and partitioning of perfluorinated compounds in the water and sediment of Nansi Lake, China	2015	Environ. Monit. Assess. 2015 OCT;187(10):611. doi: 10.1007/s10661-015-4831-9.	In this study, the distribution and partitioning of nine perfluorinated compounds (PFCs) in the water and sediment of Nansi Lake were systematically investigated. The total concentration of PFCs was in the range of 38.4-91.4 ng/L in the water and 0.47-1.81 ng/g in the sediment. The concentration of perfluorooctanoic acid (PFOA) was the highest in all the homologues in the water and was in the range of 34.9-84.6 ng/L. However, perfluorooctane sulfonate (PFOS), PFOA, and perfluoroundecanoic acid (PFUnDA) were the predominant PFCs in the sediment, and their levels were similar. The levels of PFOA, PFHpA, PFOS, PFNA, and the total PFCs in the water were relatively higher in the upper region than those in the lower region of Nansi Lake. In the sediment, the levels of PFOA, PFOS, and PFUnDA showed the similar distribution tendency. Industrial wastewater discharged from the cities around Nansi Lake was the main sources of PFCs. The partitioning coefficients (K-d) of PFOA, PFNA, PFDA, and PFOS were in the range of 0.29-0.87, 1.43-2.18, 2.08-3.15, and 2.20-2.80, respectively. Therefore, the log K-d of PFDA and PFOS was apparently high as compared to two other compounds. The organic matter content of the sediment had no effect on the partitioning of PFCs between sediment and water in Nansi Lake.			1					B	-		
D382	ばく露	Wang, XP; Wang, YX; Li, JG; Liu, JF; Zhao, YF; Wu, YN	Occurrence and dietary intake of Perfluoroalkyl substances in foods of the residents in Beijing, China	2021	Food Addit. Contam. Part B-Surveill. 2021 Jan:14(1):1-11. doi: 10.1080/19393210.2020.1821098.	The human diet has been considered to be the main source of perfluoroalkyl substances (PFASs) intake, but only a few risk assessments for PFASs alternatives and isomers with persistent and bioaccumulative properties were available. Hence, the concentrations and human exposure of 10 linear PFASs, 8 branched PFASs and 4 alternatives were characterised in animal-origin and vegetable dietary food samples consumed by Beijing residents of China. Linear-PFASs were commonly found in fish, while PFBS was mainly found in vegetables. PFASs alternative 6:2Cl-PFESA was mainly detected in freshwater and marine fish, with a mean level of 223 and 158 pg/g ww, respectively. In addition, br-PFOA and br-PFOS were only detected in pork liver and fish samples. The EDI(n-ary sumation PFOA)and EDI(n-ary sumation PFOS)values were far below the tolerable weekly intake as recommended by EFSA in 2018. However, the occurrence and exposure of PFAS alternatives suggested that the risk of these contaminants should be further evaluated.				1				B	-		
D383	ばく露	Roos, AM; Gamberg, M; Muir, D; Karrman, A; Carlsson, P; Cuyler, C; Lind, Y; Bossi, R; Riget, F	Perfluoroalkyl substances in circum-ArcticRangifer: caribou and reindeer	2022	Environ. Sci. Pollut. Res. 2022 Apr:29(16):23721-23735. doi: 10.1007/s11356-021-16729-7.	Livers of caribou and reindeer (Rangifer tarandus) from Canada (n = 146), Greenland (n = 30), Svalbard (n = 7), and Sweden (n = 60) were analyzed for concentrations of eight perfluoroalkyl carboxylic acids and four perfluoroalkane sulfonic acids. In Canadian caribou, PFNA (range < 0.01-7.4 ng/g wet weight, ww) and PFUnDA (<0.01-5.6 ng/g ww) dominated, whereas PFOS predominated in samples from South Greenland, Svalbard, and Sweden, although the highest concentrations were found in caribou from Southwest Greenland (up to 28 ng/g ww). We found the highest median concentrations of all PFAS except PFHxS in Akia-Maniitsoq caribou (Southwest Greenland, PFOS 7.2-19 ng/g ww, median 15 ng/g ww). The highest concentrations of sigma PFAS were also found in Akia-Maniitoq caribou (101 ng/g ww) followed by the nearby Kangerlussuaq caribou (45 ng/g ww), where the largest airport in Greenland is situated, along with a former military base. Decreasing trends in concentrations were seen for PFOS in the one Canadian and three Swedish populations. Furthermore, PFNA, PFDA, PFUnDA, PFDoDA, and PFTrDA showed decreasing trends in Canada's Porcupine caribou between 2005 and 2016. In Sweden, PFHxS increased in the reindeer from Norrbotten between 2003 and 2011. The reindeer from Vasterbotten had higher concentrations of PFNA and lower concentrations of PFHxS in 2010 compared to 2002. Finally, we observed higher concentrations in 2010 compared to 2002 (albeit statistically insignificant) for PFHxS in Jamtland, while PFNA, PFDA, PFUnDA, PFDoDA, and PFTrDA showed no difference at all.			1					B	-		
D384	ばく露	Jeong, Y; Da Silva, KM; Iturrospe, E; Fuiji, Y; Boogaerts, T; Van Nuijs, ALN; Koelmel, J; Covaci, A	Occurrence and contamination profile of legacy and emerging per- and polyfluoroalkyl substances (PFAS) in Belgian wastewater using target, suspect and non-target screening approaches	2022	J. Hazard. Mater. 2022 Sep:437:129378. doi: 10.1016/j.jhazmat.2022.129378.	With the growing concern regarding the health risks of per- and polyfluoroalkyl substances (PFAS), there is an increasing demand for the identification of emerging PFAS. This study provides a comprehensive investigation of legacy and emerging PFAS in 16 wastewater treatment plants (WWTPs) in Belgium using target, suspect, and non-target screening methods. Perfluorobutanoic acid (PFBA) and perfluoropentanoic acid (PFPeA) were the dominant compounds in most locations, whereas perfluorooctanoic acid (PFOA) was the most predominant PFAS in WWTP Deurne (Antwerp region). Using a suspect screening approach, 14 PFAS were annotated as confidence level (CL) of 4 or higher and 4 PFAS were annotated as CL 2a and 2b, including aqueous film forming foam (AFFF)-derived PFAS. The compound group of n:3 unsaturated fluorotelomer carboxylic acid was found using non-target screening in the wastewater from WWTP Deurne. Population exposure in a catchment area estimated using population-normalized mass loads (PNML) showed the highest value in the catchment area of WWTP Deurne, implying a potentially higher exposure to PFAS in this community.	1							B	-		
D385	ばく露	Bertin, D; Labadie, P; Ferrari, BJD; Sapin, A; Garric, J; Geffard, O; Budzinski, H; Babut, M	Potential exposure routes and accumulation kinetics for poly- and perfluorinated alkyl compounds for a freshwater amphipod: Gammarus spp. (Crustacea)	2016	Chemosphere 2016 Jul:155:380-387. doi: 10.1016/j.chemosphere.2016.04.006	Gammarids were exposed to sediments from a deposition site located on the Rhone River (France) downstream of a fluoropolymer manufacturing plant. Gammarids accumulated to various extents four long-chain perfluoroalkyl carboxylic acids (PFCAs) from C-9 to C-13, one sulfonate, perfluorooctane sulfonate (PFOS) and three of its precursors (the perfluorooctane sulfonamide (FOSA), the N-methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA), the N-ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA) and the 6:2 fluorotelomer sulfonic acid (6:2 FTSA). Whatever the compound, the steady state was not achieved after a 3-week exposure; elimination was almost complete after a 3-week depuration period for perfluorononanoic acid (PFNA), PFOS, the three precursors and the 6:2FTSA. However, this was not the case for long-chain PFCAs, whose elimination rates decreased with increasing chain length. PFAS accumulation in gammarids occurred via the trophic and respiratory pathways, in proportions varying with the carbon chain length and the terminal moiety.			1					B	-		
D386	ばく露	Senthilkumar, K; Ohi, E; Sajwan, K; Takasuga, T; Kannan, K	Perfluorinated compounds in river water, river sediment, market fish, and wildlife samples from Japan	2007	Bull. Environ. Contam. Toxicol. 2007 Oct:79(4):427-431. doi: 10.1007/s00128-007-9243-2.	Perfluorinated organic compounds (PFCs) such as PFOS, PFOA, PFBS, PFHxS, PFOSA and PFDoA were determined in river water, river sediment, liver of market fish and liver of wildlife samples from Japan. Concentrations of PFOA and PFOS in water samples were 7.9-110 and < 5.2-10 ng/L. Only PFOA were detected in sediment from Kyoto river at 1.3-3.9 ng/g dry wt. Among fish, only jack mackerel showed PFOA and PFOS at 10 and 1.6 ng/g wet wt. Wildlife liver contained PFOSA, PFOS, PFDoA, PFOA and PFHxS in the range of 0.31-362, 0.15-238, < 0.03-28, > 0.07-7.3 and < 0.03-1.5, respectively, on ng/g wet wt. Cormorants showed maximum accumulation followed by eagle, raccoon dog and large-billed crow.				1				B	-		
D387	ばく露	Chen, H; Wang, XM; Zhang, C; Sun, RJ; Han, JB; Han, GC; Yang, WC; He, X	Occurrence and inputs of perfluoroalkyl substances (PFASs) from rivers and drain outlets to the Bohai Sea, China	2017	Environ. Pollut. 2017 Feb:221:234-243. doi: 10.1016/j.envpol.2016.11.070	Concentrations of 19 PFASs in riverwater, coastal wastewater and effluents from WWTPs which were directly discharged into the Bohai Sea of China were measured and their inputs to this sea area were calculated accordingly. For riverwater samples, the total PFAS concentrations ranged from 13.1 to 69 238 ng/L. PFAS levels in riverwater collected from Liaoning Province were comparable to those from Shandong Province, while they were two orders of magnitude greater than those from Hebei Province and the city of Tianjin. The dominant PFAS patterns were spatially different. PFBS and PFOA were the predominant PFASs in riverwater samples at sites where fluorochemical industry parks are located in Liaoning Province and Shandong Province, respectively. For other sites, PFOA and PFOS were the most abundant PFASs. In contrast, the total PFAS concentrations in coastal wastewater and effluent samples ranged from 16.7 to 7 522 ng/L and from 13.1 to 319 ng/L, respectively. PFOA was dominant in these samples. Inputs of PFASs to the Bohai Sea via riverine flow, discharge of coastal wastewater and effluents were estimated to be 873 tons per year. As compared with coastal wastewater and effluent discharge, riverine input was a major source for the PFAS pollution in the Bohai Sea except for PFBS.				1				B	-		

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D388	ばく露	Liu, WY; Chen, SY; Harada, KH; Koizumi, A	Analysis of perfluoroalkyl carboxylates in vacuum cleaner dust samples in Japan	2011	Chemosphere. 2011 Dec:85(11):1734-1741. doi: 10.1016/j.chemosphere.2011.09.024.	Perfluorooctanoic acid (PFOA) has long been an environmental contaminant of concern owing to its potential health risk. However, exposure to perfluorinated carboxylic acids (PFCAs) other than PFOA is not well understood. In this study, we investigated the concentrations of PFCAs in vacuum cleaner dust in Japan to measure the PFCAs contamination in an indoor environment. Most of the 77 samples contained PFCAs with 6-13 carbon atoms. The median concentration of perfluorononanoic acid (PFNA, 23.2 ng g(-1)) was highest among PFCAs, followed by PFOA (20.8 ng g(-1)) and perfluoroundecanoic acid (PFUnDA, 12.9 ng g(-1)). The 90th percentile concentrations of PFNA, PFUnDA and perfluorotridecanoic acid (PFTrDA) were 948, 283 and 110 ng g(-1), respectively, and these were detected at greater concentrations than neighboring, even-numbered PFCAs. The proportion of long-chain PFCAs in vacuum cleaner dust from Japan was relatively higher than those reported for other countries. Factor analysis showed three independent factors. Odd-numbered long chain PFCAs (PFNA, PFUnDA and PFTrDA), which can correspond to factor 1, were major components of PFCAs in vacuum cleaner dust. Short chain PFCAs (factor 2) and even numbered long chain PFCAs (factor 3) were also statistically separated. These findings suggest that there are several sources of PFCAs with different origins in indoor environment. Further investigations into the origins of PFCAs are needed to evaluate indoor contamination with PFCAs.			1					B	-		
D389	ばく露	Hu, YN; Wei, CY; Wang, L; Zhou, Z; Wang, T; Liu, GL; Feng, YQ; Liang, Y	Cooking methods affect the intake of per- and polyfluoroalkyl substances (PFASs) from grass carp	2020	Ecotox. Environ. Safe. 2020 Oct:203:111003. doi: 10.1016/j.ecoenv.2020.111003.	Consumption of fish is one of the predominant sources of human exposure to per- and polyfluoroalkyl substances (PFASs). In this study, the effect of various cooking methods (boiling, steaming, grilling and frying) on the levels of PFASs in fish muscle and the intake of PFASs was explored by using grass carp collected from Tangxun Lake, Wuhan, China. Perfluorooctane sulfonate (PFOS) was the predominant PFASs in raw fish fillets, with the concentrations ranging from 59.6 to 136 ng/g ww, followed by perfluorobutane sulfonate (PFBS) (7.73-51.9 ng/g ww). The concentrations of long-chain PFASs in fish increased after cooking, while those of short-chain PFASs decreased. The amounts of PFASs in the cooked fish fillets decreased except PFOS. Short-chain PFASs, including PFBS and perfluoroheptanoic acid (PFHpA), were dominant in cooking juice. The highest amounts of PFBS in the juices were observed after boiling and frying, even higher than those in cooked fish fillets, suggesting that the release of short-chain PFASs to the cooking juices could not be neglected. Based on these results, the intake of short-chain PFASs amount through cooked fish fillets slightly decreased, but the intake of PFOS amount increased. However, consumption of cooking juice (fish soup) could increase the exposure risk of PFBS. Comprehensively considering the increase of PFOS and decrease of total PFASs, boiling may be the relatively better method to cook fish. As PFASs are ubiquitous and inevitable in aquatic food, it is thus important to choose appropriate cooking processes and dietary habits for reducing the intake of different PFASs from fish.				1				B	-		
D390	ばく露	Costopoulou, D; Vassiliadou, I; Leondiadis, L	PFASs intake from fish, eggs and drinking water in Greece in relation to the safety limits for weekly intake proposed in the EFSA scientific opinion of 2020	2022	Chemosphere. 2022 Jan;286(Pt 3):131851. doi: 10.1016/j.chemosphere.2021.131851.	Food consumption has been recognized as the most significant contributor to human exposure to polyfluoroalkyl and perfluoroalkyl substances (PFASs) for the general population. In 2020, EFSA introduced for the first time safety limit of 4.4 ng/kg body weight (bw) for weekly intake for the sum of perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorononanoic acid (PFNA) and perfluorohexane sulfonic acid (PFHxS) which are all perfluoralkyl acids (PFAAs) that belong to PFASs group. Fish and eggs have been found to contribute significantly, almost 50 % to PFOS and PFOA dietary intake of the Greek population. In the present study, estimation of human intake of these four PFASs from fish, eggs and drinking water consumption is attempted. Data from EFSA food consumption database for fish and eggs are used for assessment. Mean weekly intake estimated is above the tolerable weekly intake (TWI) recently proposed, mainly due to fish consumption. Exceedance of the proposed TWI emphasizes the need for continuous monitoring of levels of PFASs in food in parallel with efforts to lower these levels.			1					B	-		
D391	ばく露	Liu, WX; He, W; Qin, N; Kong, XZ; He, QS; Yang, B; Yang, C; Jorgensen, SE; Xu, FL	Temporal-spatial distributions and ecological risks of perfluoroalkyl acids (PFAAs) in the surface water from the fifth-largest freshwater lake in China (Lake Chaohu)	2015	Environ. Pollut. 2015 May:200:24-34. doi: 10.1016/j.envpol.2015.01.028	To investigate the residues, compositions, distributions and potential ecological risks of perfluoroalkyl acids (PFAAs), water samples were collected seasonally between August 2011 and November 2012 from 20 sites in Lake Chaohu and its tributary rivers. The mean concentration of total PFAAs (TPFAAs) was 14.46 +/- 6.84 ng/L PFOA was the predominant contaminant (8.62 +/- 4.40 ng/L), followed by PFBA (2.04 +/- 1.16 ng/L) and PFHxA (1.23 +/- 1.50 ng/L). The TPFAAs concentrations peaked in August 2012 in each area, except for the western river. The opposite spatial trends were found for PFOA and PFOS in both the lake and river areas. Except for PFOS and PFUdA, the levels of TPFAAs and PFAAs were significantly related to the composition of fluorescent dissolved organic matter (FDOM) but not related to total DOM expressed by dissolved organic carbon (DOC). The risk of PFOS determined by a species sensitivity distribution model was notably above that of PFOA.	1	1						B	-		
D392	ばく露	Chen, ZW; Zhan, XY; Zhang, JR; Diao, JY; Su, CH; Sun, QP; Zhou, YQ; Zhang, LL; Bi, R; Ye, M; Wang, TY	Bioaccumulation and risk mitigation of legacy and novel perfluoroalkyl substances in seafood: Insights from trophic transfer and cooking method	2023	Environ. Int. 2023 Jul:177:108023. doi: 10.1016/j.envint.2023.108023.	Per- and polyfluoroalkyl substances (PFAS) have widespread application in industrial and civil areas due to their unique physical and chemical properties. With the increasingly stringent regulations of legacy PFAS, various novel alternatives have been developed and applied to meet the market demand. Legacy and novel PFAS pose potential threats to the ecological safety of coastal areas, however, little is known about their accumulation and transfer mechanism, especially after cooking treatment. This study investigated the biomagnification and trophic transfer characteristics of PFAS in seafood from the South China Sea, and assessed their health risks after cooking. Fifteen target PFAS were all detected in the samples, of which perfluorobutanoic acid (PFBA) was dominant with concentrations ranging from 0.76 to 4.12 ng/g ww. Trophic magnification factors (TMFs) > 1 were observed for perfluorooctane sulfonate (PFOS) and 6:2 chlorinated polyfluoroalkyl ether sulfonic acid (F53B), indicating that these compounds experienced trophic magnification in the food web. The effects of different cooking styles on PFAS occurrence were further explored and the results suggested that & sigma;PFAS concentrations increased in most organisms after baking, while & sigma;PFAS amounts decreased basically after boiling and frying. Generally, there is a low health risk of exposure to PFAS when cooked seafood is consumed. This work provided quantitative evidence that cooking methods altered PFAS in seafood. Further, suggestions to mitigate the health risks of consuming PFAS-contaminated seafood were provided.	1							B	-		
D393	ばく露	Murakami, M; Takada, H	Perfluorinated surfactants (PFSs) in size-fractionated street dust in Tokyo	2008	Chemosphere. 2008 Nov:73(8):1172-1177. doi: 10.1016/j.chemosphere.2008.07.063.	We investigated perfluorinated surfactants (PFSs) in size-fractionated street dust to identify their occurrence, contributions from traffic, and potential routes of entry into waters. Street dust was collected from residential areas and heavily trafficked areas in Tokyo and sorted into fine (<63 mu m) and coarse fractions (63-2000 mu m). Five PFS species were analyzed by liquid chromatography-tandem mass spectrometry: perfluorooctanesulfonate (PFOS), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorodecanoate (PFDA), and perfluoroundecanoate (PFUA). In fine fractions, PFS contents were significantly higher in heavily trafficked street dust than in residential street dust, but in coarse fractions, no significant differences were observed. Additionally, in heavily trafficked areas, PFS contents were significantly higher in fine fractions than in coarse fractions, but in residential areas, no significant differences were observed. PFS compositions differed between size fractions, not locations, indicating differences in sources between size fractions. Fine particles from traffic contributed to PFSs in street dust. Street dust possibly acts as the origin of PFSs in street runoff and eventually enters waters. This is the first report of PFSs in street dust.			1					B	-		
D394	ばく露	Ahrens, L; Ebinghaus, R	Spatial distribution of polyfluoroalkyl compounds in dab (Limanda limanda) bile fluids from Iceland and the North Sea	2010	Mar. Pollut. Bull. 2010 Jan:60(1):145-148. doi: 10.1016/j.marpolbul.2009.10.007.	The spatial distribution of polyfluoroalkyl compounds (PFCs) was investigated in dab (Limanda limanda) bile fluids collected from Iceland and the North Sea. Concentrations of various PFCs, including perfluorinated sulfonates (C-4-C-6, C-8 PFSAs), perfluorinated carboxylic acids (C-9-C-14 PFCAs) and n-methyl perfluorooctane sulfonamidoethanol (MeFOSE), were quantified. Perfluorooctane sulfonate (PFOS) was the predominant compound with highest concentrations along the Danish and German coast (mean 9.36 ng/g wet weight (ww)). Significantly lower PFOS concentrations were found at the other sampling stations in the North Sea and Iceland ($p < 0.01$, t-test). Conversely, the spatial distribution of the PFCAs in Iceland and the North Sea was more uniform. The most abundant PFCA was perfluorononanoic acid (PFNA), while the mean concentration decreased with increasing chain length from 4.7 ng/g ww for PFNA to 0.04 ng/g ww for perfluorotetradecanoic acid (PFTeDA). Overall, the different spatial distribution of PFCs indicates different origin of sources and different transportation mechanism.			1					B	-		
D395	ばく露	Kunacheva, C; Boontanon, SK; Fujii, S; Tanaka, S; Musirat, C; Artsalee, C; Wongwattana, T	Contamination of perfluorinated compounds (PFCs) in Chao Phraya River and Bangpakong River, Thailand	2009	Water Sci. Technol. 2009 ;60:975-982. doi: 10.2166/wst.2009.462	Perfluorinated compounds (PFCs) have been used for many years, and are distributed all over the world. This study focused on occurrences of PFCs, especially perfluorooctane sulfonate (PFOS) and perfluorooctonoic acid (PFOA) in Thai rivers and industrial estate discharges, while comparing results with rivers of other Asian countries (Japan, China, and Malaysia). Surveys were conducted in Chao Phraya River, Bangpakong River and three industrial estates. A solid phase extraction (SPE) and HPLC-ESI-MS/MS were used for the analysis of these chemicals. The average concentrations of PFOS and PFOA were 1.9 and 4.7 ng/L, respectively in Chao Phraya River, while lower concentrations were detected in Bangpakong River with the averages of 0.7 ng/L for both PFOS and PFOA. Higher concentrations were detected in all industrial estate discharges with the averages of 64.3 ng/L for PFOA and 17.9 ng/L for PFOS., Total loadings from three industrial estates were 1.93 g/d for PFOS and 11.81 g/d for PFOA. The concentraion levels in Thai rivers were less than rivers in Japan, China, and Malaysia. However, PFCs loading rate of Chao Phraya River was much higher than Yodo River (Japan), due to the higher flow rate. The other six PFCs were found above the Limit of Quantification (LOQ) in most samples. PFHxS and PFNA were also highly detected in some river samples.			1					B	-		

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D396	ばく露	Schmidt, N; Fauvelle, V; Castro-Jimenez, J; Lajaunie-Salla, K; Pinazo, C; Yohia, C; Sempere, R	Occurrence of perfluoroalkyl substances in the Bay of Marseille (NW Mediterranean Sea) and the Rhone River	2019	Mar. Pollut. Bull. 2019 Dec:149:110491. doi: 10.1016/j.marpolbul.2019.110491.	Four perfluoroalkyl substances (PFAS) were analyzed in 62 duplicate surface water samples from the Rhone River and Marseille Bay (France; NW Mediterranean Sea). Perfluorooctane sulfonate (PFOS) was detected in all samples and exceeded the European Environmental Quality Standard (EQS) values in over 80% of the cases. The most contaminated samples were from the Rhone River (up to 200 ng L-1 Sigma(4) PFAS), as well as those collected near a wastewater treatment plant outlet in Marseille Bay (up to 9 ng L-1 Sigma(4) PFAS). While PFOS was the predominant PFAS in Marseille Bay, remarkably high concentrations of perfluorohexanoic acid (PFHxA) were measured in the Rhone River (8-193 ng L-1). The relative abundances of individual compounds differed thus significantly between the Rhone River and Marseille Bay, indicating different sources. A simulation made with the MARS3D model showed that PFOS inputs from the Rhone River can enter Marseille Bay at levels > EQS.		1						B	-		
D397	ばく露	Haron, DEM; Yoneda, M; Ahmad, ED; Aziz, MY	PFAS, bisphenol, and paraben in Malaysian food and estimated dietary intake	2023	Food Addit. Contam. Part B-Surveill. 2023 Apr:16(2):161-175. doi: 10.1080/19393210.2023.2188611.	Endocrine disrupting chemicals (EDCs) such as per- and polyfluoroalkyl substances (PFAS), bisphenols, and parabens are used in food packaging or as preservatives and their unintended consumption has been associated with cancer and other diseases. Food EDCs data are scarce in Malaysia. Thus, liquid chromatography mass tandem spectrometry (LC-MS/MS) was utilised to analyse 18 EDCs from different food categories. Bisphenol was the most abundant EDC found, followed by PFAS and paraben. Bisphenol levels in canned foods, dairy products, canned drinks, fruits, and vegetables ranged from 1.16 to 183 ng/g. PFAS was found in almost every food category, with canned foods having the highest concentrations (0.18-34.5 ng/g). Only canned foods, fruits, and vegetables contained parabens, with mean concentrations ranging from 0.27 to 26.7 ng/g. PFOS, PFBA, PFHQA and bisphenol A all had hazard quotients (HQ) above 1, indicating that they can pose a risk to human health.	1						B	-		
D398	ばく露	Zhang, M; Wang, P; Lu, YL; Lu, XT; Zhang, AQ; Liu, ZY; Zhang, YQ; Khan, K; Sarvajayakesavalu, S	Bioaccumulation and human exposure of perfluoroalkyl acids (PFAAs) in vegetables from the largest vegetable production base of China	2020	Environ. Int. 2020 Feb:135:105347. doi: 10.1016/j.envint.2019.105347.	This study investigated perfluoroalkyl acids (PFAAs) in edible parts of vegetables, soils, and irrigation water in greenhouse and open filed, for the first time, in Shouguang city, the largest vegetable production base in China, which is located nearby a fluorochemical industrial park (FIP). The bioaccumulation factors (BAFs) were calculated, and the human exposures of PFAAs via consumption of the vegetables for different age groups assuming the maximum levels detected in each vegetable and average consumption rates were also estimated. The Sigma PFAA levels ranged from 1.67 to 33.5 ng/g dry weight (dw) in the edible parts of all the vegetables, with perfluorobutanoic acid (PFBA) being the dominant compound with an average contribution of 49% to the Sigma PFAA level. The leafy vegetables showed higher Sigma PFAA levels (average 8.76 ng/g dw) than the fruit and root vegetables. For all the vegetables, the log io BAF values of perfluorinated carboxylic acids showed a decreasing trend with increasing chain length, with PFBA having the highest log in BAF values (average 0.98). Cabbage had higher bioaccumulation of PFBA (log(10) BAF 1.24) than other vegetables. For the greenhouse soils and vegetables, the average contribution of perfluorooctanoic acid (PFOA) to Sigma PFAA was lower than that in the open field samples, while the contributions of PFBA, PFHxA, PFPeA to Sigma PFAA were higher. Irrigation water may be an important source of PFAAs in greenhouse, while for open field vegetables and soils, atmospheric deposition may be an additional contamination pathway. The estimated maximum exposure to PFOA through vegetable consumption for urban preschool children (aged 2-5 years) was 63% of the reference dose set by the European Food Safety Authority. Suggestions are also provided for mitigating the health risks of human exposure to PFAAs.	1	1					B	-		
D399	ばく露	Zhou, Z; Shi, YL; Li, WH; Xu, L; Cai, YQ	Perfluorinated Compounds in Surface Water and Organisms from Baiyangdian Lake in North China: Source Profiles, Bioaccumulation and Potential Risk	2012	Bull. Environ. Contam. Toxicol. 2012 Sep:89(3):519-524. doi: 10.1007/s00128-012-0745-1.	The concentrations of 16 perfluorinated compounds (PFCs) were measured in surface water and organisms from Baiyangdian Lake. Perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid, and perfluorobutanoic acid (PFBA) were the major PFC species in the water at 6.8-56.8, 0.1-17.5 and 3.0-14.6 ng/L, respectively. The PFC contamination in Baiyangdian Lake was significantly impacted by the inflow from Pinghe River and Fuhe River. There was no significant correlation between the concentrations of PFCs and the trophic levels in aquatic organisms. There were no significant PFC risks in Baiyangdian Lake according to the risk assessment of PFCs in water.	1						B	-		
D400	ばく露	Galezowska, G; Rogowska, J; Olkowska, E; Ratajczyk, W; Wolska, L	Environmental Risk Assessment Resulting from Sediment Contamination with Perfluoroalkyl Substances	2021	Molecules. 2021 Jan;26(1):116. doi: 10.3390/molecules26010116.	Due to wide use of perfluoroalkyl substances (PFASs) (e.g., in metal-plating, in fire-fighting foam, lubricants) and their resistance to degradation, they occur widely in the environment. The aim of this study was to estimate the environmental risk resulting from the presence of PFASs in the Gulf of Gdansk. Therefore, 17 PFASs concentrations were determined using ultra performance liquid chromatography with tandem mass spectrometry detection (UPLC-MS/MS). Additionally, sediment ecotoxicity was investigated. The results of the chemical analysis were used to asses environmental risk of PFASs. In samples collected around discharge collectors from a wastewater treatment plant and the Vistula mouth, sigma 17PFASs values were 0.00403 divided by 40.6 and 0.509 divided by 614 ng/g d.w., respectively. In samples collected around discharge collectors, PFHxA, PFPeA, PFHpA, and PFOA were dominating, while at the Vistula River mouth, PFHxS, PFDS, and PFBS were prevalent. For most sediments, no toxic effect was observed in the toxicity tests with Heterocypris inconguens and Aliivibrio ficsheri. There was no observed correlation between the PFASs level and their ecotoxicity. Generally, the results of environmental risk assessment indicate that the PFASs would not generate high impact on the aquatic life (five water samples have shown medium risk related to PFBS and PFDoA).		1		1			B	-		
D401	ばく露	Augustsson, A; Lennqvist, T; Osbeck, CMG; Tibblin, P; Glynn, A; Nguyen, MA; Westberg, E; Vestergren, R	Consumption of freshwater fish: A variable but significant risk factor for PFOS exposure	2021	Environ. Res. 2021 Jan:192:110284. doi: 10.1016/j.envres.2020.110284.	PFOS, PFOA, PFNA and PFHxS are the PFAS substances that currently contribute most to human exposure, and in 2020 the European Food Safety Authority (EFSA) presented a draft opinion on a tolerable intake of 8 ng/kg/week for the sum of these four substances (equaling 0.42 mu g/kg if expressed as an annual dose). Diet is usually the dominating exposure pathway, and in particular the intake of PFOS has been shown to be strongly related to the consumption of fish and seafood. Those who eat freshwater fish may be especially at risk since freshwater and its biota typically display higher PFOS concentrations than marine systems. In this study, we estimated the range in PFOS intake among average Swedish normal and high consumers of freshwater fish. By average we mean persons of average weight who eat average-sized portions. The normal consumers were assumed to eat freshwater fish 3 times per year, and the high consumers once a week. Under these assumptions, the yearly tolerable intake for normal and high consumers is reached when the PFOS concentrations in fish equals 59 and 3.4 mu g per kg fish meat. For this study, PFOS concentrations in the muscle tissue of edible-sized perch, pike and pikeperch were retrieved from three different Swedish datasets, covering both rural and urban regions and a total of 78 different inland waters. Mean PFOS concentrations in fish from these sites varied from 0.3 to 750 mu g/kg. From the available data, the annual min-max dietary PFOS intake for male normal consumers was found to be in the range 0.0021-5.4 mu g/kg/yr for the evaluated scenarios, with median values of 0.02-0.16 mu g/kg/yr. For male high consumers, the total intake range was estimated to be 0.04-93 mu g/kg/yr, with median values being 0.27-1.6 mu g/kg/yr. For women, the exposure estimates were slightly lower, about 79% of the exposure in men. Despite highly variable PFOS concentrations in fish from different sites, we conclude that the three most commonly consumed freshwater species in Sweden constitute an important source for the total annual intake even for people who eat this kind of fish only a few times per year. The analyses of PFOA, PFNA and PFHxS showed values which were all below detection limit, and their contribution to the total PFAS intake via freshwater fish consumption is negligible in comparison to PFOS.			1				B	-		
D402	ばく露	Catherine, M; Nadege, B; Charles, P; Yann, A	Perfluoroalkyl substances (PFASs) in the marine environment: Spatial distribution and temporal profile shifts in shellfish from French coasts	2019	Chemosphere 2019 Aug:228:640-648. doi: 10.1016/j.chemosphere.2019.04.205	Perfluoroalkyl substances (PFASs) were investigated in filter-feeding shellfish collected from 2013 to 2017 along the English Channel, Atlantic and Mediterranean coasts of France. PFOS (perfluorooctane sulfonate), PFTrDA (perfluorotridecanoic acid), PFTeDA (perfluorotetradecanoic acid), PFDoDA (perfluorododecanoic acid) and PFUnDA (perfluoroundecanoic acid) were detected in more than 80% of samples, thus indicating widespread contamination of the French coastal environment by these chemicals. The distribution of PFAS concentrations showed differences according to sampling locations and years. PFOS was the predominant PFAS in most samples collected from English Channel and Atlantic coasts until 2014, but the opposite was observed in 2015, 2016 and 2017, while perfluoroalkyl carboxylic acids (PFCAs) prevailed in Mediterranean samples in all study years. Among PFCAs, PFTrDA showed the highest maximum (136 ng g(-1) ww) and median (0.077 ng g(-1) ww) concentrations in 2016-2017. Other PFAS median concentrations were within the 0.014 (PFNA) - 0.055 (PFTeDA) ng g(-1) ww range. The profiles determined each year in most Mediterranean samples suggest distinctive sources. PFOS median concentrations showed a significant decrease over the study years, from 0.118 to 0.126 ng g(-1) ww in 2013 - 2015 to 0.066 ng g(-1) ww in 2016 and 2017. Sigma PFCAs showed no trends in concentration ranges over the same years. The shift in PFAS profiles from PFOS to long-chain PFCAs over the study period reflects PFOS production phase-out, combined with continuous inputs of PFCAs into the marine environment. These results provide reference data for future studies of the occurrence of contaminants of emerging concern on European coasts.			1				B	-		
D403	ばく露	Wang, YX; Gao, XY; Liu, JY; Lyu, B; Li, JG; Zhao, YF; Wu, YN	Exposure to Emerging and Legacy Polyfluoroalkyl Substances in the Sixth Total Diet Study - China, 2016-2019	2022	China CDC Weekly. 2022 Mar:4(9):168-+. doi: 10.46234/ccdcw2022.042.	What is already known about this topic? Perfluoroalkyl substances (PFASs) are persistent organic pollutants, which have multi-organ toxicity and potential health risk to humans. What is added by this report? perfluorodecanoic acid (PFDA), perfluorononanoic acid (PFNA), and 9-chlorohexadecafluoro-3oxanonane-1-sulfonate (6:2 Cl-PFESA). The mean estimated weekly intakes (EWIs) of PFOA, PFOS, and 6:2 Cl-PFESA in the Sixth TDS were 2.17, 2.72, and 2.75 ng/kg body weight per week, respectively. What are the implications for public health practice? The PFASs levels in some food category and dietary exposure still need to be continuously monitored, especially for 6:2 Cl-PFESA.			1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D404	ばく露	Klenow, S; Heinemeyer, G; Brambilla, G; Dellatte, E; Herzke, D; de Voogt, P	Dietary exposure to selected perfluoroalkyl acids (PFAAs) in four European regions	2013	Food Addit. Contam. Part A-Chem. 2013 Dec:30(12):2141-2151. doi: 10.1080/19440049.2013.849006.	The dietary exposure to selected PFAAs was estimated in four selected European states (Belgium, the Czech Republic, Italy and Norway) representing Western, Southern, Eastern and Northern Europe. The harmonised sampling programme designed in the European Union project PERFOOD was targeted at identifying seven selected PFAAs, including perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), in food items that are most important both in terms of consumption and based on known high contamination patterns. The estimated average dietary exposure for adults (18-64 years) and children (3-9 years) is generally below or close to 1ngkg(-1)BWday(-1) for all seven PFAAs. Considering the high consumption of food groups that contribute most to the exposure does not result in estimates exceeding 4ng kg(-1)BWday(-1). Thus, based on the TDIs proposed by EFSA for PFOS (150ngkg(-1)BWday(-1)) and PFOA (1500ngkg(-1)BWday(-1)), no concern can be identified. There are distinct dietary exposure patterns from region to region as a result of different food consumption and contamination patterns. Foods of plant origin (e.g. fruit and vegetables) are most important for the dietary exposure to PFHxA, PFOA and PFHxS, while the consumption of foods of animal origin (particularly fish and seafood) mostly contributes to the dietary exposure to PFDA and PFUnDA. For the dietary exposure to PFNA and PFOS, food of animal and plant origin contributes with equal importance. In conclusion, region-to-region differences as well as the relative importance of food of different origin for each PFAA should be paid more attention in further research.		1	1				1	A	-	2014年と少し古い論文で、また欧州ではあるが、食事由来のPFASの曝露量を評価しており、有用な情報を提供していると考えられた。	
D405	ばく露	Murakami, M; Morita, C; Morimoto, T; Takada, H	Source analysis of perfluorocarboxylates in Tokyo Bay during dry weather and wet weather using sewage markers	2011	Environ. Chem. 2011;8(4):355-362. doi: 10.1071/EN10130.	We investigated the occurrence of perfluorocarboxylates (PFCAs) in Tokyo Bay during dry and wet weather and evaluated the contributions of wastewater effluent, untreated wastewater, and surface runoff by using two sewage markers, caffeine and crotamiton. Sigma 8PFCAs ranged from 11 to 185 ng L(-1). Perfluorononanoate (PFNA) was the major species, followed by perfluorooctanoate (PFOA) and perfluoroheptanoate (PFHpA). Principal component analysis followed by multiple linear regression revealed that the PFCAs were derived mainly from wastewater effluent during dry weather, and jointly from wastewater effluent (59%) and combined sewer overflow (41%) during wet weather. We used caffeine-to-crotamiton ratios to evaluate the contributions of untreated wastewater and wastewater effluent. Estimated concentrations of wastewater-derived PFCAs were much lower than observed concentrations during wet weather, indicating the contribution of surface runoff to contamination. During a combined sewer overflow, surface runoff had a significant effect on contamination in the bay.			1					B	-		
D406	システマティックレビュー（ばく露）	DeLuca, NM; Minucci, JM; Mullikin, A; Slover, R; Hubal, EAC	Human exposure pathways to poly- and perfluoroalkyl substances (PFAS) from indoor media: A systematic review	2022	Environ. Int. 2022 Apr:162:107149. doi: 10.1016/j.envint.2022.107149.	Background: Human exposure to per- and polyfluoroalkyl substances (PFAS) has been primarily attributed to contaminated food and drinking water. There is information indicating other sources and pathways of exposure in residential environments, but few studies report relationships between these indoor media and human bio-monitoring measurements. Methods: This study adapts existing systematic review tools and methodologies to synthesize evidence for PFAS exposure pathways from indoor environment media including consumer products, household articles, cleaning products, personal care products, and indoor air and dust. Studies were identified using innovative machine learning approaches and pathway-specific search strings to reduce time needed for literature search and screening. The included studies and systematic review were evaluated using tools modified specifically for exposure studies. The systematic review was conducted following a previously published protocol (DeLuca et al., 2021) that describes the systematic review methodology used in detail. Results: Only 7 studies were identified that measured the targeted subset of 8 PFAS chemicals in concordant household media (primarily house dust) and participant serum. Data extracted from the included studies were used to calculate exposure intake rates and estimate a percentage of occupant serum concentrations that could be attributed to the indoor exposure pathways. These calculations showed that exposure to PFOA, PFOS, PFNA, and PFHxS from contaminated house dust could account for 13%, 3%, 7%, and 25% of serum concentrations, respectively. Inhalation of PFAS in indoor air could account for less than 4% of serum PFOA concentrations and less than 2% of serum PFOS and PFNA concentrations. A risk of bias was identified due to participant profiles in most of the studies being skewed towards white, female, and higher socioeconomic status. Conclusions: Along with synthesizing evidence for estimated contributions to serum PFAS levels from indoor exposure media, this systematic review also identifies a consistent risk of bias across exposure study populations that should be considered in future studies. It highlights a major research gap and need for studies that measure concordant data from both indoor exposure media and participant serum and the need for continued research on exposure modeling parameters for many PFAS chemicals.			1					B	-	総説	
D407	ばく露	Khan, EA; Zhang, XK; Hanna, EM; Yadetie, F; Jonassen, I; Goksoyr, A; Arukwe, A	Application of quantitative transcriptomics in evaluating the ex vivo effects of per- and polyfluoroalkyl substances on Atlantic cod (Gadus morhua) ovarian physiology	2021	Sci. Total Environ.2021 Feb;755(Pt 1):142904. doi: 10.1016/j.scitotenv.2020.142904.	Because of their global consumption and persistence, per- and polyfluoroalkyl substances (PFASs), are ubiquitously distributed in the environment, as well as in wildlife and humans. In the present study, we have employed an ex vivo organ culture technique, based on the floating agarose method, of Atlantic cod ovarian tissue to investigate the effects of three different concentrations of PFOS, PFOA (1, 5 and 25 mu M) and PFNA (0.5, 5 and 50 mu M), used singly and in also in combination (1x, 20x and 100x). In the 1x exposure mixture, concentrations were decided based on their proportional levels (in molar equivalents) relative to PFOS, which is the most abundant PFAS in cod liver from a 2013 screening project. To investigate the detailed underlying mechanisms and biological processes, transcriptome sequencing was performed on exposed ovarian tissue. The number of differentially expressed genes (DEGs) having at least 0.75 log(2)-fold change was elevated in high, compared to low and medium concentration exposures. The highest PFNA, PFOA and PFOS concentrations, and the highest (100x) mixture exposure, showed 40, 68, 1295, and 802 DEGs, respectively. The latter two exposure groups shared a maximum of 438 DEGs. In addition, they both shared the majority of functionally enriched pathways belonging to biological processes such as cellular signaling, cell adhesion, lipid metabolism, immunological responses, cancer, reproduction and metabolism. Shortlisted DEGs that were specifically annotated to reproduction associated gene ontology (GO) terms were observed only in the highest PFOS and mixture exposure groups. These transcripts contributed to ovarian key events such as steroidogenesis (star, cyp19a1a), oocyte growth (amh), maturation (igfbp5b, tgf beta 2, tgf beta 3), and ovulation (pgr, mmp2). Contrary to other PFAS congeners, the highest PFOS concentration showed almost similar transcript expression patterns compared to the highest mixture exposure group. This indicates that PFOS is the active component of the mixture that significantly altered the normal functioning of female gonads, and possibly leading to serious reproductive consequences in teleosts.			1					B	-		
D408	ばく露	Liu, Y; Liu, WJ; Xu, YS; Zhao, YZ; Wang, P; Yu, SY; Zhang, JD; Tang, Y; Xiong, GN; Tao, S; Liu, WX	Characteristics and human inhalation exposure of ionic per- and polyfluoroalkyl substances (PFASs) in PM10 of cities around the Bohai Sea: Diurnal variation and effects of heating activity	2019	Sci. Total Environ. 2019 Oct:687:177-187. doi: 10.1016/j.scitotenv.2019.06.103	Atmospheric PM10 (particulate matter with aerodynamic diameter <10 mu m) samples were collected in the cities along the Bohai Sea Rim during heating and non-heating periods, and ionic per-and polyfluoroalkyl species (PFASs) in the PM10 were measured. The total concentration of ionic PFASs ranged from 21.8 to 87.0 pg/m(3), and the mean concentration of ionic PFASs during the day (42.6 pg/m(3)) was slightly higher than that at night (35.1 pg/m(3)). Generally, diurnal variations in the levels of ionic PFASs were consistent with those in the PM10 concentrations. Perfluorooctanoic acid (PFOA, 23.5-33.7%), perfluoropentanoic acid (PFPeA, 28.3-39.9%) and perfluorobutyric acid (PFBA, 17.1-20.1%) accounted for the dominant compositional contributions. Significant positive correlations ($p < 0.05$) between the main components of PFASs and O-3 implied that oxidative degradation (O-3 served as the main oxidant) in the period of non-heatingmay affect the short-chain PFASs. The clustering analysis of a 72-h backward trajectory indicated that cross-provincial transport contributed to ionic PFASs at the sampling sites. Compared with ingestion via daily diet, the inhalation of PM10 exhibited an insignificant contribution to the estimated average daily intakes (ADIs) of PFASs by different age groups. In addition, the calculated hazard ratios (HRs) for the non-cancer respiratory risk, based on the air concentrations of PFOA and perfluorooctane sulfonate (PFOS), also manifested lower non-cancer risk through inhalation exposure. Capsule: The effects of heating and non-heating activity and diurnal variation on the concentrations of PFASs, dominated by PFOA, PFPeA, and PFBA in PM10, were determined, and atmospheric trans-provincial input served as an important source.	1							B	-		
D409	ばく露	Kahkashan, S; Wang, XH; Chen, JF; Bai, YC; Ya, ML; Wu, YL; Cai, YZ; Wang, SQ; Saleem, M; Aftab, J; Inam, A	Concentration, distribution and sources of perfluoroalkyl substances and organochlorine pesticides in surface sediments of the northern Bering Sea, Chukchi Sea and adjacent Arctic Ocean	2019	Chemosphere 2019 Nov:235:959-968. doi: 10.1016/j.chemosphere.2019.06.219	Perfluoroalkyl substances (PFAS) and organochlorine pesticides (OCPs) in surface sediments were investigated from the Bering Sea, the Chukchi Sea and adjacent Arctic Ocean in 2010. Total concentrations (dry weight) of Sigma(14)PFAS in surface sediments (0.85 +/- 0.22 ng g(-1)) of the Bering Sea were lower than that in the Chukchi Sea and adjacent Arctic Ocean (1.27 +/- 0.53 ng g(-1)). Perfluoro-butanoic acid (PFBS) and perfluoro-octanoic acid (PFOA) were the dominant PFAS in these areas. The concentrations of Sigma(15)OCPs in the sediment of the Bering Sea (13.00 +/- 6.17 ng g(-1)) was slightly higher than that in the Chukchi and Arctic Ocean (12.05 +/- 2.27 ng g(-1)). The most abundant OCPs were hexachlorocyclohexane isomers (HCHs) and dichlorodiphenyltrichloroethane (DDT) and its metabolites. The composition patterns of HCHs and DDTs indicated that they were mainly derived from the early residues via river runoff. Increasing trends of PFAS, HCHs and DDTs in surface sediments from the Bering Sea to the Arctic Ocean were found, indicating oceanic transport. In summary, the concentrations of OCPs were orders of magnitude greater than the observed PFAS concentrations, and the concentrations of PFAS and OCPs in surface sediments from the Bering Sea to the Chukchi Sea and adjacent Arctic Ocean are at the low to moderate levels by comparing with other coastal and marine sediments worldwide.				1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D410	ばく露	Chen, RY; Li, GW; Yu, Y; Ma, X; Zhuang, Y; Tao, H; Shi, BY	Occurrence and transport behaviors of perfluoroalkyl acids in drinking water distribution systems	2019	Sci. Total Environ. 2019 Dec:697:134162. doi: 10.1016/j.scitotenv.2019.134162.	Although human exposure to perfluoroalkyl acids (PFAAs) through tap water is an ongoing concern, knowledge of the PFAAs occurrence in the tap water and the associated transport behaviors of PFAAs in drinking water distribution systems (DWDSs) are scarce. This investigation profiled the occurrence of 17 kinds of PFAAs in tap water of some Chinese cities, and the transport behaviors of PFAAs in DWDS were observed in eastern China. Tap water samples both along trunk pipelines and at the distal ends were collected to display the PFAAs occurrence scenarios. Loose deposit solids were also obtained to reveal their possible accumulation effect on PFAAs. The results showed that perfluorooctanoic acid (PFOA) and perfluorobutanoic acid (PFBA) widely existed in tap water samples, and were the predominant PFAAs in eastern China areas. The mean concentration of the 17 PFAAs was 77.49 ng/L (ranging from 9.29 ng/L to 266.68 ng/L). Short-chain PFAAs (mainly PFBA) concentrations were relatively stable from water treatment plant to consumer taps, while long-chain PFAAs (mainly PFOA) exhibited a significant decrease in concentration, which could be attributed to their accumulation by the loose deposits in the DWDSs. It was calculated that PFOA has a higher partition coefficient than PFBA; this means that the former has a stronger potential to be adsorbed by loose deposits. In addition, the accumulation ability of loose deposits might be associated with the composition of Al, Fe and Si in the loose deposits. The positive correlation between the short-chain PFAAs and dissolved organic carbon (DOC) indicated the possible interactions between PFAA and natural organic matter could favor short-chain PFAAs to retain in bulk water. When water quality conditions change or hydraulic disturbance occur, loose deposits may enter tap water bringing accumulated PFAAs with it, which may result in potential health risks.	1							B	-		
D411	ばく露	Munoz, G; Fechner, LC; Geneste, E; Pardon, P; Budzinski, H; Labadie, P	Spatio-temporal dynamics of per and polyfluoroalkyl substances (PFASs) and transfer to periphytic biofilm in an urban river: case-study on the River Seine	2018	Environ. Sci. Pollut. Res. 2018 Aug:25(24):23574-23582. doi: 10.1007/s11356-016-8051-9.	This study addresses the spatio-temporal dynamics of per and polyfluoroalkyl substances (PFASs) in a highly urbanized freshwater hydrosystem, the Seine River (NW France). The distribution of PFASs between water, sediment, and periphytic biofilm was investigated at three sampling sites along a longitudinal gradient upstream and downstream from the Paris urban area. Seasonal variability was assessed through four sampling campaigns performed under contrasting hydrological conditions. In the dissolved phase, aPFASs fluctuated between 2 and 9 ng L-1 upstream and 6-105 ng L-1 downstream from Paris. Negative correlations between dissolved PFAS levels and river flow rate were generally observed, corroborating the predominance of point-source PFAS inputs at these sites. 18/19 target PFASs were detected, with a predominance of PFHxS and PFOS (20% of aPFASs each), except for the farthest downstream site where 6:2 FTSA was prevalent (35 +/- 8% of aPFASs), likely reflecting industrial and urban inputs. In biofilms, aPFASs fell in the 4-32 ng g(-1) dw range, and substantial bioconcentration factors (BCFs) were reported for PFNA, PFDA, and PFOS (log BCF 2.1-4.3), higher than those of PFHxS or PFOA. BCFs varied inversely with dissolved PFAS levels, potentially pointing to concentration-dependent bioaccumulation. Biofilm community characteristics (C/N ratio) may also be an influential determinant of PFAS bioaccumulation.			1					B	-		
D412	ばく露	Mikolajczyk, S; Warenik-Bany, M; Pajurek, M	Perfluoroalkyl substances in Baltic fish - the risk to consumers	2023	Environ. Sci. Pollut. Res. 2023 May:30(21):59596-59605. doi: 10.1007/s11356-023-26626-w.	Perfluoroalkyl substances (PFASs) were investigated in five Baltic fish species (sprat, herring, salmon, trout, and cod). Each species' median lower bound (LB) concentration of Sigma 14 PFASs was as follows: in sprat it was 3.54 mu g/kg wet weight (w.w.), in cod 2.15 mu g/kg w.w., in salmon 2.10 mu g/kg w.w., in trout 2.03 mu g/kg w. w. and in herring 1.74 mu g/kg w.w.. Regarding the species' median LB of Sigma 4 PFASs (perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS)), sprat was the most contaminated with 2.90 mu g/kg w.w. and herring was the least with 1.17 mu g/kg w.w.. Among all PFASs, PFOS was found in the highest concentrations (range 0.04-9.16 mu g/kg w.w.) and the percentage share in the total concentration of Sigma 14 PFASs was between 56 and 73%. The average proportion of linear PFOS (L-PFOS) in the total PFOS (branched and linear) was the highest in salmon at 89% and trout at 87%, and in the other three species it ranged from 75 to 80%. Different consumption scenarios were assumed and the intake of PFASs was calculated for children and adults. Dietary intake via fish consumption was 3.20-25.13 ng/ kg of body weight (b.w.) for children and 1.68-8.30 ng/kg b.w. for adults. Baltic fish caught along Polish coastal areas are a significant source of PFASs, especially for children.			1					B	-		
D413	ばく露	Sorengard, M; Bergstrom, S; McCleaf, P; Wiberg, K; Ahrens, L	Long-distance transport of per- and polyfluoroalkyl substances (PFAS) in a Swedish drinking water aquifer	2022	Environ Pollut. 2022 Oct 15:311:119981. doi: 10.1016/j.envpol.2022.119981.	Use of per-and polyfluoroalkyl substance (PFAS)-containing aqueous film-forming foams (AFFF) at firefighting training sites (FFTS) has been linked to PFAS contamination of drinking water. This study investigated PFAS transport and distribution in an urban groundwater aquifer used for drinking water production that has been affected by PFAS-containing AFFF. Soil, sediment, surface water and drinking water were sampled. In soil (n = 12) at a FFTS with high perfluorooctane sulfonate (PFOS) content (87% of sigma PFAS), the sigma PFAS concentration (n = 26) ranged from below detection limit to 560 ng g(-1)dry weight. In groundwater (n = 28), the sigma PFAS concentration near a military airbase FFTS reached 1000 ng L-1. Principal component analysis (PCA) identified the military FFTS as the main source of PFAS contamination in drinking water wellfields > 10 km down-gradient. Groundwater samples taken close to the military FFTS site showed no sigma PFAS concentration change between 2013 and 2021, while a location further down-gradient showed a transitory 99.6% decrease. Correlation analysis on PFAS composition profile indicated that this decrease was likely caused by dilution from an adjacent conflating aquifer. sigma PFAS concentration reached 15 ng L-1 (PFOS 47% and PFHxS 41% of sigma PFAS) in surface river water (n = 6) and ranged between 1 ng L-1 and 8 ng L-1(PFHxS 73% and PFBS 17% of sigma PFAS) in drinking water (n = 4). Drinking water had lower PFAS concentrations than the wellfields due to PFAS removal at the water treatment plant. This demonstrates the importance of monitoring PFAS concentrations throughout a groundwater aquifer, to better understand variations in transport from contamination sources and resulting impacts on PFAS concentrations in drinking water extraction areas.				1				B	-		
D414	ばく露	Wang, YX; Liu, JY; Li, JG; Zhao, YF; Wu, YN	Dietary Exposure of Chinese Adults to Perfluoroalkyl Acids via Animal-Origin Foods: Chinese Total Diet Study (2005-2007 and 2011-2013)	2019	J. Agric. Food Chem. 2019 May:67(21):6048-6055. doi: 10.1021/acs.jafc.9b01108.	Diet has been regarded as the main exposure source of perfluoroalkyl acids (PFAAs), but the national dietary survey of PFAAs in China was limited. Here, eight typical PFAAs were detected in milk, aquatic food, meat, and eggs from the Chinese Total Diet Studies (TDSs) during 2005-2007 and 2011-2013. Aquatic food was found to be the main source of PFAAs among animal-origin foods. The estimated dietary intakes of Sigma PFAAs from animal foods (EDIanimal-origin foods) in coastal areas were relatively higher than in inland areas. The highest EDIanimal-origin foods of PFOS [4.07 and 2.02 ng kg(-1) of body weight (bw) day(-1)] and PFOA (2.19 ng kg(-1) of bw day(-1)) found in Shanghai and perfluorononanoic acid (PFNA, 2.72 ng kg(-1) of bw day(-1)) in Fujian approach or exceed current minimal risk levels from the Agency for Toxic Substances and Disease Registry and tolerable weekly intakes from the European Food Safety Authority, suggesting potential risk of PFAA exposure from animalorigin foods in these areas.			1					B	-		
D415	ばく露	Dietz, R; Riget, FF; Galatius, A; Sonne, C; Teilmann, J; Bossi, R	Spatial trends of perfluorochemicals in harbor seals (Phoca vitulina) from Danish waters	2012	Sci. Total Environ. 2012 Jan:414:732-737. doi: 10.1016/j.scitotenv.2011.09.048	Spatial trends of concentrations of perfluorinated chemicals (PFCs) were investigated in harbour seal liver tissue from seven locations in Denmark, ranging from the Wadden Sea in the southern North Sea to the Western Baltic. All samples were collected during the phocine distemper epizootic in 2002 which provided access to a large number of comparable samples over a short time period. PFOS was dominating (mean: 92% of Sigma PFC) among the PFCs in the samples, followed by considerably lower concentrations of PFHxS (1.8%), PFDA (1.7%), PFNA (1.6%) PFUnA (1.5%), PFOA (0.9%) and PFOSA (0.5%). The concentrations of all the investigated compounds showed significant differences among the seven locations. PFOS showed the highest concentrations in the Wadden Sea, where high burdens have also been recorded in German seals. Most compounds showed a trend towards higher concentrations at one or both extremes of the geographic range. Two different patterns of relative PFC concentrations were detected; one in the inner Danish waters where PFOSA and PFUnA were more prevalent and another in the Wadden Sea and Limfjord where PFOA, PFHxS and PFNA were found in greater proportions. These patterns probably represent Baltic and North Sea contamination sources.			1					B	-		
D416	ばく露	Liu, WX; He, W; Wu, JY; Wu, WJ; Xu, FL	Distribution, partitioning and inhalation exposure of perfluoroalkyl acids (PFAAs) in urban and rural air near Lake Chaohu, China	2018	Environ. Pollut. 2018 Dec;243(Pt A):143-151. doi: 10.1016/j.envpol.2018.08.052.	To investigate the distribution, partitioning, and inhalation exposure risks of perfluoroalkyl acids (PFAAs), gaseous and particulate samples were collected monthly between September 2013 and September 2015 in urban and rural areas near Lake Chaohu. Twelve PFAAs were determined by liquid chromatography mass spectrometry. The mean concentrations of PFAAs in the gaseous phase and the particulate phase were 40.31 +/- 31.47 pg/m(3) and 63.26 +/- 41.87 pg/m(3), respectively. Perfluorobutanoic acid (PFBA) was the predominant contaminant in the gaseous phase (32.56% +/- 9.28%), while perfluorooctanoic acid (PFOA) was the main contaminant in the particulate phase (33.21% +/- 18.69%). The ratios of gaseous to particulate distribution ranged from 0.01 to 16.75. The gaseous-particulate partitioning coefficients, ranging from 0.01 to 23.41 +/- 10(-2) m(3)/mu g, were significantly correlated with PM10 concentrations and meteorological conditions, such as temperature and air pressure. The inhalation exposures of PFOA and PFOS were 1.94 +/- 60.2 pg/(kg.d) and 030-4.22 pg/(kg.d), respectively. The carcinogenic risk of PFOA for urban males was the highest and that for rural females was the lowest; the risks were lower than the acceptable level (10(-6)) defined by the US Environmental Protection Agency (USEPA). The non-carcinogenic risks of PFOA and PFOS were far below one.	1							B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D417	ばく露	Fair, PA; Wolf, B; White, ND; Arnott, SA; Kannan, K; Karthikraj, R; Vena, JE	Perfluoroalkyl substances (PFASs) in edible fish species from Charleston Harbor and tributaries, South Carolina, United States: Exposure and risk assessment	2019	Environ. Res. 2019 Apr:171:266-277. doi: 10.1016/j.envres.2019.01.021	Concentrations of 11 PFASs were determined in muscle and whole fish for six species collected from Charleston, South Carolina (SC) for the assessment of potential health risks to humans and wildlife. Across all species and capture locations, total PFAS levels in whole fish were significantly higher than fillets by a factor of two- to three-fold. Mean Sigma PFAS concentrations varied from 12.7 to 33.0 ng/g wet weight (ww) in whole fish and 6.2-12.7 ng/g ww in fillets. For individual whole fish, Sigma PFASs ranged from 12.7 ng/g ww in striped mullet to 85.4 ng/g ww in spotted seatrout, and in fillets individual values ranged from 6.2 ng/g ww in striped mullet to 27.9 ng/g ww in spot. The most abundant compound in each species was perfluorooctane sulfonate (PFOS), comprising 25.5-69.6% of the Sigma PFASs. Striped mullet had significantly lower relative amounts of PFOS compared to all other species and higher relative amounts of PFUnDA compared to Atlantic croaker, spotted seatrout, and spot. Unlike whole fish, PFAS levels in fillets varied significantly by location with higher Sigma PFOS from the Ashley River than the Cooper River and Charleston Harbor, which reflects the levels of PFASs contamination in these systems. In whole fish, differences in relative concentrations of PFOS, PFNA, and PFDA occurred by capture location, suggestive of different sources. PFOS concentrations for southern flounder and spotted seatrout fillets were within the advisory range to limit fish consumption to 4 meals a month. PFOS levels exceeded screening values to protect mammals in 83% of whole fish examined and represent a potential risk to wildlife predators such as dolphins.			1					B	-		
D418	ばく露	Karaskova, P; Codling, G; Melymuk, L; Klanova, J	A critical assessment of passive air samplers for per- and polyfluoroalkyl substances	2018	Atmos. Environ. 2018 Jul:185:186-195. doi: 10.1016/j.atmosenv.2018.05.030	Since their inclusion in the Stockholm Convention, there has been a need for global monitoring of perfluorooctane sulfonate (PFOS), its salts and perfluorooctanesulfonyl fluoride (PFOSF), along with other non-listed highly fluorinated compounds. Passive air samplers (PAS) are ideal for geographic coverage of atmospheric monitoring. The most common type of PAS, using polyurethane foam (PUF) as a sorbent, was primarily developed for non-polar semivolatile organic compounds (SVOCs) and are not well-validated for polar substances such as the per- and polyfluoroalkyl substances (PFASs), however, they have been used for some PFASs, particularly PFOS. To evaluate their applicability, PAS were deployed for measurement of PFASs in outdoor and indoor air. Outdoors, two types of PAS, one consisting of PUF and one of XAD-2 resin, were deployed in an 18-week calibration study in parallel with a low-volume active air sampler (LV-AAS) in a suburban area. Indoors, PUF-PAS were similarly deployed over 12 weeks to evaluate their applicability for indoor monitoring. Samples were analysed for perfluoroalkyl carboxylic acids (PFCAs), perfluoroalkyl sulfonates (PFSAs), perfluorooctane sulfonamides (FOSAs), and perfluorooctane sulfonamidoethanols (FOSEs). In outdoor air, 17 out of the 21 PFAS were detected in more than 50% of samples, with a median Sigma(17)PFASs of 18.0 pg m(-3) while 20 compounds were detected in indoor air with a median concentration Sigma(20)PFASs of 76.6 pg m(-3) using AAS samplers. PFOS was the most common PFAS in the outdoor air while PFBA was most common indoors. Variability between PAS and AAS was observed and comparing gas phase and particle phase separately or in combination did not account for the variation observed. PUF-PAS may still have a valuable use in PFAS monitoring but more work is needed to identify the applicability of passive samplers for ionic PFAS.	1							B	-		
D419	ばく露	Jin, HB; Zhang, YF; Zhu, LY; Martin, JW	Isomer Profiles of Perfluoroalkyl Substances in Water and Soil Surrounding a Chinese Fluorochemical Manufacturing Park	2015	Environ. Sci. Technol. 2015 Apr:49(8):4946-4954. doi: 10.1021/acs.est.5b00212.	Despite that China is the largest global manufacturer of perfluoroalkyl substances (PFASs), the manufacturing methods and isomer purity of these chemicals are generally unknown. Here, sampling was conducted around a major fluorochemical manufacturing park in China in 2012, including soil and water collection inside the park, including from a wastewater treatment plant (WWTP), as well as in surrounding rivers and soil (similar to 15 km radius). Perfluoroalkyl sulfonates (PFSAs) were lower than perfluoroalkyl carboxylates (PFCAs) in all samples, and short-chain (C-4-C-6) PFCAs were predominant. Perfluoroalkyl phosphonates and phosphate diesters were occasionally detected, but at low detection frequency. Branched isomers of perfluorobutanesulfonate (PFBS) are reported for the first time, accounting for 15-27% of total PFBS in water. An enrichment of isopropyl-PFOA (28%) was found in WWTP influent, suggesting its manufacturing primarily by isopropyl telomerization. More numerous branched isomers were observed for the longer C-9-C-13 PFCAs (e.g., C-12 PFCA had 16 branched isomers), including high proportions of one major branched isomer (likely isopropyl), possibly as impurities from isopropyl-PFOA manufacturing. Overall, short-chain perfluorinated acids were the predominant PFASs being released, but PFOA was still a major chemical in use at this site, primarily from isopropyl telomerization.				1				B	-		
D420	ばく露	Guo, MM; Wu, F; Geng, QQ; Wu, HY; Song, ZL; Zheng, GC; Peng, JX; Zhao, XN; Tan, ZJ	Perfluoroalkyl substances (PFASs) in aquatic products from the Yellow-Bohai Sea coasts, China: Concentrations and profiles across species and regions	2023	Environ. Pollut. 2023 Jun:327:121514. doi: 10.1016/j.envpol.2023.121514.	Perfluoroalkyl substances (PFASs) are emerging contaminants capable of harming human health, primarily via ingesting aquatic products. The current study monitored a survey of 23 PFASs in 1049 aquatic products from the coasts of the Yellow-Bohai Sea in China to comprehensively investigate the concentrations and distributions of PFASs. PFOA, PFOS, PFNA, PFOSA, and PFUdA were more predominantly and frequently detected than other PFASs in all samples, dominating PFAS patterns in aquatic products. The mean levels of n-ary sumation PFASs in different species followed the order: marine shellfish > marine crustaceans > fish > cephalopods > sea cucumber. Profiles of PFASs differ between species, suggesting species-specific accumulation plays a role. Various aquatic species are potential environmental bioindicators that signal individual PFAS contamination. For instance, clams can act as a potential PFOA bioindicator. High n-ary sumation PFAS levels in some sites (such as Binzhou, Dongying, Cangzhou, and Weifang) could be attributed to industrial activities involving fluoropolymer manufacture. The differences be-tween PFAS concentrations and profiles in aquatic products across the study regions have been proposed as PFAS fingerprints of the Yellow-Bohai Sea coasts. Analyses of principal components and Spearman correlations indi-cated that the precursor biodegradation possibly contribute to C8-C10 PFCAs in the study samples. This study reported a wide presence of PFASs in different species of aquatic products across the Yellow-Bohai Sea coasts. The potential health risks that PFASs pose in certain species (such as marine shellfish and marine crustaceans) should not be neglected.			1					B	-		
D421	ばく露	Ngoc, NT; Vi, PT; Viet, PH; Anh, DH	Occurrence of perfluorinated chemicals (PFCs) in leachate, surface water and sediment collected from Tay Mo landfill and surrounding areas	2021	Vietnam J. Chem. 2021 Apr:59(2):239-246. doi: 10.1002/vjch.202000157.	The municipal landfill is considered to be a potential source of different environmental contaminants derived from consumer goods, including perfluorinated chemicals (PFCs). Twenty-four leachate, surface water samples and twenty-four sediment samples collected at Tay Mo landfill (Hanoi, Vietnam) and surrounding areas were analysed for sixteen PFCs. Total concentrations of PFCs in leachate and surface water ranged from 103 to 328 ng/L (mean: 161 ng/L) at Tay Mo landfill, 19.1-22.4 ng/L (mean: 20.7 ng/L) in ponds nearby the landfill, 5.19-6.96 ng/L (mean: 5.96 ng/L) in Nhue River around the landfill, 5.57-12.7 ng/L (mean: 9.00 ng/L) in the upstream and 3.81-11.5 ng/L (mean: 7.14 ng/L) in the downstream. The total concentrations of PFCs in landfill sediment which ranged from 3.52 to 6.70 ng/g (mean: 5 ng/g) was 3-4 times higher than those in sediment taken from Nhue River and the ponds around the landfill. The dominating detected compounds were short-chain perfluorinated alkyl substances like PFOA, PFHxA, PFHpA in water, and PFOS, PFBS in sediment.	1			1				B	-		
D422	ばく露	Duong, HT; Kadokami, K; Shirasaka, H; Hidaka, R; Chau, HTC; Kong, LX; Nguyen, TQ; Nguyen, TT	Occurrence of perfluoroalkyl acids in environmental waters in Vietnam	2015	Chemosphere 2015 Mar:122:115-124. doi: 10.1016/j.chemosphere.2014.11.023	This is the first nationwide study of perfluoroalkyl acids (PFAAs) in environmental waters in Vietnam. Twenty-eight river water and 22 groundwater samples collected in four major cities and 14 river water samples from the Red River were screened to investigate the occurrence and sources of 16 PFAAs. Perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA) were the most prevalent of 11 detected PFAAs with maximum concentrations in urban river water of 5.3, 18 and 0.93 ng L-1, respectively, and in groundwater of 8.2, 4.5 and 0.45 ng L-1, respectively. PFAAs in the Red River water were detected at low levels. PFAA concentrations in river water were higher in the rainy season than in the dry season, possibly due to storm water runoff, a common phenomenon in Southeast Asian countries. The highest concentrations of PFAAs in river water were observed in samples from highly populated and industrialized areas, perhaps sourced from sewage. The PFAA concentrations observed were similar to those in other Southeast Asian countries, but lower than in developed nations. From the composition profiles of PFAAs, industrial products containing PFAAs imported from China and Japan might be one of the major sources of PFAAs in the Vietnamese aquatic environment. According to the health-based values and advisory issued by the United States Environmental Protection Agency (USEPA), the concentrations of detected PFAAs in this study do not pose an immediate health risk to humans and aquatic organisms.			1					B	-		

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D423	ばく露	Smalling, KL; Romanok, KM; Bradley, PM; Morriss, MC; Gray, JL; Kanagy, LK; Gordon, SE; Williams, BM; Breitmeyer, SE; Jones, DK; DeCicco, LA; Eagles-Smith, CA; Wagner, T	Per- and polyfluoroalkyl substances (PFAS) in United States tapwater: Comparison of underserved private-well and public-supply exposures and associated health implications	2023	Environ. Int. 2023 Aug:178:108033. doi: 10.1016/j.envint.2023.108033.	Drinking-water quality is a rising concern in the United States (US), emphasizing the need to broadly assess exposures and potential health effects at the point-of-use. Drinking-water exposures to per- and poly-fluoroalkyl substances (PFAS) are a national concern, however, there is limited information on PFAS in residential tapwater at the point-of-use, especially from private-wells. We conducted a national reconnaissance to compare human PFAS exposures in unregulated private-well and regulated public-supply tapwater. Tapwater from 716 locations (269 private-wells; 447 public supply) across the US was collected during 2016-2021 including three locations where temporal sampling was conducted. Concentrations of PFAS were assessed by three laboratories and compared with land-use and potential-source metrics to explore drivers of contamination. The number of individual PFAS observed ranged from 1 to 9 (median: 2) with corresponding cumulative concentrations (sum of detected PFAS) ranging from 0.348 to 346 ng/L. Seventeen PFAS were observed at least once with PFBS, PFHxS and PFOA observed most frequently in approximately 15% of the samples. Across the US, PFAS profiles and estimated median cumulative concentrations were similar among private wells and public-supply tapwater. We estimate that at least one PFAS could be detected in about 45% of US drinking-water samples. These detection probabilities varied spatially with limited temporal variation in concentrations/numbers of PFAS detected. Benchmark screening approaches indicated potential human exposure risk was dominated by PFOA and PFOS, when detected. Potential source and land-use information was related to cumulative PFAS concentrations, and the number of PFAS detected; however, corresponding relations with specific PFAS were limited likely due to low detection frequencies and higher detection limits. Information generated supports the need for further assessments of cumulative health risks of PFAS as a class and in combination with other co-occurring contaminants, particularly in unmonitored private-wells where information is limited or not available.				1			1	A	-	米国の飲料水（個人の飲用井戸を含む）を対象とした大規模調査でPFAS濃度の情報として有用	
D424	ばく露	Ge, H; Yamazaki, E; Yamashita, N; Taniyasu, S; Ogata, A; Furuuchi, M	Particle size specific distribution of perfluoro alkyl substances in atmospheric particulate matter in Asian cities	2017	Environ. Sci.-Process Impacts 2017 Apr:19(4):549-560. doi: 10.1039/c6em00564k.	Seasonal and local characteristics of perfluorinated alkylated substances (PFASs) were examined using sizesegregated particles including an ultrafine range. The examination included sampling and analysis of ambient particles collected at four sites located in different environments in three different countries, Japan (Kanazawa and Okinawa), Hong Kong and India. To minimize the evaporation artefacts derived from PFASs during the sampling, an air sampler that permitted particles smaller than 0.1 mm (PM0.1) to be separated at a moderate pressure drop (< 5-15 kPa), was used for all of the air sampling procedures. In the case of Kanazawa, a local city in Japan, the concentration of PFASs was found to be dominated by carboxylates, especially PFOA, PFNA and PFDA regardless of the particle size and sampling period. Ultrafine particles were found to be the largest contributor to the mass fraction of PFCAs, while the maximum PFOS mass fractions were determined to be in the coarse-sized fractions. The seasonal difference in the total PFAS concentration can be largely attributed to precipitation. The results were basically similar for all sites that were examined. The type of land use may be a more influencing factor on the mass fraction of the PFASs than the country of origin. The dependency of PFAS mass fraction on the specific surface of the particle suggests that ultrafine PFAS particles are segregated, not only by gas deposition but could also be segregated by a mechanism involving compositional dependence or the primary source of the particles. Other possible sources of PFASs, other than from traffic are also possible.								B	-		
D425	ばく露	Kratzer, J; Ahrens, L; Roos, A; Backlin, BM; Ebinghaus, R	Reprint of: Temporal trends of polyfluoroalkyl compounds (PFCs) in liver tissue of grey seals (Halichoerus grypus) from the Baltic Sea, 1974-2008	2011	Chemosphere. 2011 Sep:85(2):253-261. doi: 10.1016/j.chemosphere.2011.09.001.	Temporal trends of polyfluoroalkyl compounds (PFCs) were examined in grey seal (Halichoerus grypus) liver from the Baltic Sea over a period of 35 years (1974-2008). In total, 17 of 43 PFCs were found, including the perfluoroalkyl sulfonates (C-4-C-10 PFSAs), perfluorooctanesulfinate (PFOSi), long chain perfluoroalkyl carboxylates (C-7-C-14 PFCAs), and perfluoroalkyl sulfonamides (i.e., perfluorooctane sulfonamide (FOSA) and N-ethyl perfluorooctane sulfonamide (EtFOSA)), whereas saturated and unsaturated fluorotelomer carboxylates, shorter chain PFCAs and perfluoroalkyl phosphonic acids were not detected. Perfluorooctane sulfonate (PFOS) was the predominant compound (9.57-1444 ng g(-1) wet weight (ww)), followed by perfluorononanoate (PFNA, 0.47-109 ng g(-1) WW). C-6-C-8 PFSAs, PFOSi and C-7-C-13 PFCAs showed statistically significant increasing concentrations between 1974 and 1997, with a peak in 1997 and then decreased or levelled off (except for C-12 and C-13 PFCAs). FOSA had a different temporal trend with a maximum in 1989 followed by significant decreasing concentrations until 2008. Toxicological implications for grey seals are limited, but the maximal PFOS concentration found in this study was about 40 times lower than the predicted lowest observed effect concentrations (LOEC). The statistically significant decreasing concentrations or levelling off for several PFCs in the relative closed marine ecosystem of the Baltic Sea indicate a rapidly responding to reduced emissions to the marine environment. However, the high concentrations of PFOS and continuing increasing concentrations of the longer chain PFCAs (C-12-C-14) shows that further work on the reduction of environmental emissions of PFCs are necessary.				1				B	-		
D426	ばく露	Ericson, I; Nadal, M; van Bavel, B; Lindstrom, G; Domingo, JL	Levels of perfluorochemicals in water samples from Catalonia, Spain: is drinking water a significant contribution to human exposure?	2008	Environ. Sci. Pollut. Res. 2008 Nov:15(7):614-619. doi: 10.1007/s11356-008-0040-1.	Background, aim, and scope In recent years, due to a high persistence, biomagnification in food webs, presence in remote regions, and potential toxicity, perfluorochemicals (PFCs) have generated a considerable interest. The present study was aimed to determine the levels of perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and other PFCs in drinking water (tap and bottled) and river water samples from Tarragona Province (Catalonia, Spain). Materials and methods Municipal drinking (tap) water samples were collected from the four most populated towns in the Tarragona Province, whereas samples of bottled waters were purchased from supermarkets. River water samples were collected from the Ebro (two samples), Cortiella, and Francoli Rivers. After pretreatment, PFC analyses were performed by HPLC-MS. Quantification was done using the internal standard method, with recoveries between 68% and 118%. Results In tap water, PFOS and PFOA levels ranged between 0.39 and 0.87 ng/L (0.78 and 1.74 pmol/L) and between 0.32 and 6.28 ng/L (0.77 and 15.2 pmol/L), respectively. PFHpA, PFHxS, and PFNA were also other detected PFCs. PFC levels were notably lower in bottled water, where PFOS could not be detected in any sample. Moreover, PFHpA, PFHxS, PFOA, PFNA, PFOS, PFOSA, and PFDA could be detected in the river water samples. PFOS and PFOA concentrations were between < 0.24 and 5.88 ng/L (< 0.48 and 11.8 pmol/L) and between < 0.22 and 24.9 ng/L (< 0.53 and 60.1 pmol/L), respectively. Discussion Assuming a human water consumption of 2 L per day, the daily intake of PFOS and PFOA by the population of the area under evaluation was calculated (0.78-1.74 and 12.6 ng, respectively). It was found that drinking water might be a source of exposure to PFCs as important as the dietary intake of these pollutants. Conclusions The contribution of drinking water (tap and bottled) to the human daily intake of various PFCs has been compared for the first time with data from dietary intake of these PFCs. It was noted that in certain cases, drinking water can be a source of exposure to PFCs as important as the dietary intake of these pollutants although the current concentrations were similar or lower than those reported in the literature for surface water samples from a number of regions and countries. Recommendations and perspectives Further studies should be carried out in order to increase the knowledge of the role of drinking water in human exposure to PFCs.				1				B	-		
D427	ばく露	Bangma, JT; Reiner, JL; Jones, M; Lowers, RH; Nilsen, F; Rainwater, TR; Somerville, S; Guillette, LJ; Bowden, JA	Variation in perfluoroalkyl acids in the American alligator (Alligator mississippiensis) at Merritt Island National Wildlife Refuge	2017	Chemosphere 2017 Jan:166:72-79. doi: 10.1016/j.chemosphere.2016.09.088	This study aimed to quantify concentrations of fifteen perfluoroalkyl acids (PFAAs) in the plasma of American alligators (Alligator mississippiensis) inhabiting wetlands surrounding the Kennedy Space Center (KSC) in Florida, USA located at Merritt Island National Wildlife Refuge (MINWR). Approximately 10 male and 10 female alligators (n(total) = 229) were sampled each month during 2008 and 2009 to determine if seasonal or spatial trends existed with PFAA burden. PFOS represented the highest plasma burden (median 185 ng/g) and PFHxS the second highest (median 7.96 ng/g). While no significant seasonal trends were observed, unique spatial trends emerged. Many of the measured PFAAs co-varied strongly together and similar trends were observed for PFOS, PFDA, PFUnA, and PFDoA, as well as for PFOA, PFHxS, PFNA, PFTriA, and PHA, suggesting more than one source of PFAAs at MINWR. Higher concentrations of PFOS and the PFAAs that co-varied with PFOS were collected from animals around sites that included the Shuttle Landing Facility (SLF) fire house and the Neil Armstrong Operations and Checkout (O&C) retention pond, while higher concentrations of PFOA and the PFAA that co-varied with PFOA were sampled from animals near the gun range and the old fire training facility. Sex-based differences and snout-vent length (SVL) correlations with PFAA burden were also investigated. Published by Elsevier Ltd.				1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D428	ばく露	Macheka, LR; Olowoyo, JO; Mugivhisa, LL; Abafe, OA	Determination and assessment of human dietary intake of per and polyfluoroalkyl substances in retail dairy milk and infant formula from South Africa	2021	Sci. Total Environ.2021 Feb;755(Pt 2):142697. doi: 10.1016/j.scitotenv.2020.142697.	Dairy milk and infant formula play important roles in the diet of adolescents, adults and infants, respectively, in the South African population. However, data on the occurrence of legacy and emerging contaminants such as PFAS in these important food sources is lacking. In this study, the concentration of fifteen PFAS were measured in 23 pooled retail dairy milk and 7 pooled infant formulas by means of an ultrahigh performance liquid chromatography tandem mass spectrometric method. The concentrations of Sigma(15)PFAS ranged from 0.08-15.51 ng mL(-1) and 0.42-5.74 ng mL(-1) in dairy milk and infant formulas, respectively. PFBA, PFPeA, PFuDA, PFTrDA and PFDoA were the most prevalent PFAS in both matrices with detection frequency > 96%. Highest PFAS concentrations of 2.02 ng ml(-1) and 2.76 ng ml(-1) were recorded for PFDoA in infant formulas and dairy milk, respectively. The concentrations of legacy PFAS -PFOA and PFOS, shows resemblance with global data, however, elevated concentrations of long chain C-9 - C-14 PFAS were observed in this study. Though, higher concentrations of PFAS were measured in full cream dairy milk, no statistical significant difference (P = 0.546) was observed for the various classes of dairy milk. The EDI of Sigma(15)PFAS through infant formulas were 184.92, 329.47 and 166 ngkg(-1)BWday(-1) for partially breastfed, exclusively formula fed and older infants, respectively. Similarly, the EDI of PFAS through dairy milk for toddlers, adolescents, female and male adults for the rural population were 14.17, 1.09, 2.59 and 3.16 ngkg(-1)BWday(-1) respectively while they were 20.41, 3.84, 4.13 and 4.26 ngkg(-1)BWday(-1) respectively in the urban population. Although, the EDI of PFAS through the consumption of infant formulas and dairy milk are lower than the daily tolerable limits, the relative importance of long-term exposure and the cumulative effects of multiple exposure pathways cannot be overemphasized.	1							B	-		
D429	ばく露	Blazer, VS; Gordon, SE; Walsh, HL; Smith, CR	Perfluoroalkyl Substances in Plasma of Smallmouth Bass from the Chesapeake Bay Watershed	2021	Int. J. Environ. Res. Public Health. 2021 Jun;18(11):5881. doi: 10.3390/ijerph18115881.	Smallmouth bass Micropterus dolomieu is an economically important sportfish and within the Chesapeake Bay watershed has experienced a high prevalence of external lesions, infectious disease, mortality events, reproductive endocrine disruption and population declines. To date, no clear or consistent associations with contaminants measured in fish tissue or surface water have been found. Therefore, plasma samples from two sites in the Potomac River and two in the Susquehanna River drainage basins, differing in land-use characteristics, were utilized to determine if perfluoroalkyl substances were present. Four compounds, perfluorooctane sulphonic acid (PFOS), perfluoroundecanoic acid (PFUnA), perfluorodecanoic acid (PFDA) and perfluorododecanoic acid (PFDoA), were detected in every fish. Two additional compounds, perfluorooctane sulphonamide (PFOSA) and perfluorononanoic acid (PFNA), were less commonly detected at lower concentrations, depending on the site. Concentrations of PFOS (up to 574 ng/mL) were the highest detected and varied significantly among sites. No seasonal differences (spring versus fall) in plasma concentrations were observed. Concentrations of PFOS were not significantly different between the sexes. However, PFUnA and PFDoA concentrations were higher in males than females. Both agricultural and developed land-use appeared to be associated with exposure. Further research is needed to determine if these compounds could be affecting the health of smallmouth bass and identify sources.			1					B	-		
D430	ばく露	Zushi, Y; Ye, F; Motegi, M; Nojiri, K; Hosono, S; Suzuki, T; Kosugi, Y; Yaguchi, K; Masunaga, S	Spatially Detailed Survey on Pollution by Multiple Perfluorinated Compounds in the Tokyo Bay Basin of Japan	2011	Environ. Sci. Technol. 2011 Apr;45(7):2887-2893. doi: 10.1021/es103917r.	Pollution from 35 perfluorinated compounds (PFCs) in the water of the Tokyo Bay basin was examined. The water in the basin contained relatively high levels of perfluorononanoate (PFNA), perfluorooctanoate (PFOA), and perfluorooctane sulfonate (PFOS) compared to the other PFCs, which were present at concentrations of 20.1 ng/L, 6.7 ng/L, and 5.8 ng/L, respectively. In contrast, the concentrations of their precursors and degradation products were an order of magnitude lower. Sewage treatment plant (STP) effluent in the area also contained high levels of PENA compared with the river water samples (Mann-Whitney U-test, $p < 0.0002$). From a spatial aspect, increases in PFC pollution levels correlated with increased urbanization in the study area suggested that there are nonpoint source contributors to the PFC pollution in this area. Branched isomers of the PFCs were also quantified. Samples that contained high concentrations of perfluoroalkyl carboxyfates (PFCA) showed lower proportions of its branched isomer. This indicates that the branched isomers are more prominent in the area with lower PFC pollution. This analysis was beneficial for estimating the individual contributions of different PFCA production processes. This survey provided new information on the sources, spatial distribution, and behavioral characteristics of PFC pollutants in this area.			1					B	-		
D431	ばく露	Kim, SK; Li, DH; Shoeib, M; Zoh, KD	Contribution of diffuse inputs to the aqueous mass load of perfluoroalkyl acids in river and stream catchments in Korea	2014	Sci. Total Environ. 2014 Feb:470:1430-1440. doi: 10.1016/j.scitotenv.2013.06.040	Recent studies disagree regarding the contributions of point versus non-point sources to the aqueous mass loads of perfluoroallcyl acids (PFAAs). This study investigated the longitudinal change in PFAA mass load from upstream to downstream stations along rivers and/or streams to assess the relative contributions of point versus nonpoint inputs. With concentrations 10 to 100 times higher than running water, point sources such as wastewater treatment plants (WWTPs) effluent and airport ditch-outlet (ADO) water were separated from neighboring upstream and downstream running waters using principal component analysis. Source waters were characterized by certain predominant components [e.g., perfluorobutylsulfonate (PFBS) and perfluorooctanoic acid (PFOA) in WWTP effluent and perfluorohexylsulfonate (PFHxS) and perfluorooctylsulfonate (PFOS) in ADO water], which were minor components of running water. From a mass balance assessment of PFAA mass load, certain compounds such as PFOA and PFBS dominated the contribution of point sources to the mass load in the running water at downstream stations or in small catchment basins with high levels of industrial activity. Most of the mass load in the investigated catchments was attributable to upstream running water with a minor influence from industrial, commercial, and domestic human activities. Furthermore, the negative relationship of per capita emission factors (hereafter, EFs) with population density and a lower contribution of PFAA from WWTPs (similar to 30% on average) compared to the running water-derived mass load at the national level indicated that diffuse inputs were more important contributors to aqueous PFAA contamination in each catchment basin as well as the entire watershed of the country (Korea). Volatile precursor compounds, which are readily dispersed to neighboring basins and transformed to PFAAs in the ambient environment, can be an important source of these diffuse inputs and will become more significant over time.			1	1				B	-		
D432	ばく露	Lin, Y; Capozzi, SL; Lin, L; Rodenburg, LA	Source apportionment of perfluoroalkyl substances in Great Lakes fish	2021	Environ. Pollut. 2021 Dec:290:118047. doi: 10.1016/j.envpol.2021.118047.	Due to the complex sources and fate of perfluoroalkyl substance (PFAS), their source apportionment in the environment remains a challenge. A data set of 11 straight-chain PFAS in 139 samples of fish in the Great Lakes was analyzed using positive matrix factorization (PMF) to investigate their primary sources, whose spatial variations were examined against the surrounding environmental factors. PMF analysis produced five fingerprints. Factor 1 (72% of Sigma(11) PFAS, dominated by PFOS) probably represented emissions from primary sources (such as consumer products) and secondary sources (precursors), and increased in average abundance from west to east across the Great Lakes. Factor 2 (13% of Sigma(11) PFAS) and factor 3 (7% of Sigma(11) PFAS), highly loaded with long-chain PFAS and PFNA, respectively, were thought to represent PVDF manufacture or processing in metal plating. They showed higher contributions in sparsely populated Lakes Superior and Huron. Factor 4 (5% of Sigma(11) PFAS, highly loaded with PFOS and PFHxS) presented hot spots near current and former air force bases, suggesting it was related to aqueous film-forming foams (AFFFs). Factor 5 (4% of Sigma(11) PFAS) contained primarily PFOS and PFOSA, which may imply metabolism of precursors (PFOSA) to PFOS in vivo. Unexpectedly, the spatial trends of the five sources all showed abnormally low values near the more urbanized Chicago and Milwaukee in Lake Michigan, which may be due to their unique wastewater and stormwater infrastructure or may arise from atmospheric transport of precursors. Our study indicated that PMF was an effective tool to identify sources of PFAS in fish despite absorption, distribution, metabolism, and excretion (ADME) processes which might alter fingerprints in fish relative to their surrounding environment.			1					B	-		
D433	システマティックレビュー（ばく露）	Pasecnaja, E; Bartkevics, V; Zacs, D	Occurrence of selected per- and polyfluorinated alkyl substances (PFASs) in food available on the European market - A review on levels and human exposure assessment	2022	Chemosphere. 2022 Jan;287(Pt 4):132378. doi: 10.1016/j.chemosphere.2021.132378.	Per-and polyfluorinated alkyl substances (PFASs) are considered emerging persistent organic pollutants, which are chemically, thermally, and biologically stable, or degrade to persistent end products. Dietary intake is considered as one of the main human exposure pathways of these chemicals and, having entered the human body, PFASs are not metabolised and accumulate in tissues, while their toxicological properties may cause various health problems. Several studies on the occurrence of PFASs in various food types have been conducted, including the assessment of dietary exposure. The most important sources were fish, meat, eggs, fruits, and vegetables. Fruits and vegetables recently showed relatively high levels of PFASs, and have become a more significant source of PFASs than meat. In 2020, the European Food Safety Authority (EFSA) published an opinion, setting the tolerable weekly intake (TWI) of 4.4 ng kg-1 b.w. for the sum of perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexanesulphonic acid (PFHxS), and perfluorooctanesulphonic acid (PFOS). The emphasis in this paper is on the systematization of available information on the distribution of PFASs and their levels in different food, with a special interest in data from the Europe. The current legislation and estimated dietary intakes by the general population are described. While the available information on tolerably daily intakes estimated in a number of European countries often exceeds the newly established EFSA TWI, a critical evaluation of performance characteristics of the reviewed analytical methodologies revealed the insufficient sensitivity of quantification procedures for accurate risk assessment according to the guidelines proposed by EFSA.			1					B	-	総説	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D434	ばく露	Shivakoti, BR; Tanaka, S; Fujii, S; Kunacheva, C; Boontanon, SK; Musirat, C; Seneviratne, STMLD; Tanaka, H	Occurrences and behavior of perfluorinated compounds (PFCs) in several wastewater treatment plants (WWTPs) in Japan and Thailand	2010	J. Environ. Monit. 2010 ;12:1255-1264. doi: 10.1039/b927287a	This study examines occurrences of 11 perfluorinated compounds (PFCs) in several wastewater treatment plants in Japan and Thailand. Surveys are conducted in eight wastewater treatment plants (WWTPs) in Japan and central WWTPs of five industrial estates (IEs) in Thailand. Samples are collected from all major treatment processes in order to understand the behavior of PFCs in WWTPs. PFCs are detected in all WWTPs in Japan and Thailand. Concentrations of PFCs even exceed several thousands ng/L in some WWTPs. PFOS, PFOA, and PFNA are mainly detected in WWTPs in Japan, while PFBuS, PFOA, and PFHxA are mainly detected inWWTP of IEs in Thailand. Even though some of the investigated WWTPs utilize biological treatment processes coupled with chlorination, ozonation, or activated carbon adsorption, they are found ineffective to remove PFCs. During the treatment process, PFCs are found to accumulate at exceptionally high concentration levels in the activated sludge of an aeration tank and returned activated sludge. Overall, the estimated total daily mass of discharged PFCs is 124.95 g/d (PFASs: 49.81 g/d; PFCAs: 75.14 g/d) from eight WWTPs in Japan and 55.04 g/d (PFASs: 12 g/d; PFCAs: 43.04 g/d) from five WWTPs in Thailand. Although the presented data are from a single observation in each WWTP, the results indicate that certain industries using PFCs in manufacturing processes could be the principle point source, while domestic activities could be releasing PFCs at detectable levels causing environmental concern.		1	1					B	-		
D435	ばく露	Schiavone, A; Corsolini, S; Kannan, K; Tao, L; Trivelpiece, W; Torres, D; Focardi, S	Perfluorinated contaminants in fur seal pups and penguin eggs from South Shetland, Antarctica	2009	Sci. Total Environ. 2009 Jun:407(12):3899-3904. doi: 10.1016/j.scitotenv.2008.12.058.	Perfluorinated compounds (PFCs) have emerged as a new class of global environmental pollutants. In this study, the presence of perfluorochemicals (PFCs) in penguin eggs and Antarctic fur seals was reported for the first time. Tissue samples from Antarctic fur seal pups and penguin eggs were collected during the 2003/04 breeding season. Ten PFC contaminants were determined in seal and penguin samples. The PFC concentrations in seal liver were in the decreasing order, PFOS>PFNA>PFHpA>PFUnDA while in Adelie penguin eggs were PFHpA>PFUnDA>PFDA>PFDoDA, and in Gentoo penguin eggs were PFUnDA>PFOS>PFDoDA>PFHpA. The PFC concentrations differed significantly between seals and penguins ($p<0.005$) and a species-specific difference was found between the two species of penguins ($p<0.005$). In our study we found a mean concentration of PFOS in seal muscle and liver samples of 1.3 ng/g and 9.4 ng/g wet wt, respectively, and a mean concentration in Gentoo and Adelie penguin eggs of 0.3 ng/g and 0.38 ng/g wet wt, respectively. PFCs detected in penguin eggs and seal pups suggested oviparous and viviparous transfer of PFOS to eggs and off-springs.			1					B	-		
D436	ばく露	Makowska, K; Martin, J; Rychlik, A; Aparicio, I; Santos, JL; Alonso, E; Gonkowski, S	Assessment of exposure to perfluoroalkyl substances (PFASs) in dogs by fur analysis	2021	Environ. Pollut. 2021 Oct:286:117435. doi: 10.1016/j.envpol.2021.117435.	Poly- and perfluoroalkyl substances (PFASs) are a large group of chemicals commonly used in various branches of industry, which may adversely affect the living organisms. The aim of this study were to evaluate exposure of dogs to six selected PFASs: five perfluoroalkyl carboxylic acids (perfluorobutanoic acid - PFBuA, perfluoropentanoic acid - PFPeA, perfluorohexanoic acid - PFHxA, perfluoroheptanoic acid - PFHpA, perfluorooctanoic acid-PFOA) and perfluorooctane sulfonic acid (PFOS) through the analysis of fur samples. To our knowledge this is the first study concerning the use of fur samples to evaluation of exposure of domestic animals to PFASs. Relationship between PFASs concentration and age, gender and body weight of animals was also evaluated. Fur samples were collected from 30 dogs living in Olsztyn (Poland). All PFASs studied were detected in the canine fur samples. The highest concentrations were observed in the case of PFOA and PFBuA, detected at concentrations in the range between 1.51 and 66.7 ng/g and 0.98-26.6 ng/g, respectively. During the present study generally no statistically significant differences dependent on gender, age and body weight of animals were found. This study confirms the suitability of fur samples for biomonitoring of exposure to PFASs in domestic animals, what may be important in veterinary toxicology.	1	1					B	-		
D437	ばく露	Li, L; Zheng, HY; Wang, TY; Cai, MH; Wang, P	Perfluoroalkyl acids in surface seawater from the North Pacific to the Arctic Ocean: Contamination, distribution and transportation	2018	Environ. Pollut. 2018 Jul:238:168-176. doi: 10.1016/j.envpol.2018.03.018	The bioaccumulative, persistent and toxic properties of long-chain perfluoroalkyl acids (PFAAs) resulted in strict regulations on PFAAs, especially in developed countries. Consequently, the industry manufacturing of PFAAs shifts from long-chain to short-chain. In order to better understand the pollution situation of PFAAs in marine environment under this new circumstance, the occurrence of 17 linear PFAAs was investigated in 30 surface seawater samples from the North Pacific to Arctic Ocean (123 degrees E to 24 degrees W, 32 to 82 degrees N) during the sixth Chinese Arctic Expedition in 2014. Total concentrations of PFAAs (Sigma PFAAs) were between 346.9 pg per liter (pg/L) to 3045.3 pg/L. The average concentrations of Sigma PFAAs decreased in the order of East China Sea (2791.4 pg/L, n = 2), Sea of Japan (East Sea) (832.8 pg/L, n = 6), Arctic Ocean (516.9 pg/L, n = 7), Chukchi Sea (505.2 pg/L, n = 4), Bering Sea (501.2 pg/L, n = 8) and Sea of Okhotsk (417.7 pg/L, n = 3). C4 to C9 perfluoroalkyl carboxylic acids (PFCAs) were detected in more than 80% of the surface water samples. Perfluorobutanoic acid (PFBA) was the most prevalent compound and perfluorooctanoic acid (PFOA) was the second abundant homolog. The concentration of individual PFAAs in the surface seawater of East China Sea was much higher than other sampling seas. As the spatial distribution of PFAAs in the marine environment was mainly influenced by the river inflow from the basin countries, which proved the large input from China. Furthermore, the marginal seas of China were found with the greatest burden of PFOA comparing the pollution level in surface seawater worldwide. PFBA concentration in the surrounding seas of China was also high, but distributed more evenly with an obvious increase in recent years. This large-scale monitoring survey will help the improvement and development of PFAAs regulations and management, where production shift should be taken into consideration.	1						B	-		
D438	ばく露	Zhao, PJ; Xia, XH; Dong, JW; Xia, N; Jiang, XM; Li, Y; Zhu, YM	Short- and long-chain perfluoroalkyl substances in the water, suspended particulate matter, and surface sediment of a turbid river	2016	Sci. Total Environ. 2016 Oct:568:57-65. doi: 10.1016/j.scitotenv.2016.05.221	Perfluoroallcyl substances (PFASs) have attracted attentions all around the world. However, little is known about their distribution among water, suspended particulate matter (SPM), and sediment phases in rivers, especially for the short-chain PFASs. In this work, the Yellow River, the largest turbid river in the world, was selected as a case to study eleven kinds of PFASs in the three phases of rivers. These PFASs included C4-C12 perfluorinated carboxylates (PFCAs), perfluorobutyl sulfonate (PFBS), and perfluorooctansulfonate (PFOS), among which C4-C7 PFCAs and PFBS belong to short-chain PFASs, while CS-C12 PFCAs and PFOS belong to long-chain PFASs. The results showed that the total PFAS concentration ranged from 44.7 ng L-1 to 1.52 mu g L-1 in the water, from 8.19 to 17.4 ng g(-1) min the sediment, and from 3.44 to 147 ng g(-1) min the SPM. Short-chain PFASs predominated in the water and could reach up to 88.8% of the total PEAS concentration in water, while long-chain PFASs prevailed in the sediment and SPM. The PEAS concentration in SPM showed a significant negative correlation with SPM concentration in river water ($p < 0.01$). The distribution coefficients (K-d) of PEASs between sediment/SPM and water increased with their chain length and there was a positive correlation between logK(d) and logK(ow) (ocianol-water partition coefficients). The total annual flux of all the eleven PFASs was estimated at 3.88 tons for the Yellow River into the Bohai Sea, among which the PFOA flux was the highest (0.90 tons). The widely occurrence and high concentrations of short-chain PFASs in the Yellow River indicates the shift of manufacturing focus of perfluoroalkyl chemicals from traditional long-chain ones to short-chain ones. Further studies should be conducted to evaluate the eco-environmental risks of these short-chain PFASs in water environments.				1			B	-		
D439	ばく露	Ali, AM; Langberg, HA; Hale, SE; Kallenborn, R; Hartz, WF; Mortensen, AK; Ciesielski, TM; McDonough, CA; Jenssen, BM; Breedveld, GD	The fate of poly- and perfluoroalkyl substances in a marine food web influenced by land-based sources in the Norwegian Arctic	2021	Environ. Sci.-Process Impacts 2021 Apr:23(4):588-604. doi: 10.1039/d0em00510j.	Although poly- and perfluorinated alkyl substances (PFAS) are ubiquitous in the Arctic, their sources and fate in Arctic marine environments remain unclear. Herein, abiotic media (water, snow, and sediment) and biotic media (plankton, benthic organisms, fish, crab, and glaucous gull) were sampled to study PFAS uptake and fate in the marine food web of an Arctic Fjord in the vicinity of Longyearbyen (Svalbard, Norwegian Arctic). Samples were collected from locations impacted by a firefighting training site (FFTS) and a landfill as well as from a reference site. Mean concentration in the landfill leachate was 643 +/- 84 ng L-1, while it was 365 +/- 8.0 ng L-1 in a freshwater pond and 57 +/- 4.0 ng L-1 in a creek in the vicinity of the FFTS. These levels were an order of magnitude higher than in coastal seawater of the nearby fjord (maximum level , at the FFTS impacted site). PFOS was the most predominant compound in all seawater samples and in freshly fallen snow (63-93% of). In freshwater samples from the Longyear river and the reference site, PFCA <= C-9 were the predominant PFAS (37-59%), indicating that both local point sources and diffuse sources contributed to the exposure of the marine food web in the fjord. concentrations increased from zooplankton (1.1 +/- 0.32 mu g kg(-1) ww) to polychaete (2.8 +/- 0.80 mu g kg(-1) ww), crab (2.9 +/- 0.70 mu g kg(-1) ww whole-body), fish liver (5.4 +/- 0.87 mu g kg(-1) ww), and gull liver (62.2 +/- 11.2 mu g kg(-1)). PFAS profiles changed with increasing trophic level from a large contribution of 6:2 FTS, FOSA and long-chained PFCA in zooplankton and polychaetes to being dominated by linear PFOS in fish and gull liver. The PFOS isomer profile (branched versus linear) in the active FFTS and landfill was similar to historical ECF PFOS. A similar isomer profile was observed in seawater, indicating major contribution from local sources. However, a PFOS isomer profile enriched by the linear isomer was observed in other media (sediment and biota). Substitutes for PFOS, namely 6:2 FTS and PFBS, showed bioaccumulation potential in marine invertebrates. However, these compounds were not found in organisms at higher trophic levels.				1			B	-		
D440	ばく露	Galatius, A; Dietz, R; Riget, FF; Sonne, C; Kinze, CC; Lockyer, C; Bossi, R	Temporal and life history related trends of perfluorochemicals in harbor porpoises from the Danish North Sea	2011	Mar. Pollut. Bull. 2011 Jul:62(7):1476-1483. doi: 10.1016/j.marpolbul.2011.04.011.	Eighty-five stranded or bycaught harbor porpoises collected from the Danish North Sea between 1980 and 2005 were analyzed for perfluorochemicals in the liver. PFOS was the predominant compound, making up on average 88.9% of the Sigma PFC, followed by PFOSA (7.8%). PFUnA (1.9%) and PFDA (1.2%) were detected in most samples. PFHxS, PFNA and PFOA were only found in a minority of the samples. We found substantial differences in PFC concentrations among life history stages, the highest concentrations were found in neonates, suckling juveniles and lactating females. Such differences should be considered when PFC levels in wildlife are evaluated. The high concentrations found in young porpoises are of concern as PFCs have known toxic effects on the development of the central nervous system and reproductive organs. Despite efforts to reduce PFC emissions, a decreasing temporal trend of concentrations was not detected for any compound. PFCA concentrations were found to be increasing.				1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D441	ばく露	Kwok, KY; Taniyasu, S; Yeung, LWY; Murphy, MB; Lam, PKS; Horii, Y; Kannan, K; Petrick, G; Sinha, RK; Yamashita, N	Flux of Perfluorinated Chemicals through Wet Deposition in Japan, the United States, And Several Other Countries	2010	Environ. Sci. Technol. 2010 Sep:44(18):7043-7049. doi: 10.1021/es101170c.	The widespread distribution of perfluorinated chemicals (PFCs) in different environmental matrices has prompted concern about the sources, fate, and transport of these classes of chemicals. PFCs are present in the atmosphere, but only a few studies have investigated their occurrence in precipitation. In this study, concentrations of 20 PFCs, including C3-C5 short-chain PFCs, were quantified using HPLC-MS/MS in precipitation samples from Japan (n = 31), the United States In = 12), China (n = 5), India (n = 2), and France (n = 2). Among the PFCs measured, perfluoropropanoic acid (PFPrA) was detected in all of the precipitation samples. Average total PFC concentrations ranged from 1.40 to 18.1 ng/L for the seven cities studied. The greatest total PFC concentrations were detected in Tsukuba, Japan, whereas the lowest concentrations were detected in Patna, India. PFPrA, perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA) were found to be the dominant PFCs in Japanese and U.S. precipitation samples. No observable seasonal trend was found in precipitation samples from two locations in Japan. Annual fluxes of PFCs were estimated for Japan and the U.S. and the evidence for precipitation as an effective scavenger of PFCs in the atmosphere is reported.			1					B	-		
D442	ばく露	Yang, HB; Li, GH; Rao, Z; Guo, F; Li, ZB; Xie, F; Tan, H	Occurrence and incidence of 18 per- and polyfluoroalkyl compounds in edible oils commonly consumed in Guiyang, China	2017	Food Addit. Contam. Part A-Chem. 2017 ;34:1573-1583. doi: 10.1080/19440049.2017.1339330	A systematic examination was conducted for the first time of a wide carbon-chain range of per- and polyfluoroalkyl compounds (PFASs) in 83 samples of edible vegetable and animal oils from Guiyang, China. The occurrence and levels of 18 PFASs in seven types of edible oil were analysed. Analytes were determined based on a simplified, sensitive and reliable solvent extraction and liquid chromatography-tandem mass spectrometry method. Ten target PFASs were found and the most frequently detected compounds with maximum concentration were PFOS (88%, 1.93ngg(-1)), PFNA (55.4%; 6.76ngg(-1)), PFHxS (39.8%; 0.36ngg(-1)), and PFOA (16.9%; 0.15ngg(-1)), respectively. The total PFASs concentrations ranged from 0.02 to 6.76ngg(-1), with a mean of 0.94ngg(-1). Significant differences of occurrence between vegetable oils and animal oils were demonstrated based on comparative analysis of the existing data. The investigation results showed that the effect of production reductions of PFOS and PFOA by regulatory was also reflected in edible oils. The dietary intakes of PFOS and PFOA for adults were estimated, which were lower than the available tolerable daily intake (TDI). Because of the global lack of food regulatory thresholds for most per- or polyfluoroalkyl compounds, it was difficult to draw any conclusion at this stage as to how human health is affected through exposure to these compounds. The baseline information of this study will assist in guiding the direction for future investigations and monitoring studies on occurrence, fate and human health-effect research of PFASs.			1					B	-		
D443	ばく露	Wu, J; Junaid, M; Wang, ZF; Sun, WL; Xu, N	Spatiotemporal distribution, sources and ecological risks of perfluorinated compounds (PFCs) in the Guanlan River from the rapidly urbanizing areas of Shenzhen, China	2020	Chemosphere. 2020 Apr:245:125637. doi: 10.1016/j.chemosphere.2019.125637.	Limited studies have demonstrated the environmental concerns of perfluorinated compounds (PFCs) in the rivers flowing through the rapidly urbanizing areas. Therefore, this study aims to investigate the spatial and temporal distribution, major sources and ecological risks of PFCs in the surface water samples, collecting from the Guanlan River, Shenzhen, China. The concentrations of Sigma PFCs ranged from 11.3 to 384 ng/L, with a mean value of 81.8 ng/L in the dry season, and ranged from 6.90 to 619 ng/L, with a mean value of 339 ng/L in the wet season. Short-chain PFCs such as perfluorohexane sulfonate (PFHxS) and perfluorobutane sulfonate (PFBS) were detected as the predominant compounds. Further, the spatiotemporal distribution revealed significantly higher levels of PFCs in the wet season than those in the dry season, and relatively higher levels in the tributaries than those in the mainstream. Source apportionment highlighted the industrial discharges, domestic wastewater, precipitation, and wastewater treatment plants as the major sources of PFCs. Moreover, the population density and associated urban sewage emissions observed as important indicators for PFCs uneven distribution in the area. The ecological risk assessment revealed perfluorotetradecanoic acid (PFTA, C14) posed high ecological risks to the aquatic organisms (especially for mysid) in the Guanlan River. Taken all together, this study not only unveiled the characteristics of PFCs contamination in the rapidly urbanizing catchment, but also provided the baseline data for policy makers to protect the ecological environment of the urban rivers in the rapidly growing area.				1				B	-		
D444	ばく露	Guo, YW; Shi, W; Liang, YQ; Liu, ZW; Xie, Q; Wu, JX; Wu, YP; Sun, X	Spatiotemporal and life history related trends of per- and polyfluoroalkyl substances in Indo-Pacific finless porpoises from south China sea (2007-2020)	2023	Chemosphere. 2023 Jan:310:136780. doi: 10.1016/j.chemosphere.2022.136780.	Per-and polyfluoroalkyl substances (PFASs) levels in Indo-Pacific finless porpoises (Neophocaena phocaenoides) in the Pearl River Estuary (PRE), near the most economically developed region in China, have not been charac-terized. We measured the hepatic concentrations of twelve PFASs, including nine perfluoroalkyl carboxylic acids (PFCAs) and three perfluoroalkane sulfonic acids (PFSAs) in the finless porpoises (n = 21) collected from the PRE between 2007 and 2020. The average level of PFSAs was more than 2-times higher than that of PFCAs. The order of six dominant PFASs was perfluorooctane sulfonate (PFOS) > perfluoroundecanoic acid (PFUdA) > per-fluorodecanoic acid (PFDA) > perfluorotridecanoic acid (PFTrDA) > perfluorononanoic acid (PFNA) > per-fluorododecanoic acid (PFDoDA). The levels of Hepatic PFOS of 29% samples exceeded the no observable adverse effect level (NOAEL) values. The concentration of PFASs in males was significant higher than in females. PFASs levels were significantly negatively correlated with body length in males and positively correlated in females. PFASs levels in the PRE finless porpoises were lower than in humpback dolphins possibly due to different foraging habitat toward the coast and the consumption of less fish. PFCAs levels in finless porpoises from the western PRE were higher compared to Hong Kong, possibly due to the high-intensity sources of terrestrial anthropogenic pollutants. Significant increasing spatiotemporal trends of PFSAs, PFCAs and PFASs			1					B	-		
D445	ばく露	Lu, ZB; Song, LN; Zhao, Z; Ma, YX; Wang, J; Yang, HZ; Ma, HM; Cai, MH; Codling, G; Ebinghaus, R; Xie, ZY; Giesy, JP	Occurrence and trends in concentrations of perfluoroalkyl substances (PFASs) in surface waters of eastern China	2015	Chemosphere 2015 Jan:119:820-827. doi: 10.1016/j.chemosphere.2014.08.045	Spatial distributions of perfluoroalkyl substances (PFASs) were investigated in surface waters in Shanghai, Jiangsu and Zhejiang Provinces of eastern China during 2011. A total of 39 samples of surface waters, including 29 rivers, 6 lakes and 4 reservoirs were collected. High performance liquid chromatography/negative electrospray ionization-tandem mass spectrometry (HPLC/(-)ESI-MS/MS) was used to identify and quantify PFASs. Concentrations of PFAS were greater in Shanghai than that in Zhejiang Province. Concentrations of the sum of PFASs (Sigma PFASs) in Shanghai and Kunshan ranged from 39 to 212 ng L-1, while in Zhejiang Province, concentrations of Sigma PFASs ranged from 0.68 to 146 ng L-1. Perfluorooctanoic acid (PFOA) was the prevalent PFAS in Shanghai. In contrast, PFOA and perfluorohexanoic acid (PFHxA) were the prevalent PFASs in Zhejiang Province. Concentrations of perfluorooctane sulfonate (PFOS) ranged from <0.07 to 9.7 ng L-1. Annual mass of Sigma PFASs transported by rivers that flow into the East China Sea were calculated to be more than 4000 kg PFASs. Correlation analyses between concentrations of individual PFASs showed the correlation between PFHxA and PFOA was positive, while the correlation between PFHxA and perfluorooctane sulfonamide (FOSA) was negative in Shanghai, which indicated that PFHxA and PFOA have common sources. Principal component analysis (PCA) was employed to identify important components or factors that explain different compounds, and results showed that PFHxA and FOSA dominated factor loadings.		1						B	-		
D446	ばく露	Huset, CA; Barlaz, MA; Barofsky, DF; Field, JA	Quantitative determination of fluorochemicals in municipal landfill leachates	2011	Chemosphere. 2011 Mar:82(10):1380-1386. doi: 10.1016/j.chemosphere.2010.11.072.	Twenty-four fluorochemicals were quantified in landfill leachates recovered from municipal refuse using an analytical method based on solid-phase extraction, dispersive-carbon sorbent cleanup, and liquid chromatography/tandem mass spectrometry. The method was applied to six landfill leachates from four locations in the US as well as to a leachate generated by a laboratory bioreactor containing residential refuse. All seven leachates had the common characteristic that short-chain (C-4-C-7) carboxylates or sulfonates were greater in abundance than their respective longer-chain homologs (>= C8). Perfluoroalkyl carboxylates were the most abundant (67 +/- 4% on a nanomolar (nM) basis) fluorochemicals measured in leachates: concentrations of individual carboxylates reaching levels up to 2800 ng L-1. Perfluoroalkyl sulfonates were the next most abundant class (22 +/- 2%) on a nM basis: their abundances in each of the seven leachates derived from municipal refuse were greater for the shorter-chain homologs (C-4 and C-6) compared to longer-chain homologs (C-8 and C-10). Perfluorobutane sulfonate concentrations were as high as 2300 ng L-1. Sulfonamide derivatives composed 8 +/- 2.1% (nM basis) of the fluorochemicals in landfill leachates with methyl (C-4 and C-8) and ethyl (C-8) sulfonamide acetic acids being the most abundant. Fluorotelomer sulfonates (6:2 and 8:2) composed 2.4 +/- 1.3% (nM basis) of the fluorochemicals detected and were present in all leachates.					1			B	-		
D447	ばく露	Wang, Y; Shi, YL; Cai, YQ	Spatial distribution, seasonal variation and risks of legacy and emerging per- and polyfluoroalkyl substances in urban surface water in Beijing, China	2019	Sci. Total Environ. 2019 Jul:673:177-183. doi: 10.1016/j.scitotenv.2019.04.067	In the current study, we investigated the occurrence, spatial distribution and seasonal variation of per- and polyfluoroalkyl substances (PFASs), including one group of emerging PFASs, the chlorinated polyfluoroalkyl ether sulfonic acids (Cl-PFESAs), in urban surface water (river and lake) samples from October 2013 to September 2014 (except during the frozen period) in Beijing, China. Perfluorobutanoic acid (PFBA) and perfluoropentanoic acid (PFPeA) were the dominant compounds, with average concentrations of 12.79 and 9.90 ng/L, respectively. For Cl-PFESAs, only C8 Cl-PFESA could be detected, and its concentration ranged from	1							B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D448	ばく露	Liu, ZY; Lu, YL; Shi, YJ; Wang, P; Jones, K; Sweetman, AJ; Johnson, AC; Zhang, M; Zhou, YQ; Lu, XT; Su, C; Sarvajayakesavaluc, S; Khan, K	Crop bioaccumulation and human exposure of perfluoroalkyl acids through multi-media transport from a mega fluorochemical industrial park, China	2017	Environ. Int. 2017 Sep:106:37-47. doi: 10.1016/j.envint.2017.05.014	Significant quantities of perfluoroalkyl acids (PFAAs) are released to the environment from fluorochemical manufacturing processes through wastewater discharge and air emission in China, which may lead to human exposure and health risks through crop bioaccumulation from PFAAs-contaminated soil and irrigation water. This paper systematically studied the distribution and transport of PFAAs in agricultural soil, irrigation water and precipitation, followed by crop bioaccumulation and finally human exposure of PFAAs within a 10 km radius around a mega-fluorochemical industrial park (FIP). Hotspots of contamination by PFAAs were found near the FIP and downstream of the effluent discharge point with the maximum concentrations of 641 ng/g in agricultural soil, 480 ng/g in wheat grain, 58.8 ng/g in maize grain and 4,862 ng/L in precipitation. As the distance increased from the FIP, PFAAs concentrations in all media showed a sharp initial decrease followed by a moderate decline. Elevated PFAA concentrations in soil and grains were still present within a radius of 10 km of the FIP. The soil contamination was associated with the presence of PFAAs in irrigation water and precipitation, and perfluorooctanoic acid (PFOA) was the dominant PFAA component in soil. However, due to bioaccumulation preference, short-chain perfluoroalkyl carboxylic acids (PFCAs), especially perfluorobutanoic acid (PFBA), became the major PFAA contaminants in grains of wheat and maize. The bioaccumulation factors (BAFs) for both grains showed a decrease with increasing chain length of PFAAs (approximately 0.5 log decrease per CF2 group). Compared to maize grain, wheat grain showed higher BAFs, possibly related to its higher protein content. The PFCA (C4-C8) concentrations (on a log(10) basis) in agricultural soil and grain were found to show a linear positive correlation. Local human exposure of PFOA via the consumption of contaminated grains represents a health risk for local residents, especially for toddlers and children.	1							B	-		
D449	ばく露	Gu, CJ; Xu, CY; Zhou, Q; Shen, CS; Ma, CY; Liu, SR; Yin, SS; Li, F	Congener- and isomer-specific Perfluorinated compounds in textile wastewater from Southeast China	2021	J. Clean Prod. 2021 Oct:320:128897. doi: 10.1016/j.jclepro.2021.128897.	Perfluorinated compounds (PFCs) are largely used in textile auxiliaries for the water/oil repellent finishing and have been listed as substances of very high concerns globally. Quantifying the generations and emissions of PFCs from textile and dyeing enterprises is of great significance to realizing the cleaner production management. In this study, congener- and isomer-specific PFCs were measured in regulation tank influent and final effluent from 48 textile plants in the Yangtze River Delta, China. The median Sigma(17) PFC concentrations in influent and effluent were 428.5 and 268.0 ng/L, respectively. Short- and medium-chain homologues accounted for three-quarters of the total PFCAs in these wastewater samples. Isomeric fingerprints showed an overwhelming occurrence of linear isomers rather than branched ones for PFOA, PFOS and PFHxS. This implied that PFCs in textile wastewater might not be exclusively from a 3M electrochemical fluorination (ECF) source. Raw materials played an important role in PFCs distributions since significantly higher levels of PFHpA, PFHxA, PFNA, PFDA, PFUnDA and PFTrDA were found in wastewater from chemical fibre manufacturing than from manufacturing of other materials. There was no significant discrepancy in PFCs removal rates between different treatments techniques. Although ecological risk assessment revealed an absent health risks of PFCs from effluent in the short term, the implement of textile cleaner production warrants concern due to the high volumes of water per unit fabric for processing. The widespread PFCs occurrence in textile wastewater highlighted the urgency of PFCs removal and disposal. We also encouraged the replacement of synthetic substances with natural materials, adoptions of technical improvements, and innovations such as life cycle analysis or cluster process management in the development of the textile industry.			1	1				B	-		
D450	ばく露	Liu, RL; Liu, M; Zhao, CX; Fu, JJ; Zhou, W; Zhang, QH; Hansen, M; Dong, Y	Occurrence and Health Risk of Perfluoroalkyl Acids in Popular Shellfish from a Typical Coastal Area of the East China	2023	Chem. Res. Chin. Univ. 2023 Jun:39(3):492-501. doi: 10.1007/s40242-023-3054-9.	As crucial homologous members of per- and polyfluoroalkyl substances(PFASs), perfluoroalkyl acids(PFAAs) have aroused wide public concern because of their unique properties(persistence, bioaccumulation, long-distance migration and toxicity). Studies have shown their potential hazard to wildlife and humans, with food consumption as one of the primary routes of PFAA exposure for general population, especially seafood intake. In this study, 17 PFAAs were quantified in 9 shellfish species from Yuhuan City, a typical coastal area of the East China. The total mean concentrations of PFAAs were in the range of 5.03-381 ng/g dry weight(dw), with the highest concentration found in Neverita didyma and the lowest in Babylonia lutosa. Concentrations and composition profiles of PFAAs varied significantly among different species, indicating differences in the bioaccumulation potential of PFAAs among species. Perfluorooctanoic acid(PFOA) was presented as the most abundant PFAA in this study, followed by perfluorobutanoic acid(PFBA). Significant positive correlations were observed among some individual PFAAs($p<0.05$), indicating that they may share similar pollution sources or undergo similar compound behaviors. Health risk assessment indicated a relatively high threat for local residents exposed to PFAAs through shellfish consumption.	1							B	-		
D451	ばく露	Zhao, ZW; Yue, LX; Qiao, HQ; Li, YN; Cheng, XH; Hua, X; Lin, T; Li, QL; Sun, HW	Perfluoroalkyl acids in dust on residential indoor/outdoor window glass in Chinese cities: occurrence, composition, and toddler exposure	2022	Environ. Sci. Pollut. Res. 2022 Feb:29(10):13881-13892. doi: 10.1007/s11356-021-16653-w.	The dust on indoor and outdoor surfaces of the window glasses were collected using sterile cotton balls in 11 cities from China. Two sampling campaigns were conducted with the time interval of 7 days to investigate the accumulation especially during the Spring festival holidays. Twenty-nine perfluoroalkyl acids (PFAA) were quantified to investigate concentration, composition, and toddlers' exposure. The concentrations of n-ary sumation PFAA ranged from no detection (nd) to 43 ng/m(2) (mean 8.9 +/- 10 ng/m(2)). Perfluorobutanoic acid (PFBA) was detected in 78% samples and accounted for 55 +/- 21% of n-ary sumation PFAA concentrations. 6:2 fluorotelomer sulfonic acid (6:2 FTSA) and hexafluoropropylene oxide dimer acid (HFPO-DA) were detected in more than 50% samples indicating the use of alternatives. Fluorotelomer carboxylic acid (FTCA) and fluorotelomer unsaturated acid (FTUCA) were found in the dust, implying the degradation of fluorotelomer alcohols (FTOH). The highest concentration of n-ary sumation PFAA (43 ng/m(2)) was found in outdoor dust from Xinzhou, Shanxi Province. Higher n-ary sumation PFAA concentrations were found in indoor dust than outdoor in 6 paired samples (3 from Feb. 14 and 3 from Feb. 21). In Tianjin and Handan, the concentrations of n-ary sumation PFAA from outdoor surfaces were higher in sampling campaign I (SC I, Feb. 21) than in sampling campaign II (SC II, Feb. 14), implying intensive outdoor release. The exposure of 2-year-old toddlers to PFAA via hand-to-mouth ingestion and dermal absorption was estimated; the mean values of intake were 2.1 and 1.5 pg/kg body weight, respectively, assuming an exposure time of 1 h.	1				1			B	-		
D452	ばく露	Elmoznino, J; Vlahos, P; Whitney, M	Occurrence and partitioning behavior of perfluoroalkyl acids in wastewater effluent discharging into the Long Island Sound	2018	Environ. Pollut. 2018 Dec;243(Pt A):453-461. doi: 10.1016/j.envpol.2018.07.076.	Perfluoroalkyl acids (PFAAs) were measured in aqueous and suspended particulate matter (SPM) fractions in the final effluents from 12 wastewater treatment facilities located around the Connecticut shoreline. Aqueous phase concentrations ranged from 53 to 198 ng/L for Sigma PFAAs with <= 7 perfluorinated carbons (CF2) and 2-73 ng/L for >7 CF2 PFAAs. Predominant PFAAs associated with effluent derived SPM were perfluorodecanoic acid and perfluorooctane sulfonic acid, detected in 48% and 52% of samples in concentrations ranging from 7 CF2 PFAAs. Partitioning coefficients (log K-OC) derived for effluent water and SPM phases (4.2 +/- 0.3, 4.4 +/- 0.4, 5.1 +/- 0.2 and 53 +/- 0.2 for PFOA, PFNA PFDA and PFUnA; 4.5 +/- 0.2 and 5.2 +/- 0.2 for PFOS and PFHsX respectively) were found to be of similar magnitude to aeration tank particles, though 0.5 to 2 log units greater than sludge solids and to natural system particulates including riverine SPM, estuarine SPM and sediments. Results from this study suggest that effluent derived suspended particulate matter could be an effective vector in the transport of long-chained PFAAs through wastewater treatment into receiving waters, and a potential vector to the local food chain.			1					B	-		
D453	ばく露	Thakali, A; MacRae, JD; Isenhour, C; Blackmer, T	Composition and contamination of source separated food waste from different sources and regulatory environments	2022	J. Environ. Manage. 2022 Jul:314:115043. doi: 10.1016/j.jenvman.2022.115043.	Food waste recycling is needed to create a more sustainable, circular food system; however, the process must be carefully managed to avoid the introduction and build-up of contaminants. We collected and screened source-separated food waste for five classes of contaminants (physical contaminants, heavy metals, halogenated organics, pathogens and antibiotic resistance genes) from two regulatory environments (voluntary vs mandated food separation) to quantify contamination. Physical contamination was frequently found; 57% of samples contained non-compostable waste. Most heavy metals were not detected, and although copper and zinc were present in most samples, they were always below the most stringent global standards for compost. Some samples had detectable halogenated organics, including perfluomalkyl substances (PFAS), which is cause for concern because some of these accumulate in the food chain. PFBA was detected in 60%, PFHxS in 8% and PFNA in 4% of samples tested. The pathogen Salmonella was present in 3% (2/71) and L. monocytogenes in 11% (8/71) of samples. Shiga toxin-producing E. coli was not detected. Next generation sequencing showed the presence of several genera that contain foodborne pathogens, most commonly Yersinia. Antibiotic resistance genes tet(M) and bla TEM were present in 96% and 97% of samples respectively, however the last-resort colistin resistance gene mcr-1 was not detected. Overall contamination in our source-separated samples was low, with the exception of some antibiotic resistance genes, however our processing method might have underestimated packaging-associated contamination. Regulatory environment did not affect contamination, but carbon, nitrogen phosphorus, calcium, copper, tet (M), and physical contamination varied by source type.	1		1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D454	ばく露	Yu, SY; Liu, WJ; Xu, YS; Zhao, YZ; Wang, P; Wang, X; Li, XY; Cai, CY; Liu, Y; Xiong, GN; Tao, S; Liu, WX	Characteristics of perfluoroalkyl acids in atmospheric PM10 from the coastal cities of the Bohai and Yellow Seas, Northern China	2018	Environ. Pollut. 2018 Dec;243(Pt B):1894-1903. doi: 10.1016/j.envpol.2018.10.002.	The concentration distributions, compositional profiles and seasonal variations of 17 perfluoroalkyl acids (PFAAs) in PM10 (particles with aerodynamic diameters < 10 mu m) were determined in seven coastal cities of the Bohai and Yellow Seas. The detection rates of perfluorooctanoic acid (PFOA) and short-chain components (perfluoroalkyl carboxylic acids (PFCAs) with <= 7 carbon atoms and perfluoroalkane sulfonic acids (PFSAs) with <= 5 carbon atoms) were much higher than those of other long-chain PFAA species. The annual average concentration of total PFAAs in PM10 ranged from 23.6 pg/m(3) to 94.5 pg/m(3) for the sampling cities. The monthly mean concentrations of PFAAs in PM10 in some sampling cities reached a peak value in winter, while no significant seasonal differences presented in other cities. High concentrations of PFAAs in the northern cities generally occurred during the local heating period (from November to March). Generally, the dominant components of PFAAs were PFOA and perfluorobutyric acid (PFBA). Some significantly positive correlations (p <0.01) between the 10 dominant components were revealed in the sampling cities, which implied similar sources and fate behaviors. Based on the simulated 72-hr backward trajectory tracking of air masses, the clustering results demonstrated the sampling cities were affected mainly by the atmospheric transport in sequence from the northwest, the southwest and the open seas, and many transport trajectories of air masses passed by the local fluorine chemical manufacturers in Liaoning, Shandong, Jiangsu, and Hubei Provinces. The estimated average daily intake (ADI) corresponding to the residents in different age groups indicated insignificant contributions to PFOA and perfluorooctane sulfonate (PFOS) exposures by inhalation of PM10 compared to ingestion by daily diet, while the higher ADI of PFOA than the reported levels for adults should be a concern. The calculated hazard ratios (HR) exhibited low noncancer risks by inhalation exposure to PFOA and PFOS in PMio.	1							B	-		
D455	ばく露	Yao, YM; Zhu, HH; Li, B; Hu, HW; Zhang, T; Yamazaki, E; Taniyasu, S; Yamashita, N; Sun, HW	Distribution and primary source analysis of per- and poly-fluoroalkyl substances with different chain lengths in surface and groundwater in two cities, North China	2014	Ecotox. Environ. Safe. 2014 Oct:108:318-328. doi: 10.1016/j.ecoenv.2014.07.021	Per- and poly-fluoroalkyl substances (PFASs) have been widely detected in the hydrosphere. The knowledge on the distribution and composition patterns of PFAS analogues with different chain length significantly contribute to their source analysis. In the present study, a regional scale investigation of PFASs in surface river waters and adjacent ground waters was carried out in two cities of China with potential contamination, Tianjin and Weifang. A total of 31 water samples were collected, and 20 PFASs therein were measured by a high-performance liquid chromatograph-tandem mass spectrometer (HPLC-MS/MS). The possible sources of PFASs in the aquatic environment were assessed primarily by concentration patterns as well as hierarchical cluster analysis. In all 4 rivers investigated in the two cities, perfluoroalkyl carboxylic acids (PFCAs) were the dominant compounds contributing over 70% of the PFASs detected. Perfluorooctanoic acid (PFOA) was the dominant PFCA with a concentration range of 8.58-203 ng/L in Tianjin and 6.37-25.9 ng/L in Weifang, respectively. On the average, the highest concentration was observed in samples from Dagu Drainage Canal (Dagu) in Tianjin and those short-chain PFASs (C4-C6) was detected with a comparable level of the longer-chain PFASs (> C6). Specifically, perfluorobutanoic acid (PFBA) was dominant in the short-chain analogues. This indicates that a remarkably increasing input of short-chain PFASs might be related to wastewater treatment plant effluent or industrial discharges, which could be possibly due to the switch of manufacturing to short-chain products. In Weifang, precipitation and subsequent surface runoff as non-point sources could be significant inputs of PFASs into surface water while groundwater was possibly subjected to severe point sources with Sigma PFASs concentration up to similar to 100 ng/L. The inconsistent distribution patterns in groundwater suggest complicated pathways of contamination.	1							B	-		
D456	ばく露	Yeung, LWY; Miyake, Y; Wang, Y; Taniyasu, S; Yamashita, N; Lam, PKS	Total fluorine, extractable organic fluorine, perfluorooctane sulfonate and other related fluorochemicals in liver of Indo-Pacific humpback dolphins (Sousa chinensis) and finless porpoises (Neophocaena phocaenoides) from South China	2009	Environ. Pollut. 2009 Jan:157(1):17-23. doi: 10.1016/j.envpol.2008.08.005.	The concentrations of 10 PFCs (perfluorinated compounds: PFOS, PFHxS, PFOSA, N-EtFOSA, PFDoDA, PFUnDA, PFDA, PFNA, PFOA, and PFHpA) were measured in liver samples of Indo-Pacific humpback dolphins (Sousa chinensis) (n = 10) and finless porpoises (Neophocaena phocaenoides) (n = 10) stranded in Hong Kong between 2003 and 2007. PFOS was the dominant PFC in the tissues at concentrations ranging at 26-693 ng/g ww in dolphins and 51.3-262 ng/g ww in porpoises. A newly developed combustion ion chromatography for fluorine was applied to measure total fluorine (TF) and extractable organic fluorine (ECF) in these liver samples to understand PFC contamination using the concept of mass balance analysis. Comparisons between the amounts of known PFCs and EOF in the livers showed that a large proportion (similar to 70%) of the organic fluorine in both species is of unknown origin. These investigations are critical for a comprehensive assessment of the risks of these compounds to humans and other receptors.			1					B	-		
D457	ばく露	Pan, CG; Liu, YS; Ying, GG	Perfluoroalkyl substances (PFASs) in wastewater treatment plants and drinking water treatment plants: Removal efficiency and exposure risk	2016	Water Res. 2016 Dec:106:562-570. doi: 10.1016/j.watres.2016.10.045	Perfluoroalkyl substances (PFASs) are a group of chemicals with wide industrial and commercial applications, and have been received great attentions due to their persistence in the environment. The information about their presence in urban water cycle is still limited. This study aimed to investigate the occurrence and removal efficiency of eighteen PFASs in wastewater treatment plants (WWTPs) and drinking water plants (DWTPs) with different treatment processes. The results showed that both perfluorobutane sulfonic acid (PFBS) and perfluorooctane sulfonic acid (PFOS) were the predominant compounds in the water phase of WWTPs and DWTPs, while PFOS was dominant in dewatered sludge of WWTPs. The average total PFASs concentrations in the three selected WWTPs were 19.6-232 ng/L in influents, 15.5-234 ng/L in effluents, and 31.5-49.1 ng/g dry weight in sludge. The distribution pattern of PFASs differed between the wastewater and sludge samples, indicating strong partition of PFASs with long carbon chains to sludge. In the WWTPs, most PFASs were not eliminated efficiently in conventional activated sludge treatment, while the membrane bio-reactor (MBR) and Unitank removed approximately 50% of long chain (C >= 8) perfluorocarboxylic acids (PFCAs). The daily mass loads of total PFASs in WWTPs were in the range of 1956-24773 mg in influent and 1548-25085 mg in effluent. PFASs were found at higher concentrations in the wastewater from plant A with some industrial wastewater input than from the other two plants (plant B and plant C) with mainly domestic wastewater sources. Meanwhile, the average total PFASs concentrations in the two selected DWTPs were detected at 4.74-14.3 ng/L in the influent and 3.34-13.9 ng/L in the effluent. In DWTPs, only granular activated carbon (GAC) and powder activated carbon (PAC) showed significant removal of PFASs. The PFASs detected in the tap water would not pose immediate health risks in the short term exposure. The findings from this study showed that effective treatment technology should be applied to eliminate this group of chemicals in the urban water cycle based on the precautionary principle.			1		1			B	-		
D458	ばく露	Zhao, YG; Wan, HT; Law, AYS; Wei, X; Huang, YQ; Giesy, JP; Wong, MH; Wong, CKC	Risk assessment for human consumption of perfluorinated compound-contaminated freshwater and marine fish from Hong Kong and Xiamen	2011	Chemosphere. 2011 Sep:85(2):277-283. doi: 10.1016/j.chemosphere.2011.06.002.	Perfluorinated compounds (PFCs) are man-made fluoro-surfactants that are identified as global pollutants and can pose health risks to humans and wildlife. Two aspects of risk assessment were conducted in this study, including exposure and response. Exposure was estimated by using the concentrations of PFCs in fish and applying standard exposure factors. Among different PFCs, PFOS, PFOA, PFNA, PFDA, PFU-dA and PFTrDA were detected. Total concentrations of PFC in fish ranged from 0.27-8.4 ng g(-1) to 0.37-8.7 ng g(-1) respectively in Hong Kong and Xiamen. The calculated hazard ratio (HR) of PFOS for all fish was less than 1.0. However, the HR for mandarin fish in Hong Kong and bighead carp, grass carp and tilapia in Xiamen, had HR values of approximately 0.5, indicating that frequent consumption of these 4 more contaminated fish species might pose an unacceptable risk to human health. Our data support the notion that the released/disposed chemical pollutants into water systems make fish a source of environmental toxicants to humans. The risks and potential effects of PFCs to health of coastal population in the Pearl River Delta are of concern.			1					B	-		
D459	ばく露	Wilkinson, JL; Swinden, J; Hooda, PS; Barker, J; Barton, S	Markers of anthropogenic contamination: A validated method for quantification of pharmaceuticals, illicit drug metabolites, perfluorinated compounds, and plasticisers in sewage treatment effluent and rain runoff	2016	Chemosphere 2016 Sep:159:638-646. doi: 10.1016/j.chemosphere.2016.06.039	An effective, specific and accurate method is presented for the quantification of 13 markers of anthropogenic contaminants in water using solid phase extraction (SPE) followed by high performance liquid chromatography (HPLC) tandem mass spectrometry (MS/MS). Validation was conducted according to the International Conference on Harmonisation (ICH) guidelines. Method recoveries ranged from 77 to 114% and limits of quantification between 0.75 and 4.91 ng/L. A study was undertaken to quantify the concentrations and loadings of the selected contaminants in 6 sewage treatment works (STW) effluent discharges as well as concentrations in 5 rain-driven street runoffs and field drainages. Detection frequencies in STW effluent ranged from 25% (ethinylestradiol) to 100% (benzoylecgonine, bisphenol-A (BPA), bisphenol-S (BPS) and diclofenac). Average concentrations of detected compounds in STW effluents ranged from 3.62 ng/L (ethinylestradiol) to 210 ng/L (BPA). Levels of perfluorinated compounds (PFCs) perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) as well as the plasticiser BPA were found in street runoff at maximum levels of 1160 ng/L, 647 ng/L and 2405 ng/L respectively (8.52, 3.09 and 2.7 times more concentrated than maximum levels in STW effluents respectively). Rain-driven street runoff may have an effect on levels of PFCs and plasticisers in receiving rivers and should be further investigated. Together, this method with the 13 selected contaminants enables the quantification of various markers of anthropogenic pollutants: inter alia pharmaceuticals, illicit drugs and their metabolites from humans and improper disposal of drugs, while the plasticisers and perfluorinated compounds may also indicate contamination from industrial and transport activity (street runoff).			1					B	-		
D460	ばく露	Besis, A; Botsaropoulou, E; Samara, C; Katsoyiannis, A; Hanssen, L; Huber, S	Perfluoroalkyl substances (PFASs) in air-conditioner filter dust of indoor microenvironments in Greece: Implications for exposure	2019	Ecotox. Environ. Safe. 2019 Nov:183:109559. doi: 10.1016/j.ecoenv.2019.109559.	The occurrence of perfluoroalkyl substances (PFASs) was for the first time investigated in various working microenvironments (internet cafes, electronics shops, coffee shops, restaurants, etc.) in Thessaloniki, Greece, using the dust trapped by central air conditioner (A/C) filters. Perfluorooctane sulfonic acid (PFOS) was found in the range from 16 to 227 ng g(-1), however it was detectable in only 30% of samples. On the contrary, perfluorohexanoic acid (PFHxA) was found in 85% of samples in the range from 3.6 to 72.5 ng g(-1), while 90-95% of samples exhibited perfluorooctanoic acid (PFOA), perfluorodecanoic acid (PFDcA) and perfluorododecanoic acid (PFDoDA) in the range from 10-653 ng g(-1), 3.2-7.4 ng g(-1) and 3.8-13.1 ng g(-1), respectively. The PFAS profile varied largely among the different microenvironment categories suggesting different sources. Estimated daily intakes through dust ingestion were calculated.		1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D461	ばく露	Xiao, F; Halbach, TR; Simcik, MF; Gulliver, JS	Input characterization of perfluoroalkyl substances in wastewater treatment plants: Source discrimination by exploratory data analysis	2012	Water Res. 2012 Jun:46(9):3101-3109. doi: 10.1016/j.watres.2012.03.027.	This paper presents a methodology based on multivariate data analysis for identifying input sources of perfluoroallkyl substances (PFASs) detected in 37 wastewater treatment plants (WWTPs) across more than 40 cities in the state of Minnesota (USA). Exploratory analysis of data points has been carried out by unsupervised pattern recognition (cluster analysis), correlation analysis, ANOVA and per capita discharges in an attempt to discriminate sources of PFASs in WWTPs. Robust cluster solutions grouped the database according to the different PFAS profiles in WWTP influent. Significantly elevated levels of perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA) and/or perfluorooctane sulfonate (PFOS) in influent have been found in 18 out of 37 WWTPs (49%). A substantial increase in the concentrations of PFHxA and/or PFOA from influent to effluent was observed in 59% of the WWTPs surveyed, suggestive of high concentration inputs of precursors. The fate of one precursor (8:2 fluorotelomer alcohol) in WWTP was modeled based on fugacity analysis to understand the increasing effluent concentration. Furthermore, population-related emissions cannot wholly explain the occurrence and levels of PFASs in WWTPs. Unusually high influent levels of PFASs were observed in WWTPs located in specific industrial areas or where known contamination had taken place. Despite the restriction on the production/use of PFOA and PFOS, this paper demonstrates that wastewater from industrial activities is still a principal determinant of PFAS pollution in urban watersheds.		1						B	-		
D462	ばく露	Kuroda, K; Murakami, M; Oguma, K; Takada, H; Takizawa, S	Investigating sources and pathways of perfluoroalkyl acids (PFAAs) in aquifers in Tokyo using multiple tracers	2014	Sci. Total Environ. 2014 Aug:488:51-60. doi: 10.1016/j.scitotenv2014.04.066	We employed a multi-tracer approach to investigate sources and pathways of perfluoroalkyl acids (PFAAs) in urban groundwater, based on 53 groundwater samples taken from confined aquifers and unconfined aquifers in Tokyo. While the median concentrations of groundwater PFAAs were several ng/L, the maximum concentrations of perfluorooctane sulfonate (PFOS, 990 ng/L), perfluorooctanoate (PFOA, 1800 ng/L) and perfluorononanoate (PFNA, 620 ng/L) in groundwater were several times higher than those of wastewater and street runoff reported in the literature. PFAAs were more frequently detected than sewage tracers (carbamazepine and crotamiton), presumably owing to the higher persistence of PFAAs, the multiple sources of PFAAs beyond sewage (e.g., surface runoff, point sources) and the formation of PFAAs from their precursors. Use of multiple methods of source apportionment including principal component analysis-multiple linear regression (PCA-MLR) and perfluoroalkyl carboxylic acid ratio analysis highlighted sewage and point sources as the primary sources of PFAAs in the most severely polluted groundwater samples, with street runoff being a minor source (44.6% sewage, 45.7% point sources and 9.7% street runoff, by PCA-MLR). Tritium analysis indicated that, while young groundwater (recharged during or alter the 1970s, when PFAAs were already in commercial use) in shallow aquifers (<50 m depth) was naturally highly vulnerable to PFAA pollution, PFAAs were also found in old groundwater (recharged before the 1950s, when PFAAs were not in use) in deep aquifers (50-500 m depth). This study demonstrated the utility of multiple uses of tracers (pharmaceuticals and personal care products; PPCPs, tritium) and source apportionment methods in investigating sources and pathways of PFAAs in multiple aquifer systems.			1				B	-		
D463	ばく露	Miner, KR; Clifford, H; Taruscio, T; Potocki, M; Solomon, G; Ritari, M; Napper, IE; Gajurel, AP; Mayewski, PA	Deposition of PFAS 'forever chemicals' on Mt. Everest	2021	Sci. Total Environ. 2021 Mar:759:144421. doi: 10.1016/j.scitotenv.2020.144421.	Mt. Everest, one of the most coveted climbing mountains on earth, also contains the highest altitude chemical contamination on land. For the first time, meltwater and snow samples from Mt. Everest's Khumbu Glacier were analyzed for forever chemicals per- and polyfluoroalkyl substances (PFAS). Our research team utilized solid-phase extraction (SPE) and liquid chromatography-tandemmass spectrometry (LC-MS/MS) to identify pollutants sampled from Everest Base Camp, Camp 1, Camp 2, and Everest Balcony. From the 14 PFAS compounds tested for, we found perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and perfluorohexanoic acid (PFHxA) in Mt. Everest snow and meltwater. The highest concentrations found were 26.14 ng/L and 10.34 ng/L PFOS at Base Camp and Camp 2, respectively. However, PFAS species were seen within 1-2 orders of magnitude in all sampling siteswith detection, potentially suggesting awidespread presence on themountain. Our samples are the highest altitude PFAS samples ever retrieved and indicate the need for further sampling both on Mt. Everest and in the below-glacier watershed. Published by Elsevier B.V.		1						B	-		
D464	ばく露	Yan, H; Cousins, IT; Zhang, CJ; Zhou, Q	Perfluoroalkyl acids in municipal landfill leachates from China: Occurrence, fate during leachate treatment and potential impact on groundwater	2015	Sci. Total Environ. 2015 Aug:524:23-31. doi: 10.1016/j.scitotenv.2015.03.111	Raw and treated landfill leachate samples were collected from 5 municipal landfill sites in China to measure the concentrations and contamination profile of perfluoroalkyl acids (PFAAs) in leachate during different steps of treatment. The total concentration of PFAAs (Sigma PFAAs) ranged from 7280 to 292,000 ng L-1 in raw leachate and from 98.4 to 282,000 ng L-1 in treated leachate. The dominant compounds measured were PFOA (mean contribution 28.8% and 36.8% in raw and treated leachate, respectively) and PFBS (26.1% and 40.8% in raw and treated leachate, respectively). A calculation of mass flows during the leachate treatment processes showed that the fate of individual PFAAs was substance and treatment-specific. The Chinese national leakage of Sigma PFAAs to groundwater from landfill leachate was estimated to be 3110 kg year(-1), which is a significant environmental release that is potentially threatening the sustainable use of groundwater as a drinking water source.				1			B	-		
D465	ばく露	Taniyasu, S; Yamashita, N; Yamazaki, E; Rostkowski, P; Yeung, LWY; Kurunthachalam, SK; Kannan, K; Loganathan, BG	Contamination Profiles of Perfluorinated Chemicals in the Inland and Coastal Waters of Japan Following the Use of Fire-Fighting Foams	2015	ACS Symp. Ser. 2015:1206:221-244. doi: 10.1021/bk-2015-1206.ch011	This study deals with the effects of natural disasters involving earthquake followed by tsunami and consequent human activities, on the quality of the inland and coastal waters of Japan. Two cases of accidental petrochemical fires in Japan that involved the use of aqueous film-forming foam (AFFF) have been investigated as potential sources of perfluoroalkyl substances (PFASs) in inland and coastal waters of Japan. PFASs were identified and quantified in seawater, lake water, snow, runoff and surface soil samples. Concentrations of individual PFASs were measured in water samples using high-performance liquid chromatography with electrospray tandem mass spectrometry (HPLC-MS/MS). The total concentrations of PFASs in seawater and lake water samples from the city of Tomakomai ranged from 0.43 to 519 ng/L. The greatest concentration of PFOS was found at T19 (311 ng/L) in December 2003. Total fluorine (TF), inorganic fluorine (IF), and extractable organic fluorine (EOF) were also measured in the samples using a newly developed method: combustion ion chromatography for fluorine (CIC-F). Results revealed that IF was the major contributor to TF in water samples. The major portion of EOF still remains unknown, suggesting the occurrence of other fluorinated organic compounds in addition to known individual PFASs such as PFOS, PFOA, and PFNA. In addition, composition and profiles of PFASs in two locations impacted by AFFF were different, suggesting different sources of organic fluorine released from AFFF. In Tomakomai, release of AFFF is believed to be a major source of PFASs, while in Kashima other sources such as byproducts of the fluorochemical industry appear to contribute to contamination.			1				B	-		
D466	ばく露	Liu, WX; He, W; Wu, JY; Wu, WJ; Xu, FL	Effects of fluorescent dissolved organic matters (FDOMs) on perfluoroalkyl acids (PFAAs) in lake and river water	2019	Sci. Total Environ. 2019 May:666:598-607. doi: 10.1016/j.scitotenv.2019.02.219	This study presents the effects of fluorescent dissolved organic matters (FDOM) on perfluoroalkyl acids (PFAAs) in western Lake Chaohu and its inflow rivers. The surface water samples from the 27 sites in western Lake Chaohu and its inflow rivers were collected in March and September 2013. The contents of PFAAs and the FDOM in the water samples were measured by a high-performance liquid chromatograph - mass spectrometer (HPLC-MS) and by a fluorescence spectrophotometer, respectively. The temporal-spatial distributions of PFAAs and FDOM, as well as their interrelationships, were investigated. Eleven PFAA components were detected, and the mean concentration of total PFAAs (TPFAAs) in western Lake Chaohu and its inflow rivers were 12.93 +/- 5.19 ng/L and 11.84 +/- 950 ng/L, respectively. PFOA was the predominant contaminant in two regions (7.13 +/- 3.07 ng/L and 430 +/- 2.14 ng/L) followed by PFHxA (172 +/- 0.80 ng/L and 1.42 +/- 1.41 ng/L) and PFBA (1.44 +/- 078 ng/L and 1.37 +/- 0.78 ng/L). The mean concentration of total FDOM in western Lake Chaohu and its inflow rivers were 220.0 +/- 4030 mu g quinine sulfate units (Q.S.)/L and 406.3 +/- 213.1 mu g Q.S./L, respectively. The significant, positive correlations were observed between the PFAAs and FDOMs in both the lake area and the inflow rivers. However, no significant correlation was observed between PFAAs and the dissolved organic carbon (DOC) in the lake area. This finding indicated that the residues and distributions of PFAAs were significantly dependent on the compositions of dissolved organic matters (DOM) and not on the total content of DOM.	1	1					B	-		
D467	ばく露	Schlummer, M; Solch, C; Meisel, T; Still, M; Gruber, L; Wolz, G	Emission of perfluoroalkyl carboxylic acids (PFCA) from heated surfaces made of polytetrafluoroethylene (PTFE) applied in food contact materials and consumer products	2015	Chemosphere 2015 Jun:129:46-53. doi: 10.1016/j.chemosphere.2014.11.036	Polytetrafluoroethylene (PTFE) has been widely discussed as a source of perfluorooctanoic acid (PFOA), which has been used in the production of fluoropolymers. PTFE may also contain unintended perfluoroalkyl carboxylic acids (PFCAs) caused by thermolysis of PTFE, which has been observed at temperatures above 300 degrees C. Common PTFE coated food contact materials and consumer goods are operated at temperatures above 200 degrees C. However, knowledge on possible emissions of PFCAs is limited. Therefore, it was the aim of this study to investigate and evaluate the emission of PFCAs from PTFE coated products with both, normal use and overheating scenarios. Four pans, claimed to be PFOA free, and nine consumer products were investigated. At normal use conditions (<230 degrees C), emissions from PTFE surfaces were trapped for 1 h. Overheating scenarios (>260 degrees C) recorded emissions during a 30 min heating of empty pans on a stove. Emissions were analyzed by LC-ESI-MS. Results indicate the emission of PFCAs, whereas no perfluorinated sulfonic acids were traced. At normal use conditions total emissions of PFCAs accounted for 4.75 ng per hour. Overheated pans, however, released far higher amounts with up to 12190 ng PFCAs per hour at 370 degrees C. Dominating contributors where PFBA and PFOA at normal use and PFBA and PFPeA during overheating. Temperature seems to be the main factor controlling the emission of PFCAs. A worst case estimation of human exposure revealed that emissions of PFCAs from heated PTFE surfaces would be far below the TDI of 1500 ng PFOA per kg body weight.	1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D468	ばく露	Gebbink, WA; Glynn, A; Darnerud, PO; Berger, U	Perfluoroalkyl acids and their precursors in Swedish food: The relative importance of direct and indirect dietary exposure	2015	Environ. Pollut. 2015 Mar:198:108-115. doi: 10.1016/j.envpol.2014.12.022	We analyzed food market basket samples obtained in Sweden from 1999, 2005, and 2010 for perfluoroallcyl acids (PFAAs) and a range of precursor compounds. Perfluorooctane sulfonic acid (PFOS) precursors were detected in all food year pools with the highest concentrations in 1999. Six polyfluoroalkyl phosphate diesters (diPAPs, 4:2/6:2, 6:2/6:2, 6:2/8:2, 8:2/8:2, 6:2/10:2, and 10:2/10:2) were detected in the year pools with the highest Sigma diPAP concentrations in 1999 and 2005. All precursors were predominantly found in meat, fish, and/or eggs based on analysis of individual food groups from 1999. Based on year pools, PFOS precursors contributed between 4 and 1% as an indirect source to total dietary PFOS intakes between 1999 and 2010. Perfluorohexanoic acid (PFHxA) exposure originated entirely from diPAPs, whereas for perfluorooctanoic acid (PFOA) and perfluorodecanoic acid (PFDA), diPAPs contributed between 1 and 19% to total exposure. The lowest precursor contributions were generally seen in food samples from 2010.		1						B	-		
D469	ばく露	Park, S; Kim, DH; Yoon, JH; Kwon, JB; Choi, H; Shin, SK; Kim, M; Kim, HK	Study on Pollution Characteristics of Perfluoroalkyl Substances (PFASs) in Shallow Groundwater	2023	Water. 2023 Apr;15(8):1480. doi: 10.3390/w15081480.	Perfluoroalkyl substances (PFASs) in shallow groundwater are increasingly being studied due to the global occurrence, environment persistence, bioaccumulation, and potential human health risk. In this research, 16 PFAS (11 perfluorinated carboxylic acids and 5 perfluorinated sulfonic acids) concentrations in groundwater were quantified to obtain information on geographical distribution and PFAS detection pattern for 4 years in South Korea. In the results, groundwater PFAS concentration ranged from non-detectable to average 45.2 ng/L (sum of PFASs). The major PFAS compounds were perfluorooctanoic acid (PFOA), perfluoropentanoic acid (PFPeA), perfluorohexanoic acid (PFHxA), perfluorohexane sulfonate (PFHxS), and perfluorooctane sulfonate (PFOS). The short chain (C < 8) PFASs were more prevalent than long chain (C > 8) PFASs in shallow groundwater. However, the detection patterns of 15 PFASs were different for each aquifer. Subsequently, through a health risk assessment, a non-carcinogenic risk level through ingestion, inhalation, and dermal contact for PFOA and PFOS was determined at 10(-1), and it presents the need for PFAS management of groundwater.		1						B	-		
D470	ばく露	Liu, Y; Li, X; Wang, X; Qiao, XC; Hao, SR; Lu, JR; Duan, XD; Dionysiou, DD; Zheng, BH	Contamination Profiles of Perfluoroalkyl Substances (PFAS) in Groundwater in the Alluvial-Pluvial Plain of Hutuo River, China	2019	Water. 2019 Nov;11(11):2316. doi: 10.3390/w11112316.	Over the past decade, concerns about perfluoroalkyl substances (PFAS) have increased rapidly among the scientific community due to their global distribution and persistence in various environmental matrices. The occurrences of 10 PFAS in groundwater in the alluvial-pluvial plain of Hutuo River (APPHR) in the North China Plain (NCP) were analyzed via UPLC-MS/MS and solid phase extraction. Total PFAS concentrations ranged from 0.56 ng/L to 13.34 ng/L, with an average value of 2.35 ng/L. Perfluorooctanoic acid (PFOA) and perfluorohexanoic acid (PFHxA) were dominant PFAS contaminants with high detection rates of 98.39% and 95.16%, respectively, and PFOA was the main pollutant with a mean concentration of 0.65 ng/L. The hydrogeological conditions have an important influence on the concentrations of PFAS in groundwater. Comparatively, the concentration of PFAS in groundwater in the study area is not very high, but it reflects that the groundwater in this region is affected by industrial sources to some extent. Local government should pay more attention on industrial pollution control and groundwater protection in this area.		1						B	-		
D471	ばく露	Sim, W; Choi, S; Choo, G; Yang, M; Park, JH; Oh, JE	Organophosphate Flame Retardants and Perfluoroalkyl Substances in Drinking Water Treatment Plants from Korea: Occurrence and Human Exposure	2021	Int. J. Environ. Res. Public Health. 2021 Mar;18(5):2645. doi: 10.3390/ijerph18052645.	In this study, the concentrations of organophosphate flame retardants (OPFR) and perfluoroalkyl substances (PFAS) were investigated in raw water and treated water samples obtained from 18 drinking water treatment plants (DWTPs). The n-ary sumation 13OPFR concentrations in the treated water samples (29.5-122 ng/L; median 47.5 ng/L) were lower than those in the raw water (37.7-231 ng/L; median 98.1 ng/L), which indicated the positive removal rates (0-80%) of n-ary sumation 13OPFR in the DWTPs. The removal efficiencies of n-ary sumation (27)PFAS in the DWTPs ranged from -200% to 50%, with the n-ary sumation (27)PFAS concentrations in the raw water (4.15-154 ng/L; median 32.0 ng/L) being similar to or lower than those in the treated water (4.74-116 ng/L; median 42.2 ng/L). Among OPFR, tris(chloroisopropyl) phosphate (TCIPP) and tris(2-chloroethyl) phosphate (TCEP) were dominant in both raw water and treated water samples obtained from the DWTPs. The dominant PFAS (perfluorooctanoic acid (PFOA) and perfluorohexanoic acid (PFHxA)) in the raw water samples were slightly different from those in the treated water samples (PFOA, L-perfluorohexane sulfonate (L-PFHxS), and PFHxA). The 95-percentile daily intakes of n-ary sumation 13OPFR and n-ary sumation (27)PFAS via drinking water consumption were estimated to be up to 4.9 ng/kg/d and 0.22 ng/kg/d, respectively. The hazard index values of OPFR and PFAS were lower than 1, suggesting the risks less than known hazardous levels.		1						B	-		
D472	ばく露	Shaw, S; Berger, ML; Brenner, D; Tao, L; Wu, Q; Kannan, K	Specific accumulation of perfluorochemicals in harbor seals (Phoca vitulina concolor) from the northwest Atlantic	2009	Chemosphere. 2009 Feb:74(8):1037-1043. doi: 10.1016/j.chemosphere.2008.10.063.	Concentrations of perfluorochemicals (PFCs) including perfluoroalkylsulfonates (PFSAs), and perfluoroalkylcarboxylates (PFCAs) were determined in liver of harbor seals (n = 68) collected from the northwest Atlantic between 2000 and 2007. Of ten PFCs measured, perfluorooctane sulfonate (PFOS) concentrations were the highest in liver (8-1388 ng/g, ww), followed by perfluoroundecanoic acid (PFUnDA) (< 1-30.7 ng/g, ww). An unusual accumulation profile of long-chain (C7-C12) PFCAs, and the predominance of PFUnDA, followed by PFNA in seal liver suggested that fluorotelomer alcohols (FTOHs) may be a major source of PFCAs in the northwest Atlantic. No gender-related differences in the concentrations of individual PFCs or total PFCs were found. Concentrations of PFOS and PFDS were higher in tissues of the pups than the adults, whereas concentrations of the PFCAs were similar between pups and adults. PFOS concentrations in the pups were 2.6-fold higher than those in the adult females, suggesting the importance of maternal transfer of PFCs. Hepatic PFOS concentrations were strongly, positively correlated with PFOSA, PFDS and individual PFCAs, indicating that harbor seals are exposed simultaneously to these compounds. Temporal comparisons of hepatic PFC concentrations showed a marginal increase of PFOS and PFCAs in the adult seals from 2000 to 2007. Unlike the spatial trend observed for polychlorinated biphenyls (PCBs), no south to north (urban-rural-remote) decreasing trend was observed for PFCs, suggesting the presence of diffuse sources of PFC contamination throughout the northwest Atlantic.			1					B	-		
D473	ばく露	Tan, KY; Lu, GH; Yuan, X; Zheng, Y; Shao, PW; Cai, JY; Zhao, YR; Zhu, XH; Yang, YL	Perfluoroalkyl Substances in Water from the Yangtze River and Its Tributaries at the Dividing Point Between the Middle and Lower Reaches	2018	Bull. Environ. Contam. Toxicol. 2018 Nov:101(5):598-603. doi: 10.1007/s00128-018-2444-z.	The Yangtze River drainage basins are China's most important economic development zones and also the locations of several large-scale fluorine chemical industries. In order to reveal the contribution from the tributaries at the dividing point between the middle and lower reaches of the Yangtze River with respect to perfluorinated substances (PFASs), 17 PFAS compounds in surface water, groundwater, and tap water samples were analyzed in the tributary system of the Jiujiang section of the Yangtze River. The total concentrations of PFASs in the surface waters ranged from 7.8 to 586.2ng/L. High proportion of short-chain compound PFBS in surface waters in Nanchang City, Poyang Lake, and the Yangtze River was observed which is likely of WWTPs' origin.				1				B	-		
D474	ばく露	Joerss, H; Menger, F; Tang, JH; Ebinghaus, R; Ahrens, L	Beyond the Tip of the Iceberg: Suspect Screening Reveals Point Source-Specific Patterns of Emerging and Novel Per- and Polyfluoroalkyl Substances in German and Chinese Rivers	2022	Environ. Sci. Technol. 2022 May:56(9):5456-5465. doi: 10.1021/acs.est.1c07987.	Only a few dozens of the several thousand existing per- and polyfluoroalkyl substances (PFAS) are monitored usingconventional target analysis. This study employed suspectscreening to examine patterns of emerging and novel PFAS inGerman and Chinese river water affected by industrial pointsources. In total, 86 PFAS were (tentatively) identified andgrouped into 18 structure categories. Homologue patterns revealeddistinct differences betweenfluoropolymer production sites of thetwo countries. In the Chinese Xiaoqing River Basin, the C8homologue was the most prevalent compound of the emergingseries of chlorinated perfluoroalkyl carboxylic acids (Cl-PFCAs)and perfluoroalkylether carboxylic acids (PFECAs). In contrast, C6and shorter homologues were dominant in the German Alz River.This indicates that the phaseout of long-chain compounds in Europe and their ongoing production in Asian countries also apply tounregulated emerging PFAS classes. Additional characteristics to differentiate the point sources were the peak area ratio ofperfluorobutane sulfonic acid (PFBS) versus the emerging compound hydro-substituted PFBS (H-PFBS) as well as the occurrenceof byproducts of the sulfonated tetrafluoroethylene-based polymer Nafion. The large number of identified unregulated PFASunderlines the importance of a grouping approach on a regulatory level, whereas the revealed contamination patterns can be used toestimate, prioritize, and minimize contributions of specific sources				1				B	-		
D475	ばく露	Li, YJ; Braunig, J; Thai, PK; Rebosura, M; Mueller, JF; Yuan, ZG	Formation and fate of perfluoroalkyl acids (PFAAs) in a laboratory-scale urban wastewater system	2022	Water Res. 2022 Jun:216:118295. doi: 10.1016/j.watres.2022.118295.	The fate and formation of perfluoroalkyl acids (PFAAs) have been investigated during wastewater treatment processes but studies for the entire urban wastewater system comprising the sewage transport and wastewater and sludge treatment processes are scarce. This work performs an integrated assessment of the formation and fate of PFAAs in the urban wastewater system together with their behavior in separate components of the system. To achieve this, PFAAs were monitored over five weeks in a laboratory-scale urban wastewater system comprising sewer reactors, a wastewater treatment reactor, and an anaerobic sludge digester. The system was fed with real domestic wastewater. The total mass of 11 PFAAs flowing out of the laboratory wastewater system significantly ($p < 0.05$) increased by 112 +/- 14 (mean +/- standard error)% compared to that entering the system. Formation of PFAAs was observed in all three biological processes of the system. In anaerobic sewer process, perfluoropentanoic acid (PFPeA), perfluoroheptanoic acid (PFHpA), and perfluorooctane sulfonate (PFOS) exhibited significant formation ($p < 0.05$) with the mass flow increased by 79 +/- 24%, 109 +/- 31%, and 57 +/- 17%, respectively. During the wastewater treatment process, perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA), and perfluorododecanoic acid (PFDoDA) demonstrated significant increase ($p < 0.05$) in their mass flows by 176 +/- 56%, 92 +/- 21%, and 516 +/- 184%, respectively. In contrast, only PFHxA was found to significantly ($p < 0.05$) increase by 130 +/- 40% during anaerobic digestion process. The total mass of 11 PFAAs discharged through the effluent (201 +/- 24 ng day(-1)) was 5 times higher than that through the digested sludge (29 +/- 6 ng day(-1)).		1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D476	ばく露	Tang, JW; Zhang, YZ; Sun, JJ; Shi, XL; Sun, C; Zhang, CH	Occurrence and characteristics of perfluoroalkyl substances (PFASs) in electroplating industrial wastewater	2019	Water Sci. Technol. 2019 Feb:79(4):731-740. doi: 10.2166/wst.2019.092.	The potential negative effects of perfluoroalkyl substances (PFASs) discharged into aquatic environments are drawing increasing attention. However, little research has been undertaken on PFASs in wastewater from electroplating industrial parks. In this study, the concentration profiles and geographical distribution of 11 PFASs were analyzed in water samples collected from different production workshops and an artificial landscaped lake. The total concentrations of PFASs (Sigma(11) PFASs) at various points in the production drainage system range from 229.5 to 5410.6 ng/L, and are mainly contributed by nickel plating, pickling, and the cyanide bright silver plating procedure, which correspond to cyanide-containing and acid-alkali wastewater conditioning tanks. Wastewater treatment by oxidation and precipitation removed 52.6% and 20% of PFASs, respectively. E il PFASs in effluents is about 538 ng/L, which consists of perfluorooctanoic acid (PFOA, 430.5 ng/L), followed by perfluorooctane sulfonate (PFOS, 35.27 ng/L), perfluorohexane sulfonate (PFHxS, 28.05 ng/L), and perfluorohexanoic acid (PFHxA, 18.3 ng/L). Principal component analysis suggests that the Sigma(11) PFASs in electroplating wastewater is very high and short-chain (C4-C8) PFASs have high detection and contribution rates. As a result, much attention should be paid to the increase in short-chain substitution effects and pollution around the factory area.		1						B	-		
D477	ばく露	Mu, HX; Wang, JW; Chen, L; Hu, HD; Wang, JF; Gu, C; Ren, HQ; Wu, B	Identification and characterization of diverse isomers of per- and polyfluoroalkyl substances in Chinese municipal wastewater	2023	Water Res. 2023 Feb:230:119580. doi: 10.1016/j.watres.2023.119580.	Linear and branched isomers of per- and polyfluoroalkyl substances (PFASs) are simultaneously present in the environment. However, isomer profiles of PFASs in municipal wastewater treatment plants (WWTPs) are still unknown because of the limitations of standards. Here, influent and effluent samples from 148 municipal WWTPs in China were collected. Ion mobility spectrometry was introduced into high-resolution mass spectrometry-based suspect screening methods to identify the target and suspect PFAS isomers. A total of 38 branched isomers of 14 typical PFASs were identified in wastewater samples. Linear PFASs had higher detection rates (22.3%-100%) than branched isomers (2.0%-98%). Compared to the influents, proportions of branched isomers of most PFASs (except for perfluoropentanoic acid and perfluorohexanoic acid) increased in the effluents. The conventional biological treatment processes (such as anaerobic-anoxic-aerobic and oxidation ditch treatments) had poor removal efficiency for linear PFASs (<21.4%) and branched isomers (<13.4%). No difference on removal efficiency among treatment processes was found. Furthermore, isomer composition in the WWTPs showed obvious differences between East China region and other regions, and the usage of short-chain PFASs (perfluorobutanesulfonic acid and perfluorohexanesulfonic acid) may be a key factor for driving this difference. This study sheds lights on the identification and characterization of PFAS isomers in WWTPs, which would be useful for development of monitoring and control strategies of PFASs.		1		1			B	-		
D478	ばく露	Liu, BL; Zhang, H; Li, JY; Dong, WH; Xie, LW	Perfluoroalkyl acids (PFAAs) in sediments from rivers of the Pearl River Delta, southern China	2017	Environ. Monit. Assess. 2017 MAY;189(5):213. doi: 10.1007/s10661-017-5921-7.	Having been largely used in industrial and household products, perfluoroalkyl acids (PFAAs) appear in environmental and biological systems with prevalence and persistence and have raised great concern in recent years. The present study is aimed at studying concentrations and composition profiles of 16 PFAAs in surface sediments collected from 51 sampling locations in 4 main rivers of the Pearl River Delta, one of the economy-developed areas in China. The total PFAA concentrations (Sigma PFAAs) were determined in a wide range of 1.89-15.1 ng g(-1) dw (dry weight) with an average concentration to be 3.54 ng g(-1) dw. Higher S PFAAs were observed in the downstream of Dongjiang River and the Pearl River, possibly due to the discharge of industrial wastewater. Perfluoropentanoic acid PFPeA) and perfluorooctane sulfonate (PFOS) were the dominant PFAAs, accounting for 51 to 85% of Sigma PFAAs in 27% of the samples. High PFPeA concentrations in sediments of urban river were scarcely observed in previous studies worldwide. The sources of shortchain perfluoroalkyl carboxylic acids (PFCAs) were significantly different from those of other PFAAs. Preliminary hazard assessment proved negligible for PFOS, perfluorooctanoic acid (PFOA), PFPeA, and perfluorohexanoic acid (PFHxA) concentrations in sediments from rivers of the Pearl River Delta.		1					B	-		
D479	ばく露	Zhou, JQ; Baumann, K; Chang, NM; Morrison, G; Bodnar, W; Zhang, ZF; Atkin, JM; Surratt, JD; Turpin, BJ	Per- and polyfluoroalkyl substances (PFASs) in airborne particulate matter (PM2.0) emitted during floor waxing: A pilot study	2022	Atmos. Environ. 2022 Jan:268:118845. doi: 10.1016/j.atmosenv.2021.118845.	Per-and polyfluoroalkyl substances (PFASs), with their water- and heat-resistant properties, have been widely used in industrial and consumer products, including floor waxes. Adverse health effects are associated with PFAS exposures (e.g., increased risk of cancer and immunotoxicity); however, exposures resulting from the use of PFAS-containing products are poorly understood. This study examines PFAS emissions during professional floor stripping/waxing and their potential for occupational exposures. We measured PFASs in dust and airborne particulate matter (PM2.0, aerodynamic diameter & LE;2.0 mu m) before, during, and after floor stripping/ waxing activities in three rooms in a university building. PM2.0 samples were analyzed for 34 targeted PFASs by ultra-high performance liquid chromatography coupled to electrospray ionization triple quadrupole mass spectrometer (UHPLC/ESI-MS/MS). In total, ten PFASs were detected in PM2.0 collected during floor stripping/waxing. Five were consistently higher during floor stripping/waxing compared to before (two with 95% confidence interval): perfluoro-2-methoxyacetic acid, perfluorobutanoic acid, perfluorohexanoic acid, perfluoroheptanoic acid, and perfluorooctane sulfonic acid. For these five, estimated exposures during floor stripping were 80.6, 320.5, 83.8, 29.6, and 157.7 pg m(-3) per hour of floor stripping, respectively, one order of magnitude greater than typical residential indoor and two orders of magnitude greater than ambient outdoor concentrations. Estimated emission rates were 3.0, 9.6, 3.4, 1.5, and 6.5 ng h(-1)m(-2), respectively (34.6% uncertainty). Inhalation occupational exposures were in the range of 9.42-23.2 pg per kg body weight per hour of floor stripping across the five PFASs.	1	1					B	-		
D480	ばく露	Park, H; Choo, G; Kim, H; Oh, JE	Evaluation of the current contamination status of PFASs and OPFRs in South Korean tap water associated with its origin	2018	Sci. Total Environ. 2018 Sep:634:1505-1512. doi: 10.1016/j.scitotenv.2018.04.068	We investigated the concentrations of perfluoroalkyl substances (PFASs) and organophosphate flame retardants (OPFRs) in 44 tap water samples, collected from eight major cities in South Korea served by four representative watersheds, to evaluate the water contamination status. The total concentrations of PFASs and OPFRs ranged from 1.44 to 224 ng/L (median = 11.9 ng/L), and 74.0 to 342 ng/L (median = 151 ng/L), respectively. The predominant compounds in tap water were perfluorohexane sulfonate (PFHxS), perfluoropentanoic acid (PFPeA), perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA), tris(2-chloroethyl) phosphate (TCEP), tris (chloroisopropyl) phosphate (TCIPP), and tris(2-butoxyethyl) phosphate (TBOEP). Tap water originating from the Nakdong River within an industrial complex showed a notably higher PFHxS proportion to total PFASs. In addition, significantly higher PFAS levels were found in river-originating tap water than in lake/reservoiroriginating tap water (Mann-Whitney U test, $p < 0.05$). Meanwhile, major OPFRs showed no clear difference in distribution by region, and no significant difference in major OPFR levels was observed according to tap water origin. Finally, the average human exposure via tap water consumption was estimated for PFASs (46.8 ng/person/day) and OPFRs (254 ng/person/day).		1					B	-		
D481	ばく露	Chen, JD; Lu, JJ; Ning, JY; Yan, YJ; Li, SM; Zhou, L	Pollution characteristics, sources, and risk assessment of heavy metals and perfluorinated compounds in PM2.5 in the major industrial city of northern Xinjiang, China	2019	Air Qual. Atmos. Health 2019 Aug:12(8):909-918. doi: 10.1007/s11869-019-00706-8.	At present, research on PM2.5 has focused on eastern and central China; little attention has been given to Xinjiang, the most northwestern part of China. Ten kinds of heavy metals (HMs) and 12 kinds of perfluorinated compounds (PFCs) in atmospheric PM2.5 are detected by inductively coupled plasma mass spectrometry and high-performance liquid chromatography-mass spectrometry, respectively. Principal component analysis and risk assessment methods are used to study HMs and PFCs and explore their pollution levels and health risks. Results show that HMs and PFCs are prevalent in atmospheric PM2.5 of Shihezi and Urumqi. The spatial distributions of HMs and PFCs in four sampling sites are development zone (B1) = industrial park (A1) > factory (A3) > school (A2) and A1 > A3 > B1 > A2, respectively. In the four sampling sites, copper, lead, zinc, and cadmium (Cd) contents are relatively high. Perfluorooctane sulfonate (PFOS), perfluorohexanoic acid (PFHxA), and perfluorooctanoic acid (PFOA) are the most prevalent PFCs. Risk assessment results show that PFCs in the atmosphere will not harm residents, but the Cd and nickel (Ni) in HMs are harmful to humans, especially Cd, which has both carcinogenic and non-carcinogenic risks. These findings indicate that the carcinogenic risk of HMs and PFCs in children is higher than in adults. In addition, HMs and PFCs may cause joint toxicity.		1					B	-		
D482	ばく露	Zhou, YQ; Wang, TY; Li, QF; Wang, P; Li, L; Chen, SQ; Zhang, YQ; Khan, K; Meng, J	Spatial and vertical variations of perfluoroalkyl acids (PFAAs) in the Bohai and Yellow Seas: Bridging the gap between riverine sources and marine sinks	2018	Environ. Pollut. 2018 Jul:238:111-120. doi: 10.1016/j.envpol.2018.03.027	Perfluoroalkyl acids (PFAAs) are being increasingly reported as emerging contaminants in riverine and marine settings. This study investigated the contamination level and spatial distribution of 17 PFAAs within the depth profile of the Bohai and Yellow Seas using newly detected sampling data from 49 sites (June 29 to July 14, 2016). Moreover, the riverine flux of 11 selected PFAAs in 33 rivers draining into the Bohai and Yellow Seas was estimated from previous studies (2002-2014) in order to establish the relationship between riverine sources and marine sinks. The results showed that the Bohai and Yellow Seas were commonly contaminated with PFAAs: total concentrations of PFAAs in the surface, middle, and bottom zones ranged from 4.55 to 556 ng L-1, 4.61-575 ng L-1, and 4.94-572 ng L-1, respectively. The predominant compounds were PFOA (0.55-449 ng L-1), PFBA (<LOQ-34.5 ng L-1), and PFPeA (<LOQ-54.3 ng L-1), accounting for 10.1-87.0%, 5.2-59.5%, and 0.6-68.6% of the total PFAAs, respectively. In general, the ΣPFAA concentrations showed a slightly decreasing trend with sampling depth. Contamination was particularly severe in Laizhou Bay, fed by the Xiaoqing River and an industrial park known for PFAA production. The total riverine PFAA mass flux into the Bohai and Yellow Seas was estimated to be 72.2 t y-1, of which 94.8% was carried by the Yangtze and Xiaoqing Rivers. As the concentration of short-chain PFAAs begins to rise in seawater, further studies on the occurrence and fate of short-chain PFAAs with special focus on effective control measures would be very timely, particularly in the Xiaoqing River and Laizhou Bay.	1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D483	ばく露	Li, XT; Wang, Y; Qian, CJ; Zheng, ZX; Shi, YL; Cui, JS; Cai, YQ	Perfluoroalkyl acids (PFAAs) in urban surface water of Shijiazhuang, China: Occurrence, distribution, sources and ecological risks	2023	J. Environ. Sci. 2023 Mar:125:185-193. doi: 10.1016/j.jes.2022.01.031	It is extremely important to analyze the contaminative behaviors of Perfluoroalkyl acids (PFAAs) due to their serious threats to urban environments which are closely related to hu-mans. Current study aimed to explore the distribution, source apportionment and ecologi-cal risk assessment of PFAAs in surface water from Shijiazhuang, China. The concentrations of EPFAAs ranged from 19.5 to 125.9 ng/L in the investigation area. Perfluorobutanesulfonic acid (PFBS) and perfluoropentanoic acid (PFPeA) were the predominant contaminants (mean value: 14.3ng/L and 16.6 ng/L, respectively). The distribution of PFAAs according to geospa-tial analysis and hierarchical clustering analysis (HCA) showed that higher levels of E PFAAs were detected in the southern surface water of Shijiazhuang and there was a stepwise de-crease from the wet season to the dry season. Furthermore, based on source apportionment, the dominant potential sources were found to be wastewater treatment plant (WWTP) ef-fluents and industrial discharge. The risk quotients (RQs) revealed low ecological risks of all PFAAs for aquatic organisms in Shijiazhuang surface water. Collectively, this study provided basic data for regulatory strategies for controlling PFAA pollutions in urban surface water. ?? 2022 The Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences.				1				B	-		
D484	ばく露	Hogue, C	PFAS pollution rides the wind	2020	Chem. Eng. News. 2020 Jun:98(21):8-8.	Two toxic, persistent per- and polyfluoroalkyl substances (PFAS) used at a Chemours factory in West Virginia pollute soil and groundwater as far as 48 km downwind of the plant, researchers report (Environ. Sci. Technol. 2020, DOI: 10.1021/acs.est.9b07384). The findings demonstrate that windblown air emissions from the plant have been a main route of distribution for the two PFAS into the environment, says study co-author Linda K. Weavers, an environmental engineer at the Ohio State University. The study's data also show that the atmospheric transport of PFAS from the plant is more widespread than previously thought, Weavers says. Discharges of wastewater into the Ohio River were once thought to be the primary way the facility released PFAS into the environment. For decades, the plant, owned by DuPont from the middle of the last century until it spun off Chemours in 2015, released perfluorooctanoic acid (PFOA), which was used as a processing (全文DL不可)					1			B	-		
D485	ばく露	Stasinakis, AS; Thomaidis, NS; Arvaniti, OS; Asimakopoulos, AG; Samaras, VG; Ajibola, A; Mamais, D; Lekkas, TD	Contribution of primary and secondary treatment on the removal of benzothiazoles, benzotriazoles, endocrine disruptors, pharmaceuticals and perfluorinated compounds in a sewage treatment plant	2013	Sci. Total Environ. 2013 Oct:463:1067-1075. doi: 10.1016/j.scitotenv.2013.06.087	The occurrence and fate of 36 emerging contaminants, belonging to five different classes, (benzotriazoles, BTRs; benzothiazoles, BTHs; perfluorinated compounds, PFCs; non-steroidal anti-inflammatory drugs, NSAIDs and endocrine disruptors, EDCs) were investigated in raw, treated wastewater (both particulate and dissolved phases), and in sludge from a sewage treatment plant (STP) in Athens, Greece. The average concentrations of BTRs, BTHs, NSAIDs and EDCs in raw wastewater ranged between 11 ng L-1 and 727 mu g L-1, while PFCs did not exceed 100 ng L-1. In dewatered sludge, the average concentrations ranged between 0.8 ng g(-1), dw (perfluorohexanoic acid, PFHxA) and 3895 ng g(-1) dw (nonylphenol, NP). The distribution of emerging contaminants between particulate and dissolved phase was different among the compounds. BTRs and BTHs showed lower solid-liquid distribution coefficients (K-d) than all other compounds. For 9 over the 27 compounds detected in influents, the removal efficiency was higher than 70%, while the others either were removed to a lesser extent or detected at higher concentrations in effluents. Based on this, advanced treatment processes should be applied in the future for achieving adequate emerging contaminants removal in STPs. Regarding removal mechanisms, almost 60% of BTRs and 30 to 75% of BTHs were removed in bioreactors, while the contribution of primary and secondary clarifiers was of minor importance. Sorption to primary sludge was a significant mechanism affecting EDCs fate in STP.		1					B	-		
D486	ばく露	Li, P; Yu, R; Hou, F; Zhao, Y	Legacy and emerging poly- and perfluoroalkyl substances in wastewater treatment plant and receiving water: abundance, removal, and potential ecological risk	2023	Environ. Sci. Pollut. Res. 2023 Mar:30(11):29929-29941. doi: 10.1007/s11356-022-24340-7.	Poly- and perfluoroalkyl substances (PFASs) are toxic persistent organic pollutants and bioaccumulative chemicals, which affect the environment and ecology. PFASs in the wastewater treatment plant (WWTP) and receiving river downstream were investigated. Fourteen out of eighteen PFASs were detected, ranging from 197 to 0.14 ng L-1. The main pollutants were 2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoro-propoxy) propanoic acid (HFPO-DA), perfluorooctane sulfonate (PFOS), and perfluorooctanoic acid (PFOA). The concentration of HFPO-DA (181 ng L-1) was the highest in influent, which indicated the use and emission of PFASs in the sewage collection region of WWTP changed from legacy to emerging ones. However, PFOS from catering wastewater as the main source was dominant PFASs in the reclaimed water. Biological treatment could be effective in the removal of PFASs, especially for HFPO-DA. HFPO-DA could directly bind to cytochrome P450 and bring potential ecotoxicity to the surrounding environment, and the ecological risk of degradation products should be under consideration. Coagulation might result in PFASs release from sludge. More attention should be paid to sewage treatment process decision of WWTP for the control of PFASs.					1			B	-		
D487	ばく露	Yong, ZY; Kim, KY; Oh, JE	The occurrence and distributions of per- and polyfluoroalkyl substances (PFAS) in groundwater after a PFAS leakage incident in 2018	2021	Environ. Pollut. 2021 Jan;268(Pt B):115395. doi: 10.1016/j.envpol.2020.115395.	Per- and polyfluoroalkyl substances (PFAS) concentrations of groundwater in three cities of the Nakdong River Basin in South Korea were quantified to investigate PFAS contamination and the effect of PFAS leakage incident that occurred in the study area in 2018. Groundwater PFASs concentration ranged from non-detectable (N.D.) to 36.9 ng/L (mean 14.1 ng/L), in which, perfluorooctanoic acid (PFOA), perfluorohexanoic acid (PFHxA), perfluoropentanoic acid (PFPeA), and perfluorohexane sulfonate (PFHxS) were commonly observed. Compared to long-chain (C >= 8) PFAS, short-chain (		1					B	-		
D488	ばく露	Yu, NY; Shi, W; Zhang, BB; Su, GY; Feng, JF; Zhang, XW; Wei, S; Yu, HX	Occurrence of Perfluoroalkyl Acids Including Perfluorooctane Sulfonate Isomers in Huai River Basin and Taihu Lake in Jiangsu Province, China	2013	Environ. Sci. Technol. 2013 Jan:47(2):710-717. doi: 10.1021/es3037803.	The spatial distribution of 10 perfluoroalkyl acids including linear and branched (six monotrifluoromethyl isomers) perfluorooctane sulfonate (PFOS) in surface water was investigated in Huai River Basin and Taihu Lake in Jiangsu Province, China. In the water samples from Huai River Basin, perfluorooctanoic acid (PFOA) and PFOS were the predominant compounds (mean 18 ng/L and 4.7 ng/L, respectively), while in samples from Taihu Lake, PFOA, perfluorohexanoic acid (PFHxA), and PFOS were the predominant compounds (mean 56 ng/L, 19 ng/L, and 15 ng/L, respectively). Branched PFOS (Br-PFOS) isomers accounting for 48.1% to 62.5% of total PFOS were enriched in all samples from Taihu Lake, compared to technical electrochemical fluorination (ECF) PFOS (Br-PFOS similar to 30.0%), while the similar phenomena were not found in samples from Huai River Basin (Br-PFOS 29.0-35.0%). Principal component analysis (PCA) on the percentages of the individual isomer showed that the first two components accounted for 78.4% and 15.3% of the overall observed data variance. Samples from Huai River Basin were grouped together with the ECF PFOS standard suggesting the profiles were similar, while samples from Taihu Lake were grouped by themselves, suggesting that isomer profiles in these samples were different from that of Huai River Basin. The obvious difference in isomer profiles probably results from the different environmental behaviors of PFOS isomers and/or unknown sources (PFOS or PFOS precursors).		1					B	-		
D489	ばく露	Arinaitwe, K; Keltsch, N; Taabu-Munyaho, A; Reemtsma, T; Berger, U	Perfluoroalkyl substances (PFASs) in the Ugandan waters of Lake Victoria: Spatial distribution, catchment release and public exposure risk via municipal water consumption	2021	Sci. Total Environ. 2021 Aug:783:146970. doi: 10.1016/j.scitotenv.2021.146970.	Perfluoroalkyl substances (PFASs) have scarcely been studied in the Lake Victoria Basin and Africa in general. We investigated spatial profiles of PFASs in the Ugandan part of Lake Victoria, their influxes and human exposure via drinking water. We analyzed open lake water, riverine water (Rivers Kagera and Sio), urban drainage water (Nakivubo Channel), over-lake bulk atmospheric deposition and municipal tap water (Kampala, Jinja and Entebbe). The average concentrations (ng/L) for individual target PFASs were in the ranges of 0.08-23.8 (Nakivubo Channel), 0.01-10.8 (Murchison Bay), R. Kagera, >R. Sio > Nakivubo Channel. Perfluorohexanoic acid (PFHxA) and perfluorooctane sulfonic acid (PFOS) had the highest influx and retention estimates, respectively. Perfluoroalkane sulfonates (PFSAs) were mostly associated with urban drainage samples. PFASs were likely recycled from the Nakivubo Channel, through the Murchison Bay, into municipal drinking water. The estimated human exposure to Sigma(11)PFASs via drinking water indicated low risk of adverse health effects.		1					B	-		
D490	ばく露	Meng, J; Wang, TY; Wang, P; Zhu, ZY; Li, QF; Lu, YL	Perfluoroalkyl Substances in Daling River Adjacent to Fluorine Industrial Parks: Implication from Industrial Emission	2015	Bull. Environ. Contam. Toxicol. 2015 Jan:94(1):34-40. doi: 10.1007/s00128-014-1419-y.	The pollution level and source of perfluoroalkyl substances (PFASs) in mainstream and tributary of Daling River in northeast China were investigated in present study. Concentrations of PFASs in surface water and sediment ranged from 4.6 to 3,410 ng/L and from 0.08 to 2.6 ng/g dry weight, respectively. The lowest levels of PFASs were found in vicinity of a drinking water source located in upstream of Daling River. Xihe tributary, which is adjacent to two local fluorine industrial parks, contained the highest level of PFASs. Short-chain PFASs, including perfluorobutanoic acid and perfluorobutane sulfonate, were of higher levels due to their emerging as alternative products for perfluorooctane sulfonate. High level of perfluorooctanoic acid was also found in Daling River. Based on these results, it can be concluded that the relatively severe pollutions of Xihe tributary were caused by long-term development of the two local fluorine industry parks.	1			1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D491	ばく露	Liu, BL; Zhang, H; Yu, Y; Xie, LW; Li, JY; Wang, XX; Dong, WH	Perfluorinated Compounds (PFCs) in Soil of the Pearl River Delta, China: Spatial Distribution, Sources, and Ecological Risk Assessment	2020	Arch. Environ. Contam. Toxicol. 2020 Feb:78(2):182-189. doi: 10.1007/s00244-019-00674-1.	This study investigated the levels, spatial distribution, sources, and ecological risks of 16 perfluorinated compounds (PFCs) in 68 surface soil samples (0-20 cm) from 7 cities in the Pearl River Delta (PRD), China. Sixteen target PFCs, including perfluoroalkyl carboxylic acids (PFCAs, C-5-C-14, C-16, and C-18) and perfluoroalkyl sulfonic acids (PFSAs, C-4, C-6, C-8, and C-10), were analyzed by high-performance liquid chromatography-negative electrospray ionization-tandem mass spectrometry (HPLC/ESI-MS/MS). Concentrations of total PFCs (n-ary sumation PFCs) ranged from 2.19 to 98.5 mu g kg(-1) (dry weight, dw), with an average of 5.97 mu g kg(-1) dw. Perfluorooctane sulfonate (PFOS) was the dominant PFC, accounting for 23.9% of n-ary sumation PFCs. The highest n-ary sumation PFCs was found in the soil sample collected from Dongguan with a large number of manufacturing industries. There were no significant differences of n-ary sumation PFCs among unban, industrial, and agricultural soils, indicating similar pollution sources in soil of the PRD. More than 70% of n-ary sumation PFCs in soil of the PRD could be attributed to the four principal components, represented by PFOS and perfluorooctanoic acid (PFOA), perfluoropentanoic acid (PFPeA) and perfluorohexanoic acid (PFHxA), perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUdA). Ecological risk assessment indicated that PFOA had low risk to soil plants and animals. However, the risk of PFOS to soil plants was relatively high in some studied regions.							B	-		
D492	ばく露	Shi, B; Wang, TY; Yang, HF; Zhou, YQ; Bi, R; Yang, L; Yoon, SJ; Kim, T; Khim, JS	Perfluoroalkyl acids in rapidly developing coastal areas of China and South Korea: Spatiotemporal variation and source apportionment	2021	Sci. Total Environ. 2021 Mar:761:143297. doi: 10.1016/j.scitotenv.2020.143297.	Polyfluoroalkyl substances (PFASs) are recognized as emerging contaminants that have captured worldwide attention. They are primarily transported in environments and spread around the globe due to their persistent and bioaccumulative characteristics. In this study, 15 PFASs were detected in major rivers of the rapidly developing coastal areas of China and South Korea. The concentrations and compositions of these PFASs varied greatly between different regions along the coastline. The total concentrations ranged from 14.9 to 16,500 ng L-1, and the mean concentrations of Sigma(15)PFASs in Liaodong Bay, Bohai Bay, Laizhou Bay, and the west coast of South Korea were 124 ng L-1, 81.4 ng L-1, 1550 ng L-1, and 36.2 ng L-1, respectively. In Laizhou Bay, the relatively high perfluorooctanoic acid (PFOA) was due to the high usage and manufacturing of PFOA-containing products and contributed 59% of the total compounds. In Liaodong Bay and Bohai Bay, PFBA and PFOA were the most abundant compounds, accounting for >55% of the total compounds. Along the west coast of South Korea, PFBA and PFPeA were the most prevalent compounds, contributing 28% and 24% of the total compounds, respectively. The data collected in the last decade were analyzed to investigate the temporal trends of selected PFASs. The total concentration of Sigma(10) PFASs decreased in both China and South Korea, while the proportion of short-chain PFASs increased. The proportion of C-4-C-7 PFCAs in South Korea rapidly increased from 46% to 79% but decreased from 49% to 43% in China. The positive matrix factorization (PMF) model successfully addressed the site-specific source apportionment, which showed that 53% of the PFASs in Laizhou Bay were due to fluorine manufacturing. The results of this study provide novel insights into elucidating the spatiotemporal distribution and complicated sources of PFASs over a large area and provide a clear message for all stakeholders, water and coastal managers, and scientists.	1						B	-		
D493	ばく露	Fliedner, A; Rudel, H; Dreyer, A; Pirntke, U; Koschorreck, J	Chemicals of emerging concern in marine specimens of the German Environmental Specimen Bank	2020	Environ. Sci Eur. 2020 MAR 2;32(1):36. doi: 10.1186/s12302-020-00312-x.	Background Descriptor 8 of the Marine Strategy Framework Directive (MSFD) (Directive 2008/56/EC) addresses the good environmental status with regard to pollution of marine waters by chemical contaminants. Commission decision (EU) 2017/848 lays down the criteria and methodological standards on good environmental status of marine waters. Member States, in regional or subregional cooperation, shall establish lists of relevant contaminants beside those already covered by the Water Framework Directive (WFD). To provide information on emerging contaminants in marine biota, the German Environmental Specimen Bank (ESB) has compiled data of blue mussels and eelpouts from coastal sites in the North and Baltic Seas. Substances identified by the International Council for the Exploration of the Sea (ICES) as of emerging concern for the marine environment have been used as a starting point. Results and conclusions The study presents data of 19 emerging flame retardants and degradation products, 40 per- and polyfluoroalkyl substances (PFAS) and three cyclic volatile methylsiloxanes (cVMS). Among the emerging flame retardants, only Dec 602 was detected in all samples of 2015. Dec 604, Cl-10-antiDP, 1,5-DPMA, EH-TBB, PBEB, TBP-AE, BATE, BTBPE and HBBz were constantly < limit of quantification (LOQ). Time trends were barely detected. Legacy PBDE still dominates in most samples. PFAS concentrations were usually higher in samples from the North Sea sites compared to samples from the Baltic Sea. PFOS dominated in most samples. Increasing trends over time were detected for PFNA, PFDA and PFDoDA at the Baltic Sea site and for PFDA at one North Sea site. Concentrations of the cVMS D4, D5 and D6 were below the detection limit at the ESB sampling sites. Based on the results, it should be considered to include the emerging flame retardants DP and Dec 602 and the long-chain perfluoroalkyl substances PFNA, PFDA, PFUnDA and PFDoDA in a regular monitoring in the North and Baltic Seas.			1				B	-		
D494	ばく露	East, A; Anderson, RH; Salice, CJ	Per- and Polyfluoroalkyl Substances (PFAS) in Surface Water Near US Air Force Bases: Prioritizing Individual Chemicals and Mixtures for Toxicity Testing and Risk Assessment	2021	Environ. Toxicol. Chem. 2021 Mar:40(3):859-870. doi: 10.1002/etc.4893.	Per- and polyfluoroalkyl substances (PFAS) are a large class of persistent chemicals used for decades in industrial and commercial applications. A key challenge with regard to estimating potential risk to ecological (and human) receptors associated with PFAS exposure lies in the fact that there are many different PFAS compounds and several to many can co-occur in any given environmental sample. We applied a data science approach to characterize and prioritize PFAS and PFAS mixtures from a large dataset of PFAS measurements in surface waters associated with US Air Force Installations with a history of the use of aqueous film-forming foams (AFFFs). Several iterations of stakeholder feedback culminated in a few main points that advanced our understanding of a complex dataset and the larger ecotoxicological problem. First, perfluorooctane sulfonate (PFOS) was often a dominant PFAS in a given surface water sample, frequently followed by perfluorohexane sulfonate (PFHxS). Second, a 4-chemical mixture generally accounted for >80% of the sum of all routinely reported PFAS in a sample, and the most representative 4-chemical mixture was composed of PFOS, PFHxS, perfluorohexanoic acid (PFHxA), and perfluorooctanoic acid (PFOA). We suggest that these results demonstrate the utility of formalized data science analysis and assessment frameworks to address complex ecotoxicological problems. Specifically, our example dataset results can be used to provide perspective on toxicity testing, ecological risk assessments, and field studies of PFAS in and around AFFF-impacted sites.		1					B	-		
D495	ばく露	Filipovic, M; Woldegiorgis, A; Norstrom, K; Bibi, M; Lindberg, M; Osteras, AH	Historical usage of aqueous film forming foam: A case study of the widespread distribution of perfluoroalkyl acids from a military airport to groundwater, lakes, soils and fish	2015	Chemosphere 2015 Jun:129:39-45. doi: 10.1016/j.chemosphere.2014.09.005	Historical usage of aqueous film forming foams (AFFFs) at military airports is a potential source of perfluoroalkyl acids (PFAAs) to the nearby environment. In this study, the distribution of perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA), perfluorohexane sulfonate (PFHxS) and perfluorooctane sulfonate (PFOS) in soil, groundwater, surface water, tap water well, and fish muscle was investigated at a closed down military airfield (F18) and its surroundings in Stockholm, Sweden. The presence of PFOS at AFFF training sites was inventoried. One major finding of the study is that a former airfield, abandoned since 1994, may still be a point source of PFAAs to nearby recipients. PFOS and PFOA were ubiquitous in the soil samples at former AFFF training sites with concentrations ranging from 2.18 to 8520 ng g(-1) dry weight and <0.12-287 ng g(-1) dry weight respectively. The sum of PFAAs in the groundwater and surface waters ranged from 738 to 51000 ng L-1 and		1					B	-		
D496	ばく露	Chen, LG; Tsui, MMP; Lam, JCW; Hu, CY; Wang, Q; Zhou, BS; Lam, PKS	Variation in microbial community structure in surface seawater from Pearl River Delta: Discerning the influencing factors	2019	Sci. Total Environ. 2019 Apr:660:136-144. doi: 10.1016/j.scitotenv.2018.12.480	Contamination of perfluoroalkyl acids (PFAAs) is ubiquitously detected in various environments. However, their potential effects onmicrobial communities remain largely unknown. In this study, surface seawater of the Pearl River Delta (PRD) is sampled tomeasure PFAA concentrations and profile the structure of free-living microbial community. Total PFAAs concentrations range from 131 to 1563 pg L-1 in surface seawater. PFOS (16-470 pg L-1), PFOA (27-272 pg L-1), PFHpA (18-201 pg L-1) and PFBA(25-152 pg L-1) are themajor homologues, indicating continued industrial application or release of PFOS and a gradual shift towards using shorter-chain PFAAs. Concentrations of PFAAs from this recent cruise aremuch lower than previous reports, whichmay be due to the effectivemanagement of PFAA usage around PRD region. In addition, the microbial community in PRD surface seawater is predominantly colonized by the Proteobacteria phylum (27.2 to 61.5%) and the Synechococcus genus (5.6 to 38.6%). The structure of the microbial communities varies among stations, mainly resulting from different abundances of Synechococcus, Prochlorococcus and Nitrosopumilus. Geochemical parameters (e.g., nutrients and salinity) and phytoplankton are significantly associated with themicrobial community dynamics in surface seawater. In the interactive network ofmicrobiota, a subset of bacteria (i.e., Fluviicola, Nitrosopumilus, Limnohabitans, Sediminibacterium, C39 and Polynucleobacter) shows significantly positive correlations with PFAAs (R > 0.6; P < 0.001). Overall, this study gives a timely monitoring of PFAA pollution around PRD area. Shift in environmental microbiota by geochemical factors and phytoplankton is also observed, which may affect biogeochemical cycling.	1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D497	ばく露	McGregor, R; Zhao, Y	The in situ treatment of TCE and PFAS in groundwater within a silty sand aquifer	2021	Remediation. 2021 Mar:31(2):7-17. doi: 10.1002/rem.21675.	Chlorinated ethenes such as trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride along with per- and polyfluoroalkyl substances (PFAS) have been identified as chemicals of concern in groundwater; with many of the compounds being confirmed as being carcinogens or suspected carcinogens. While there are a variety of demonstrated in-situ technologies for the treatment of chlorinated ethenes, there are limited technologies available to treat PFAS in groundwater. At a former industrial site shallow groundwater was impacted with TCE, cis-1,2-DCE, and vinyl chloride at concentrations up to 985, 258, and 54 mu g/L, respectively. The groundwater also contained maximum concentrations of the following PFAS: 12,800 ng/L of perfluoropentanoic acid, 3240 ng/L of perfluorohexanoic acid, 795 ng/L of perfluorobutanoic acid, 950 ng/L of perfluorooctanoic acid, and 2140 ng/L of perfluorooctanesulfonic acid. Using a combination of adsorption, biotic, and abiotic degradation in situ remedial approaches, the chemicals of concern were targeted for removal from the groundwater with adsorption being utilized for PFAS whereas adsorption, chemical reduction, and anaerobic biodegradation were used for the chlorinated ethenes. Sampling of the groundwater over a 24-month period indicated that the detected PFAS were treated to either their detection, or below the analytical detection limit over the monitoring period. Postinjection results for TCE, cis-1,2-DCE, and vinyl chloride indicated that the concentrations of the three compounds decreased by an order of magnitude within 4 months of injection, with TCE decreasing to below the analytical detection limit over the 24-month monitoring period. Cis-1,2-DCE, and vinyl chloride concentrations decreased by over 99% within 8 months of injections, remaining at or below these concentrations during the 24-month monitoring period. Analyses of Dehalococcoides, ethene, and acetylene over time suggest that microbiological and reductive dechlorination were occurring in conjunction with adsorption to attenuate the chlorinated ethenes and PFAS within the aquifer. Analysis of soil cores collected pre- and post-injection, indicated that the distribution of the colloidal activated carbon was influenced by small scale heterogeneities within the aquifer. However, all aquifer samples collected within the targeted injection zone contained total organic carbon at concentrations at least one order of magnitude greater than the preinjection total organic carbon concentrations.	1	1						B	-		
D498	ばく露	Giovanoulis, G; Nguyen, MA; Arwidsson, M; Langer, S; Vestergren, R; Lagerqvist, A	Reduction of hazardous chemicals in Swedish preschool dust through article substitution actions	2019	Environ. Int. 2019 Sep:130:104921. doi: 10.1016/j.envint.2019.104921.	Consumer goods and building materials present in the preschool environment can be important sources of hazardous chemicals, such as plasticizers, bisphenols, organophosphorus and brominated flame retardants, poly-and perfluoroalkyl substances, which may pose a health risk to children. Even though exposure occurs via many different pathways, such as food intake, inhalation, dermal exposure, mouthing of toys etc., dust has been identified as a valuable indicator for indoor exposure. In the present study, we evaluate the efficiency of product substitution actions taken in 20 Swedish preschools from the Stockholm area to reduce the presence of hazardous substances in indoor environments. Dust samples were collected from elevated surfaces in rooms where children have their everyday activities, and the concentrations found were compared to the levels from a previous study conducted in 2015 at the same preschools. It was possible to lower levels of hazardous substances in dust, but their continued presence in the everyday environment of children was confirmed since bisphenol A, restricted phthalates and organophosphate esters were still detectable in all preschools. Also, an increase in the levels of some of the substitutes for the nowadays restricted substances was noted; some of the alternative plasticizers to phthalates, such as DEHA and DEHT, were found with increased concentrations. DINP was the dominant plasticizer in preschool dust with a median concentration of 389 mu g/g, while its level was significantly (p = 0.012) higher at 716 mu g/g in preschools with polyvinyl chloride (PVC) flooring. PBDEs were now less frequently detected in dust and their levels decreased 20% to 30%. This was one of the few times that PFAS were analyzed in preschool dust, where 6:2 diPAP was found to be most abundant with a median concentration of 1140 ng/g, followed by 6:2 PAP 151 ng/g, 8:2 diPAP 36 ng/g, N-Et-FOSAA 18 ng/g, PFOS 12 ng/g, PFOA 7.7 ng/ g and PFNA 1.1 ng/g. In addition, fluorotelomer alcohols were detected in 65-90% of the samples. Children's exposure via dust ingestion was evaluated using intermediate and high daily intake rates of the targeted chemicals and established health limit values. In each case, the hazard quotients (HQs) were < 1, and the risk for children to have adverse health effects from the hazardous chemicals analyzed in this study via dust ingestion was even lower after the product substitution actions were taken in preschools.			1					B	-		
D499	ばく露	Montes, R; Mendez, S; Cobas, J; Carro, N; Neuparth, T; Alves, N; Santos, MM; Quintana, JB; Rodil, R	Occurrence of persistent and mobile chemicals and other contaminants of emerging concern in Spanish and Portuguese wastewater treatment plants, transnational river basins and coastal water	2023	Sci. Total Environ. 2023 Aug:885:163737. doi: 10.1016/j.scitotenv.2023.163737.	This work investigated, during one year, the occurrence and fate of 52 contaminants of emerging concern (CECs) in transnational river basins and coastal areas of the North of Portugal and Galicia (NW Spain) and the wastewater treat-ment plants (WWTPs) discharging on these environments. The different CECs investigated included pharmaceuticals, personal care products, industrial chemicals, among others, of which ca. 90 % would fulfill the persistence, mobility and toxicity criteria proposed by the German Environmental Agency. The results showed the ubiquitous presence of these CECs and an incomplete removal of over 60 % of them with current conventional WWTPs. These findings high-light the requirement of a prominent and coordinated upgrade of WWTP treatments in order to meet the future European Union regulations on urban wastewater treatment and surface water quality. In fact, even some compounds exhibiting high removals, such as caffeine or xylene sulfonate, were frequently detected in river and estuarine waters at the high ng L-1 level. Thus, our preliminary risk assessment study concluded that 18 of the CECs presented a potential risk for the environment, being caffeine, sulpiride, perfluorooctanoic acid (PFOA), diclofenac, fipronil and perfluorobutanoic acid (PFBA) the most concerning ones. Yet, additional toxicity data as well as a more robust infor-mation on persistence and mobility of CECs are necessary for better estimating the magnitude of the problem and im-prove risk assessment. As an example, in the case of the antidiabetic metformin, recent research has revealed toxicity for model fish species at concentration levels below those found in 40 % of the river water samples analyzed in this work.	1							B	-		
D500	ばく露	Beskoski, VP; Yamamoto, K; Yamamoto, A; Okamura, H; Hayashi, M; Nakano, T; Matsumura, C; Fukushi, K; Wada, S; Inui, H	Distribution of perfluoroalkyl compounds in Osaka Bay and coastal waters of Western Japan	2017	Chemosphere 2017 Mar:170:260-265. doi: 10.1016/j.chemosphere.2016.12.028	Perfluoroalkyl acids (PFAAs) including perfluoroalkyl sulfonates (PFSAs) and perfluoroallcyl carboxylates (PFCAs) were analyzed in sediment samples taken from Ajifu Waterway in Osaka city, from Osaka Bay, and from Kagoshima Bay, as well as in fifteen seawater samples collected from Osaka Bay and coastal waters of Western Japan. In all sediment samples, only PFCAs were detected, and the highest concentration was determined in Ajifu Waterway, where Sigma PFAA was 58990 ng kg(-1) dry weight. The total concentrations of PFAAs in sea water samples ranged between the limit of quantification and 53.4 ng L-1, and perfluorohexanoic acid was the most prevalent and had the highest concentration of 37 ng L-1. The changes in the patterns and concentrations of PFAA5 in Osaka Bay and coastal waters of Western Japan indicate that the PFAAs in surface waters are influenced by sources from Keihanshin Metropolitan Area, mainly the Yodo River basin, and the dilution effect which naturally occurs during their transport to the Pacific Ocean.		1						B	-		
D501	ばく露	Li, B; Danon-Schaffer, MN; Li, LY; Ikonomou, MG; Grace, JR	Occurrence of PFCs and PBDEs in Landfill Leachates from Across Canada	2012	Water Air Soil Pollut. 2012 Jul:223(6):3365-3372. doi: 10.1007/s11270-012-1115-7.	Polybrominated diphenyl ethers (PBDEs) and perfluorinated compounds (PFCs) are both classes of persistent organic pollutants with potential major health and environmental concerns. Many PBDE- and PFC-containing products are ultimately discarded in landfills. In samples from 28 landfills and dumpsites across Canada, PBDEs and PFCs were detected in almost all landfill leachate samples, with concentrations up to 1,020 and 21,300 ng/L, respectively. Mean concentrations were 166 ng/L for PBDEs and 2,950 ng/L for PFCs. Landfill leachates from southern Canada generally had greater concentrations of PBDEs and PFCs than those from northern Canada. The dominant compounds were decabromodiphenyl ether (BDE-209) (mean contribution 52 %) for the PBDEs and perfluorohexanoic acid (mean contribution 25 %) for the PFCs. There were strong correlations for some compounds within each contaminant class, such as the major congeners in the penta-BDE commercial mix (BDE-47, BDE-99, and BDE-100). Estimated average aPBDE and aPFC loadings from an urban landfill to the environment were calculated to be 3.5 and 62 tonnes/year, respectively.		1						B	-		
D502	ばく露	Chen, MK; Wang, CF; Wang, XP; Fu, JJ; Gong, P; Yan, JP; Yu, ZL; Yan, FP; Nawab, J	Release of Perfluoroalkyl Substances From Melting Glacier of the Tibetan Plateau: Insights Into the Impact of Global Warming on the Cycling of Emerging Pollutants	2019	J. Geophys. Res.-Atmos. 2019 Jul:124(13):7442-7456. doi: 10.1029/2019JD030566.	The Tibetan Plateau (TP) has encountered rapid warming, with more than 50% of lakes expanding and 80% of glaciers retreating. Melting glaciers are known as a secondary source of pollutants, but the dynamics and release features of water-soluble emerging chemicals have not been studied in the TP. Glacial ice and snow, meltwater runoff, rain, and lake water were collected in Nam Co basin, in the central TP. The total concentrations of perfluoroalkyl acids (PFAAs) were 1,413 pg/L for glacial ice, followed by 1,277 pg/L for meltwater runoff, 980 pg/L for lake water, and 616 pg/L for rain. Perfluorobutanoic acid is dominant in runoff and glacial ice, while lake water contained high proportions of perfluorobutane sulfonate and perfluorooctane sulfonate. During the melting season, meltwater runoff generally had greater PFAAs concentrations, and the PFAAs release fluxes were strongly related to the glacial melt intensity. Due to the direct input of PFAAs by melted glaciers, south shore of Lake Nam Co contained higher PFAAs concentrations. The estimated input fluxes of PFAAs to the lake by rain and glacial and nonglacial runoff were 1,425, 1,342, and 2,192 mg/day, respectively. Taken together, these evidences suggest that melting glaciers are sources of PFAAs, while the lake is the receptor. Given the continuity of glacial melt and high concentrations of water-soluble emerging pollutants in glacier, the melting process will increase the risks of emerging pollutants to freshwater sources and should be of great concern.	1			1				B	-		

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D503	ばく露	Seibert, D; Zorzo, CF; Borba, FH; de Souza, RM; Quesada, HB; Bergamasco, R; Baptista, AT; Inticher, JJ	Occurrence, statutory guideline values and removal of contaminants of emerging concern by Electrochemical Advanced Oxidation Processes: A review	2020	Sci. Total Environ. 2020 Dec:748:141527. doi: 10.1016/j.scitotenv.2020.141527.	A wide variety of chemical compounds are used in human activities; however, part of these compounds reach surface water, groundwater and even water considered for potable uses. Due to the limited efficiency of water treatment by the Water and Wastewater Treatment Plants, the presence of these compounds in natural and human consumption waters can be very harmful due to their high persistence and adverse effects; these characteristics define the contaminants of emerging concern (CECs). Water treatment by Electrochemical Advanced Oxidation Processes (EAOPs) has been evaluated as a promising process for the removal of persistent and recalcitrant organic contaminants. With this background, the present review aims to gather studies and information published between 2015 and 2020 regarding the occurrence of CECs in surface, potable and groundwater, its treatment by EAOPs, the main operating conditions and by-product generation of EAOPs, contaminant toxicity assessments and international statutory guideline values concerning CEC standards and allowable concentrations in the environment and treated drinking water. Therefore, in this review it was found that the compounds bisphenol A (BPA), diethyltoluamide (DEET), 17 alpha-ethinyl estradiol (EE2), perfluorobutanoic acid (PFBA), carbamazepine, caffe ine and atrazine were the most frequently detected in water sources, with concentrations ranging from 35.54-4800, 121-98, 0.005-38.5, 5-742.904, 0.0071-586, 0.89-1040, and 100-323 (ng L-1), respectively. Among the operational conditions of EAOPs, current density, pH and oxidant concentration are the main operational parameters that have an influence on these treatment technologies, besides the by-products generated, which might be removed by the integration of EAOPs with biological digestion treatments. Regarding the values of water quality standards, many CECs do not have established standard allowable concentration values, which represents a concern toward the possible toxic effects of these compounds on non-target organisms.	1							B	-		
D504	ばく露	Zhou, YQ; Meng, J; Zhang, M; Chen, SQ; He, B; Zhao, H; Li, QF; Zhang, S; Wang, TY	Which type of pollutants need to be controlled with priority in wastewater treatment plants: Traditional or emerging pollutants?	2019	Environ. Int. 2019 Oct:131:104982. doi: 10.1016/j.envint.2019.104982.	Although wastewater treatment plants (WWTPs) can purify wastewater, they also discharge numerous contaminants into the environment through effluent discharge and sludge disposal. The occurrence, emission flux, and risk assessment of traditional pollutants (e.g., heavy metals [HMs]), and emerging pollutants (e.g., perfluoroalkyl substances [PFASs] and pharmaceutical and personal care products [PPCPs]) in WWTP emissions are of important concern. The present study analyzed 17 PFASs, 25 PPCPs, and 8 HMs in influent, effluent, and excess sludge from six WWTPs along the Yanghe River, North China. Samples were collected during four sampling campaigns from November 2016 to July 2017. The mean concentrations of PFASs and PPCPs in influent were 46.4 ng L-1 and 6.57 mu g L--1,L- respectively; while those in effluent were 38.5 ng L-1 and 2.14 mu g L-1, respectively. The highest concentrations of HMs was detected of Zn in influent (2,866 mu g L-1) and effluent (3,960 mu g L-1). According to the concentration composition, short-chain PFASs, fluoroquinolones (FQs), and Zn were the predominant components in both influents and effluents. The mean PFAS and PPCP concentrations in excess sludge were 5.95 ng g(-1) and 3.74 mu g g(-1) dry weight (dw). Zn was the most abundant HMs in excess sludge with the concentration range of 156-14,271 mu g g(-1) dw. The compositions of PFASs, PPCPs and HMs differed between wastewater and excess sludge. The estimated emission flux of these pollutants was ordered as HMs > PPCPs> PFASs through effluent discharge and sludge disposal. Sludge disposal discharged more PPCPs and HMs into the environment than effluent discharge, which was contrary for PFASs. Relative risk of each pollutant is calculated by comparing the mean effluent concentration with the median effective concentration. Algae and fish were selected as recipient organisms to calculate the relative risk of 23 selected pollutants towards aquatic organisms. The highest-risk pollutant was Zn on both algae and fish, while perfluorobutane sulfonate (PFBS) and atenolol (ATE) posed the lowest risk. In general, HMs (regarded as traditional pollutants) presented higher risks in effluent, followed by the emerging pollutants (PPCPs and PFASs). Therefore, control of traditional pollutants should be prioritized in WWTPs in this region. This study presents an overall assessment of the current status of traditional and emerging pollutants in WWTPs and provides useful information for upgrading wastewater treatment processes.				1				B	-		
D505	ばく露	da Silva, BF; Aristizabal-Henao, JJ; Aufmuth, J; Awkerman, J; Bowden, JA	Survey of per- and polyfluoroalkyl substances (PFAS) in surface water collected in Pensacola, FL	2022	Heliyon. 2022 Aug;8(8):e10239. doi: 10.1016/j.heliyon.2022.e10239.	As the persistence of per-and polyfluoroalkyl substances (PFAS) become a global concern, information about the occurrence and characteristics of PFAS in estuarine and marine ecosystems is poorly represented. In this study, the presence of 51 PFAS were monitored in the Pensacola Bay System (PBS), Florida, USA. Due to the presence of many potential PFAS sources in close proximity to the PBS (e.g., military bases, industries, airports and several firefighting stations), the distribution and concentration of PFAS in this estuarine environment provides insights into the fate of these complex compounds as well as the possible impacts on coastal systems. Surface water was collected and analyzed from 45 different sites via Strata-X-AW cartridge extractions and ultra-high pressure liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS) analysis. Recoveries for many PFAS (13/51) were > 60% (mean 77 %), with relative standard deviations below 20%, except for N-methylperfluoro-1-octanesulfo-namidoacetic acid (N-MeFOSAA) (22%). Of the perfluoroalkyl carboxylic acids (PFCAs), which comprised the majority of PFAS detected: perfluorooctanoic acid (PFOA) and perfluorohexanoic acid (PFHxA) were present in all samples; however, perfluoropentanoic acid (PFPeA) was the individual PFAS with the highest concentration of this group (51.9 ng.L-1, at site 81). The PFAS detected at the highest concentrations were perfluoroalkyl sulfonic acids (PFSA), with perfluorooctane sulfonic acid (PFOS) having the highest detected concentration (269 ng.L-1, at site 81). At all sites, at least eight or more PFAS were quantified. Past and current use of PFAS-containing materials and their fate in areas surrounding military bases, airports, and industries, require more in-depth monitoring efforts to better determine the need for regulation, management, and/or remediation. Here, sites located close to areas suspected of PFAS use had elevated concentrations. For example, one coastal location near an airfield had a sigma PFAS of 677 ng.L-1. Expansion from these ongoing efforts will focus on assessment of PFAS-related effects in local wildlife and evaluating the distribution of PFAS at these hotspot sites during large episodic weather events, a critically understudied phenomenon regarding PFAS and vulnerable coastal environments.		1						B	-		
D506	ばく露	Eun, H; Yamazaki, E; Taniyasu, S; Miecznikowska, A; Falandysz, J; Yamashita, N	Evaluation of perfluoroalkyl substances in field-cultivated vegetables	2020	Chemosphere. 2020 Jan:239:124750. doi: 10.1016/j.chemosphere.2019.124750.	Perfluoroalkyl substances (PFASs) were investigated in three types of vegetables (fruit, leafy, and root vegetables) that were cultivated and harvested from 2014 to 2017. The cultivated soil was mainly affected by perfluoroalkyl carboxylic acid (PFCAs; 91.8% detection rate) rather than perfluoroalkyl sulfonic acids (PFSAs; 8.2%). The cultivated soil (i.e., a volcanic cohesive soil) had a high total organic carbon (TOC = 3.4%) and therefore showed strong adsorption of long-chain PFASs. Short-chain PFCAs (i.e., under C9) were mainly detected in vegetables; specifically, PFBA showed high concentration in tomato shoots. Principal component analysis (PCA) plots clearly showed that PFASs in vegetables were different from those of cultivated soil, air, and rainwater. Interestingly, the whole potato (i.e., including peel) was in the same group as soil, indicating that the whole potato can easily be affected by the cultivated soil. Energy Dispersive X-ray Spectrometry-Scanning Electron Microscope (EDS-SEM) results showed that presence of unremovable micron-sized cultivated soil particles on the potato surface. Comparing the regional differences between the cultivated area of Tsukuba city (East Japan) and Osaka city (West Japan), PFASs patterns were similar in cucumber but differed in green perilla and potato.	1							B	-		
D507	ばく露	Zhang, AQ; Wang, P; Lu, YL; Zhang, M; Zhou, YQ; Wang, YC; Zhang, S	Occurrence and health risk of perfluoroalkyl acids (PFAAs) in seafood from Yellow Sea, China	2019	Sci. Total Environ. 2019 May:665:1026-1034. doi: 10.1016/j.scitotenv.2019.02.165	PFAAs have emerged as persistent organic pollutants (POPs) in a variety of environmental matrixes and biota, posing potential hazards for wildlife and humans. Diet has been considered as an important source for human exposure to PFAAs and seafood accounts for a relatively large proportion in human diets, especially for coastal residents. In an effort to clarify the impact of PFAAs in seafood on human health, 17 PFAAs were determined in 42 pooled seafood samples (14 species) from the Yellow Sea areas, China. The concentrations of total PFAAs (sum of 17 PFAAs, Sigma PFAAs) were in the range of 1.10-1067 ng/g dry weight (dw), with the highest concentration found in swimming crab (Portunus trituberculatus) and the lowest in silvery pomfret (Pampus argenteus). Concentrations and composition profiles of PFAAs varied significantly among different species, suggesting that bioaccumulation potential of PFAAs differed from species to species. The distinct spatial distribution of PFAAs in four categories of seafood could be mainly attributed to the contamination patterns of PFAAs in three nearby cities. PFBA was presented as the most abundant PFAA in this study, which was different from the findings in many other studies where PFOS was the predominant compound. Furthermore, the human health risk assessment suggested that a comprehensive action plan is needed to protect people from high exposure to PFAAs through seafood consumption.	1							B	-		
D508	ばく露	Huang, ZZ; Zhang, X; Wang, X; Deji, Z; Lee, HK	Occurrence of Perfluoroalkyl and Polyfluoroalkyl Substances in Ice Cream, Instant Noodles, and Bubble Tea	2022	J. Agric. Food Chem. 2022 Sep:70(35):10836-10846. doi: 10.1021/acs.jafc.2c01434.	Food consumption is a significant exposure route to perfluoroalkyl and polyfluoroalkyl substances (PFAS). The concentrations of 27 PFAS in fast food were determined by ultrahigh-performance liquid chromatography-high resolution mass spectrometry. In ice cream, instant noodles, and bubble tea, some PFAS were detected, among which perfluorooctanoic acid, perfluoro-n-butanoic acid, and 6:2 polyfluoroalkyl phosphate monoester showed relatively high concentrations. PFAS migrating from bubble tea cups to the food simulant of 50% ethanol aqueous solution showed a difference compared with those migrating into bubble tea matrices. The migration of 27 PFAS to bubble tea samples indicated that long storage time increased PFAS levels (up to 4.8 times) and so did high storage temperature (up to 7.3 times). The hazard ratio, defined as the ratio of the estimated daily intake and the reference dose, was calculated, and it suggests that the total PFAS exposure risk due to consumption of bubble tea should be of concern.								B	-		

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D509	ばく露	Ahrens, L; Barber, JL; Xie, ZY; Ebinghaus, R	Longitudinal and Latitudinal Distribution of Perfluoroalkyl Compounds in the Surface Water of the Atlantic Ocean	2009	Environ. Sci. Technol. 2009 May:43(9):3122-3127. doi: 10.1021/es803507p.	Perfluoroalkyl compounds (PFCs) were determined in 2 L surface water samples collected in the Atlantic Ocean onboard the research vessels Maria S. Merian along the longitudinal gradient from Las Palmas (Spain) to St. Johns (Canada) (150 W to 52 degrees W) and Polarstern along the latitudinal gradient from the Bay of Biscay to the South Atlantic Ocean (46 degrees N to 26 degrees S) in spring and fall 2007, respectively. After filtration the dissolved and particulate phases were extracted separately, and PFC concentrations were determined using high-performance liquid chromatography interfaced to tandem mass spectrometry. No PFCs were detected in the particulate phase. This study provides the first concentration data of perfluorooctanesulfonamide (FOSA), perfluorohexanoic acid, and perfluoroheptanoic acid from the Atlantic Ocean. Results indicate that trans-Atlantic Ocean currents caused the decreasing concentration gradient from the Bay of Biscay to the South Atlantic Ocean and the concentration drop-off close to the Labrador Sea. Maximum concentrations were found for FOSA, perfluorooctanesulfonate, and perfluorooctanoic acid at 302, 291, and 229 pg L-1, respectively. However, the concentration of each single compound was usually in the tens of picograms per liter range. South of the equator only FOSA and below 4 degrees S no PFCs could be detected.		1						B	-		
D510	ばく露、蓄積性	Lee, JW; Lee, HK; Lim, JE; Moon, HB	Legacy and emerging per- and polyfluoroalkyl substances (PFASs) in the coastal environment of Korea: Occurrence, spatial distribution, and bioaccumulation potential	2020	Chemosphere. 2020 Jul:251:126633. doi: 10.1016/j.chemosphere.2020.126633.	Contamination by per- and polyfluoroalkyl substances (PFASs) is of great concern in global environments. Due to strong regulation of legacy PFASs, emerging PFASs including alternatives and precursors have been introduced to the industrial market. In this study, legacy and emerging PFASs were measured in seawater, sediment, and bivalves collected along the Korean coast to investigate the occurrence, distribution, contamination sources, and bioaccumulation potential of PFASs. Wide concentration ranges of legacy PFASs were detected in multiple environmental samples, indicating widespread contamination. C8-based PFASs (e.g., PFOA and PFOS) were still major contaminants in all of the environmental samples. Some precursors, such as 8:2 fluorotelomer sulfonate (8:2 FTS) and N-ethyl-perfluorooctane sulfona-midoacetic acid (N-EtFOSAA), and perfluoro-2-propoxypropanoic potassium 9-chlorohexadecafluoro-3-oxanonane-1-sulfonate (F-53B), an alternative to PFOS, were detected in sediment or bivalve samples, implying a shift in consumption patterns from legacy to emerging PFASs. The highest concentrations of PFASs in environmental samples were found at the locations near industrial complexes, such as those for the semi-conductor, paper mill, automobile, and metal-plating industry. This result indicates that PFAS contamination is associated with intensive industrial activities in the coastal environment. Matrix-dependent contamination and profiles of PFASs were observed. Seawater was dominated by short-chained PFASs as a prompt reflection of regulation, while the sediment and bivalves were dominated by long-chained PFASs. Carbon-chain length was a major factor governing environmental behavior and bioaccumulation of PFASs. This was the first nation-wide survey on legacy and emerging PFASs in the coastal environment of Korea.								B	-		
D511	ばく露	Gallen, C; Drage, D; Kaserzon, S; Baduel, C; Gallen, M; Banks, A; Broomhall, S; Mueller, JF	Occurrence and distribution of brominated flame retardants and perfluoroalkyl substances in Australian landfill leachate and biosolids	2016	J. Hazard. Mater. 2016 Jul:312:55-64. doi: 10.1016/j.jhazmat.2016.03.031	The levels of perfluroalkyl substances (PFASs), polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecane (HBCDDs) were studied in Australian landfill leachate and biosolids. Leachate was collected from 13 landfill sites and biosolids were collected from 16 wastewater treatment plants (WWTPs), across Australia. Perfluorohexanoate (PFHxA) (12-5700 ng/L) was the most abundant investigated persistent, bioaccumulative and toxic (PBT) chemical in leachate. With one exception, mean concentrations of PFASs were higher in leachate of operating landfills compared to closed landfills. Polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecane isomers (HBCDDs) were detected typically at operating landfills in comparatively lower concentrations than the PFASs. Decabromodiphenyl ether (BDE-209) (<0.4-2300 ng/g) and perfluoroctanesulfonate (PFOS) (		1						B	-		
D512	ばく露	Routti, H; Krafft, BA; Herzke, D; Eisert, R; Oftedal, O	Perfluoroalkyl substances detected in the world's southernmost marine mammal, the Weddell seal (Leptonychotes weddellii)	2015	Environ. Pollut. 2015 Feb:197:62-67. doi: 10.1016/j.envpol.2014.11.026	This study investigates concentrations of 18 perfluoroalkyl substances (PFAS) in blood plasma of adult lactating Weddell seals (Leptonychotes weddellii) (n = 10) from McMurdo Sound, Antarctica. Perfluoroundecanoic acid (PFUnDA) was detected in all samples at concentrations ranging from 0.08 to 0.23 ng/ml. Perfluorooctane sulfonate (PFOS), perfluorohexanoate (PFHxA) and perfluorotridecanoate (PFTriDA) were sporadically detected, while the remaining compounds were below the limit of detection. This is the first report of detectible concentrations of PFASs in an endemic Antarctic marine mammal species. We suggest that the pollutants have been subjected to long range atmospheric transportation and/or derive from a local source. A review of these and published data indicate that perfluoroalkyl carboxylates (PFCAs) dominate in biotic PFAS patterns in species feeding south of the Antarctic Circumpolar Current (ACC), whereas PFOS was the major PFAS detected in species feeding predominantly north of the current.		1						B	-		
D513	ばく露	Gottschall, N; Topp, E; Edwards, M; Payne, M; Kleywegt, S; Lapen, DR	Brominated flame retardants and perfluoroalkyl acids in groundwater, tile drainage, soil, and crop grain following a high application of municipal biosolids to a field	2017	Sci. Total Environ. 2017 Jan:574:1345-1359. doi: 10.1016/j.scitotenv.2016.08.044	Dewatered municipal biosolids (DMB) were applied at a rate of 22 Mg dw ha(-1) to an agricultural field in fall 2008. Concentrations of polybrominated diphenyl ethers (PBDEs; BDE-47, -99, -100, -153, -154, -183, -197, 207, -209), other brominated flame retardants (BFRs; HBB, PBEB, DBDPE, BTBPE) and perfluoroalkyl acids (PFAAs; PFHxS, PFOS, PFDS, PFOSA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA, PFTA) were monitored in tile drainage, groundwater (2 m, 4 m and 6 m depth), soil cores (0-0.3 m) pre-and post-application, DMB aggregates incorporated into the soil post-application, and in wheat (Triticum spp.) planted post-application. Several compounds were detected in soil and water pre-application and on a reference field plot. PBDEs, other BFRs and PFAAs were detected in tile drainage and 2 m groundwater throughout the post-application study period; a few PBDEs were also detected sporadically at lower depths in groundwater. Some of these compounds had not been detected pre-application, while some exceeded reference field plot/pre-application levels (some significantly ($p < 0.05$) in tile drainage); both cases indicating biosolid-based water contamination. In DMB aggregates, several PBDE congeners were found to have dissipated exponentially, with reductions >90% in many of them within 1 year post-application. Exponential dissipation of other BFRs and PFAAs in DMB aggregates were not significant. No PBDEs, other BFRs, or PFAAs were detected in wheat grain.			1					B	-		
D514	ばく露	Shimizu, MS; Garcia, RS; Avery, GB; Kieber, RJ; Skrabal, SA; Mead, RN	Distribution of legacy and emerging per- and polyfluoroalkyl substances in riverine and coastal sediments of Southeastern North Carolina, USA	2022	Environ. Sci.-Process Impacts 2022 Nov:24(11):2119-2128. doi: 10.1039/d2em00246a.	The sediment distribution of per- and polyfluoroalkyl substances (PFAS) along a river to ocean transect was investigated. Samples were collected between September 2017 and October 2019 with targeted quantification of six legacy and replacement PFAS by LC-MS/MS. Total PFAS concentrations ranged from below the LOQ to 7.47 ng per g dry weight with PFOA, PFOS, HFPO-DA and PFMOAA the most frequently detected. Significant correlations ($p < 0.05$) were found between PFOS and HFPO-DA sedimentary concentration and percent organic carbon (% OC); however, PFOA and PFMOAA were not correlated with sediment % OC. This study highlights the occurrence of the replacement PFAS in sediments for the first time. Sediment extracts were screened for 18 additional PFAS compounds by high resolution mass spectrometry. A series of perfluorinated ether carboxylic acid and perfluorinated ether sulfonic acid with either one or two acidic functional groups were detected at various locations in the upper portion of the Cape Fear River. A series of chromatographically resolved isomers ($C7F13O5S1$; M-1) were detected and may be Nafion (TM) degradation products.					1			B	-		
D515	ばく露	Elizalde, MP; Gomez-Lavin, S; Urtiaga, AM	Migration of perfluorinated compounds from paperbag to Tenax (R) and lyophilised milk at different temperatures	2018	Int. J. Environ. Anal. Chem. 2018 Dec:98(15):1423-1433. doi: 10.1080/03067319.2018.1562062.	Migration tests of perfluoroalkyl substances (PFASs) from a grease-proof paperbag used for packaging of pet food have been carried out. No migration of perfluorocaboxylic acids (PFCAs), from PFBA to PFTeDA, to the simulant Tenax (R) was found after 10 days at 40 degrees C. However, the increase of temperature in the range 80-160 degrees C gave rise to the migration of the PFCAs. Finally, the migration to real foods such as lyophilised whole and low-fat milk samples at 80 and 120 degrees C was studied. The results indicate that the migration percentages of the PFCASs into food samples are much higher than those obtained into Tenax (R).	1							B	-		
D516	ばく露	Hu, JR; Lyu, Y; Chen, H; Cai, LL; Li, J; Cao, XQ; Sun, WL	Integration of target, suspect, and nontarget screening with risk modeling for per- and polyfluoroalkyl substances prioritization in surface waters	2023	Water Res. 2023 Apr:233:119735. doi: 10.1016/j.watres.2023.119735.	Though thousands of per-and polyfluoroalkyl substances (PFAS) have been on the global market, most research focused on only a small fraction, potentially resulting in underestimated environmental risks. Here, we used complementary target, suspect, and nontarget screening for quantifying and identifying the target and nontarget PFAS, respectively, and developed a risk model considering their specific properties to prioritize the PFAS in surface waters. Thirty-three PFAS were identified in surface water in the Chaobai river, Beijing. The suspect and nontarget screening by Orbitrap displayed a sensitivity of > 77%, indicating its good performance in identifying the PFAS in samples. We used triple quadrupole (QqQ) under multiple-reaction monitoring for quantifying PFAS with authentic standards due to its potentially high sensitivity. To quantify the nontarget PFAS without authentic standards, we trained a random forest regression model which presented the differences up to only 2.7 times between measured and predicted response factors (RFs). The maximum/minimum RF in each PFAS class was as high as 1.2-10.0 in Orbitrap and 1.7-22.3 in QqQ. A risk-based prioritization approach was developed to rank the identified PFAS, and four PFAS (i.e., perfluorooctanoic acid, hydrogenated perfluorohexanoic acid, bistri-flimide, 6:2 fluorotelomer carboxylic acid) were flagged with high priority (risk index > 0.1) for remediation and management. Our study highlighted the importance of a quantification strategy during environmental scrutiny of PFAS, especially for nontarget PFAS without standards.		1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D517	ばく露	Wilson, TB; Stevenson, G; Crough, R; de Araujo, J; Fernando, N; Anwar, A; Scott, T; Quinteros, JA; Scott, PC; Archer, MJG	Evaluation of Residues in Hen Eggs After Exposure of Laying Hens to Water Containing Per- and Polyfluoroalkyl Substances	2021	Environ. Toxicol. Chem. 2021 Mar:40(3):735-743. doi: 10.1002/etc.4723.	Per- and polyfluoroalkyl substances (PFAS) have been used in aqueous film-forming foams used in firefighting, resulting in soil and groundwater contamination and leading to human exposure via animal products grown in contaminated areas. The present study reports the relationship between PFAS intake by hens and the PFAS concentrations in the edible parts of eggs. Laying hens were exposed via drinking water to different concentrations of 4 PFAS compounds (perfluorooctane sulfonate [PFOS], perfluorohexane sulfonate [PFHxS], perfluorooctanoic acid [PFOA], and perfluorohexanoic acid) over 61 d. Egg PFAS residues were assessed for a further 30 d after exposure ceased. The target concentrations of PFAS were 0, 0.3, 3, 30, and 300 mu g/L for the treatment groups T1-T5, respectively; and PFAS residues were determined from the eggs collected every second day. There was a linear correlation between the PFAS concentrations in the drinking water of hens and those detected in the egg, which could be useful in estimating PFAS concentrations in the egg by measuring water concentrations. Exposure of hens to drinking water with PFAS concentrations below the Australian Government Department of Health limits (PFOS and PFHxS, 0.07 mu g/L; PFOA, 0.56 mu g/L), and with no other sources of PFAS exposure, is unlikely to result in egg PFAS concentrations that would exceed the 10% limit set by Food Standards Australia New Zealand for human consumption.		1						B	-		
D518	ばく露	Schultes, L; Vestergren, R; Volkova, K; Westberg, E; Jacobson, T; Benskin, JP	Per- and polyfluoroalkyl substances and fluorine mass balance in cosmetic products from the Swedish market: implications for environmental emissions and human exposure	2018	Environ. Sci.-Process Impacts 2018 Dec:20(12):1680-1690. doi: 10.1039/c8em00368h.	Per- and polyfluoroalkyl substances (PFASs) are a diverse class of >4700 chemicals used in commercial products and industrial processes. Concerns surrounding PFASs are principally due to their widespread occurrence in humans and the environment and links to adverse health effects. One of the lesser known uses for PFASs is in cosmetic products (CPs) which come into contact with the skin (e.g. hair products, powders, sunblocks, etc.). In the present work, thirty-one CPs from five product categories (cream, foundation, pencil, powder and shaving foam) were analyzed for 39 PFASs by liquid chromatography-tandem mass spectrometry, as well as extractable organic fluorine (EOF) and total fluorine (TF) by combustion ion chromatography (CIC). This multi-platform approach enabled determination of the fraction of fluorine accounted for by known PFASs (i.e. fluorine mass balance). Foundations and powders contained 25 different PFASs with the most frequently detected being perfluorinated carboxylic acids (perfluoroheptanoic acid and perfluorohexanoic acid) and polyfluoroalkyl phosphate esters (PAPs). sigma(14)PAP concentrations up to 470 g g(-1) were measured in products listing mixtures of PAPs as an ingredient. For all samples, sigma(39)PFAS concentrations only explained a small fraction of the EOF and TF, pointing to the presence of unknown organic and/or inorganic fluorinated substances, including polymers. While creams, pencil and shaving foams did not contain measurable concentrations of any of the 39 PFASs targeted here, CIC revealed high to moderate TF content. Overall, these data highlight the need for further investigations into the occurrence of PFASs in CPs and their importance with regards to human and environmental exposure.		1						B	-		
D519	ばく露	Gomez, C; Vicente, J; Echavarri-Erasun, B; Porte, C; Lacorte, S	Occurrence of perfluorinated compounds in water, sediment and mussels from the Cantabrian Sea (North Spain)	2011	Mar. Pollut. Bull. 2011 May:62(5):948-955. doi: 10.1016/j.marpolbul.2011.02.049.	Perfluorinated compounds (PFCs) have emerged as significant global environmental pollutants with persistent, bioaccumulative and toxic properties. The aim of this study was to determine the occurrence of PFCs in water (wastewater, submarine emissaries and port-waters), sediment and transplanted mussels in estuarine areas of high urban and industrial impact from Northern Spain. Five PFCs of industrial use were studied: perfluorooctanesulfonate, perfluorohexanesulfonate, perfluorobutanesulfonate, perfluorooctanoate acid and perfluorononanoate acid. After selective extraction, samples were analyzed by Ultra Performance Liquid Chromatography coupled to tandem mass spectrometry. Sigma PFCs ranged from 0.06 to 10.9 ng/L in water, with higher levels in wastewater treatment plants effluents and port waters than in submarine emissaries. Little accumulation was observed in sediments and mussels with Sigma PFCs ranging from 0.01-0.13 ng/g dw and 0.01-0.06 ng/g ww, respectively. Most ubiquitous compounds were PFOS and PFOA. Mass fluxes of PFCs to the Cantabrian Sea are estimated and the impact to the coastal ecosystem is discussed.			1	1				B	-		
D520	ばく露	Lee, DG; Roehrdanz, PR; Feraud, M; Ervin, J; Anumol, T; Jia, A; Park, M; Tamez, C; Morelius, EW; Gardea-Torresdey, JL; Izbicki, J; Means, JC; Snyder, SA; Holden, PA	Wastewater compounds in urban shallow groundwater wells correspond to exfiltration probabilities of nearby sewers	2015	Water Res. 2015 Nov:85:467-475. doi: 10.1016/j.watres.2015.08.048	Wastewater compounds are frequently detected in urban shallow groundwater. Sources include sewage or reclaimed wastewater, but origins are often unknown. In a prior study, wastewater compounds were quantified in waters sampled from shallow groundwater wells in a small coastal California city. Here, we resampled those wells and expanded sample analyses to include sewage- or reclaimed water-specific indicators, i.e. pharmaceutical and personal care product chemicals or disinfection byproducts. Also, we developed a geographic information system (GIS)-based model of sanitary sewer exfiltration probability combining a published pipe failure model accounting for sewer pipe size, age, materials of construction, with interpolated depths to groundwater to determine if sewer system attributes relate to wastewater compounds in urban shallow groundwater. Across the wells, groundwater samples contained varying wastewater compounds, including acesulfame, sucralose, bisphenol A, 4-tert-octylphenol, estrone and perfluorobutanesulfonic acid (PFBS). Fecal indicator bacterial concentrations and toxicological bioactivities were less than known benchmarks. However, the reclaimed water in this study was positive for all bioactivity tested. Excluding one well intruded by seawater, the similarity of groundwater to sewage, based on multiple indicators, increased with increasing sanitary sewer exfiltration probability (modeled from infrastructure within ca. 300 m of each well). In the absence of direct exfiltration or defect measurements, sewer exfiltration probabilities modeled from the collection system's physical data can indicate potential locations where urban shallow groundwater is contaminated by sewage.				1				B	-		
D521	ばく露	Lin, AYC; Panchangam, SC; Ciou, PS	High levels of perfluorochemicals in Taiwan's wastewater treatment plants and downstream rivers pose great risk to local aquatic ecosystems	2010	Chemosphere. 2010 Aug:80(10):1167-1174. doi: 10.1016/j.chemosphere.2010.06.018.	We studied perfluorochemicals (PFCs) in the influents and effluents of two municipal wastewater treatment plants (MWWTPs) and in the effluents of an industrial wastewater treatment plant (IWWTP). The impact of IWWTP effluents on the receiving rivers (the Nanmen and Keya Rivers) was evaluated by measuring PFC levels in the surface waters of both rivers and the sediments of the Nanmen River. Perfluorooctane sulfonate (PFOS) (293 ng L-1) and perfluorohexanoic acid (406 ng L-1) were identified as the compounds present in greatest concentrations in the influents and effluents of both MWWTPs, which are largely influenced by domestic sources. High concentrations of PFCs (up to 10 000 ngL(-1)) were found in IWWTP effluents and receiving rivers, with more perfluoroalkyl sulfonates (PFASs) found than perfluoroalkylcarboxylic acids (PFCAs). This study confirms the IWWTP as the point source of the persistent contamination of the Nanmen and Keya Rivers. Sediments of the Nanmen River were also impacted by IWWTP discharges, with high concentrations of PFOS (up to 90 000 ng kg(-1)). PFCAs with longer carbon chains exhibited preferred partitioning onto the sediments. The occurrence of higher PFC concentrations in Taiwan's aquatic media compared to other countries stresses the necessity for PFC risk management. Accordingly, a preliminary risk assessment was performed using the predicted no-effect concentration (PNEC) and indicative maximum permissible concentration (iMPC). The likelihood of ecological risk due to PFOS was plausible at a risk quotient of 1.21, as calculated using iMPC. Given our findings of high environmental PFC concentrations, rapid and meaningful steps should be taken to reduce entry of PFCs into Taiwan's aquatic environment.		1						B	-		
D522	ばく露	Mclachlan, MS; Holmstrom, KE; Reth, M; Berger, U	Riverine discharge of perfluorinated carboxylates from the European continent	2007	Environ. Sci. Technol. 2007 Nov:41(21):7260-7265. doi: 10.1021/es071471p.	The discharge of C-6-C-9 perfluorinated carboxylates (PFCAs) from major European rivers was studied and employed to assess European emissions of these compounds Water samples were collected close to the mouths of 14 major rivers including the Rhine, Danube, Elbe, Oder, Seine, Loire, and Po. PFCA concentrations were determined using LC-MS/MS and used together with the mean annual water flow to estimate the riverine discharge of the PFCAs. The highest concentration measured was 200 ng/L for perfluorooctanoate (PFOA) in the Po River. The Po accounted for two-thirds of the total PFOA discharge of all the rivers studied, suggesting a major industrial source of PFOA in the Po watershed. All other nonremote rivers showed PFOA concentrations in the lower ng/L range, which indicates that widely distributed sources are also significant contributors to PFOA emissions in Europe. The total discharge of PFOA from the European rivers was estimated to be 14 tonnes/year, which is in reasonable agreement with reported emissions estimates. However, the total riverine discharge of perfluorohexanoate (PFHxA) of 2.8 tonnes/year estimated in this study was three times greater than the reported global emissions estimate, suggesting that there are significant, as yet unidentified sources of this compound.		1						B	-		
D523	ばく露	Simukoko, CK; Mwakalapa, EB; Muzandu, K; Mutoloki, S; Evensen, O; Raeder, EM; Muuller, MB; Polder, A; Lyche, JL	Persistent organic pollutants (POPs) and per- and polyfluoroalkyl substances (PFASs) in liver from wild and farmed tilapia (Oreochromis niloticus) from Lake Kariba, Zambia: Levels and geographic trends and considerations in relation to environmental quality standards (EQSs)	2023	Environ. Res. 2023 Sep:232:116226. doi: 10.1016/j.envres.2023.116226.	The current study was carried out to investigate a wide variety of persistent organic pollutants (POPs) in wild and farmed tilapia (Oreochromis niloticus) in Lake Kariba, Zambia, and assess levels of POPs in relation to Environmental Quality Standards (EQSs). Concentrations of organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs), polybrominated diphenyls (PBDEs), and perfluoroalkyl substances (PFASs) were determined in liver samples of tilapia. PFASs compounds PFOS, PFDA and PFNA were only detected in wild fish, with the highest median PFOS levels in site 1 (0.66 ng/g ww). Concentrations of POPs were in general highest in wild tilapia. The highest median n-ary sumation DDTs (93 and 81 ng/g lw) were found in wild tilapia from sites 1 and 2, respectively 165 km and 100 km west of the fish farms. Lower DDE/DDT ratios in sites 1 and 3 may indicate relatively recent exposure to DDT. The highest median of n-ary sumation 17PCBs (3.2 ng/g lw) and n-ary sumation 10PBDEs (8.1 ng/g lw) were found in wild tilapia from sites 1 and 2, respectively. The dominating PCB congeners were PCB-118,-138,-153 and-180 and for PBDEs, BDE-47,-154, and-209. In 78% of wild fish and 8% of farmed fish n-ary sumation 6PBDE concentrations were above EQSbiota limits set by the EU. This warrants further studies.			1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D524	ばく露	Gonzalez-Gaya, B; Dachs, J; Roscales, JL; Caballero, G; Jimenez, B	Perfluoroalkylated Substances in the Global Tropical and Subtropical Surface Oceans	2014	Environ. Sci. Technol. 2014 Nov:48(22):13076-13084. doi: 10.1021/es503490z.	In this study, perfluoroalkylated substances (PFASs) were analyzed in 92 surface seawater samples taken during the Malaspina 2010 expedition which covered all the tropical and subtropical Atlantic, Pacific and Indian oceans. Nine ionic PFASs including C6--C10 perfluoroalkyl carboxylic acids (PFCAs), C4 and C6-C8 perfluoroalkyl sulfonic acids (PFSAs) and two neutral precursors, perfluoroalkyl sulfonamides (PFASAs), were identified and quantified The Atlantic Ocean presented the broader range in concentrations of total PFASs (131-10900 pg/l,, median 645 pg, n = 45) compared to the other oceanic basins, probably due to a better spatial coverage. Total concentrations in the Pacific ranged from 344 to 2500 pg/ (median = 527 pg/L, n 27) and in the Indian Ocean from 176 to 1976 pg/l, (Median = 329, n = 18). Perfluorooctanesulfonic acid (PFOS) was the most abundant compound, accounting for 33% of the total -PFASs globally, followed by perfluorodecanoic acid (PFDA, 22%) and perfluorohexanoic acid (PF 12%), being the rest of the individual congeners under 10% of total PFASs, even for perfluorooctane carboxylic acid (PFOA, 696). PFASAs accounted for less than 1% of the total PFASs concentration. This study reports the ubiquitous occurrence of PFGAs, PFSAs, and PFASAs in the global., ocean, being the first attempt, to our knowledge, to show a comprehensive assessment in surface water samples collected a single oceanic expedition covering tropical and subtropical oceans. The potential factors affecting their distribution patterns were assessed including the distance to coastal regions; oceanic subtropical gyres, current's and biogeochemical processes. Field evidence of biogeochemical controls on the occurrence of PFASs was tentatively assessed considering environmental variables (solar radiation, temperature, chlorophyll a concentrations among others) and these showed significant correlations with some PFASs, but explaining small to moderate percentages of variability. This suggests that a number of physical and biogeochemical processes collectively drive the oceanic occurrence and fate of PFASs in a complex manner.		1						B	-		
D525	ばく露	Jiang, WW; Zhang, YF; Yang, LP; Chu, XL; Zhu, L	Perfluoroalkyl acids (PFAAs) with isomer analysis in the commercial PFOS and PFOA products in China	2015	Chemosphere 2015 May:127:180-187. doi: 10.1016/j.chemosphere.2015.01.049	Perfluoroalkyl acids (PFAAs) have been widely used in consumer and industrial products for decades and are widely detected in the environment and humans all over the world. The information on the isomeric profiles of commercial products is important to identify the manufacturing origins of PFAAs in the environment. For the first time, the PFAA compositions and isomeric profiles of perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) were reported in three PFOS and five PFOA commercial products manufactured in China. The purity of the three PFOS products was 76.7-80.6%. The major impurity in the PFOS products is PFOA, which contributes more than 10%. Other impurities include perfluorohexane-sulfonate (PFHxS), perfluorohexanoate (PFHxA) and perfluoroheptanoate acids (PFHpA). The percentage of linear PFOS (n-PFOS) in the three products was 66.2-71.9%, similar to that in the product manufactured by 3M (70.3%). The purity of the five PFOA products was relatively high (94.0-95.8%), and the major impurity was PFOS (2.06-3.09%). The percentage of n-PFOA in the five PFOA products was 76.4-77.9%, which was similar to that in the 3M PFOA (78%). Although it is widely accepted that telomerization is currently the predominant manufacturing method for PFOA, yielding an isomerically pure and linear product, the results in the present study suggest that electrochemical fluorination is still used by some manufacturers in China.		1						B	-		
D526	ばく露	Shan, GQ; Chen, XW; Zhu, LY	Occurrence, fluxes and sources of perfluoroalkyl substances with isomer analysis in the snow of northern China	2015	J. Hazard. Mater. 2015 Dec:299:639-646. doi: 10.1016/j.jhazmat.2015.07.074	In this study, perfluoroalkyl substances (PFASs) and the isomers of perfluorooctanoate (PFOA) and perfluorooctanesulfonate (PFOS) were analyzed in fresh snow samples collected from 19 cities in northern China, 2013. The levels of total PFASs in the snow samples were 33.5-229 ng/L, suggesting heavy atmospheric pollution of PFASs in northern China. PFOA (9.08-107 ng/L), PFOS (3,52-54.3 ng/L), perfluoroheptanoate (PFHpA) (3.66-44.8 ng/L), and perfluorohexanoate (PFHxA) (3.21-23.6 ng/L) were predominant with a summed contribution of 82% to the total PFASs. The particulate matters (PMs) associated PFASs contributed 21.5-56.2% to the total PFASs in the snow, suggesting PMs are vital for the transport and deposition of airborne PFASs. Partitioning of PFASs between PM and dissolved phases was dependent on the carbon chain length and end functional groups. Isomer profiles of PFOA and PFOS in the snow were in agreement with the signature of the historical 3 M electrochemical fluorination (ECF) products, suggesting that the ECF products were still produced and used in China. Further source analysis showed that the airborne PFASs in urban area were mainly due to direct release rather than degradation of their precursors.		1						B	-		
D527	ばく露	Sznajder-Katarzynska, K; Surma, M; Wiczkowski, W; Cieslik, E	The perfluoroalkyl substance (PFAS) contamination level in milk and milk products in Poland	2019	Int. Dairy J. 2019 Sep:96:73-84. doi: 10.1016/j.idairyj.2019.04.008	Cross-sectional studies concerning the contamination of milk and milk products by perfluoroalkyl substances (PFASs) are presented and the extent of contamination that may occur in food samples, collected in Poland in 2016 is evaluated; not only milk, cottage cheese, natural yoghurt and butter but also previously untested foods, including kefir, sour cream and Camembert-type cheese. Levels of 7 perfluoroalkyl carboxylic acids (PFCAs) and 3 perfluoroalkane sulfonates (PFSAs) were analysed using the QuEChERS extraction method followed by micro-HPLC-MS/MS. All PFASs were detected with an RSD of lower than 10%. The most commonly detected was perfluorooctanoic acid, followed by perfluorobutanoic acid and perfluorohexane sulfonate, on par with perfluorooctane sulfonate. The largest contributor to the total PFAS concentration in the investigated food samples was perfluorobutanoic acid, and its summary concentration within the group was estimated to be 13.34 ng g(-1). The results for 43.4% of samples analysed were greater than LOQ (limit of quantification).	1						B	-		
D528	ばく露	Tang, AP; Zhang, XH; Li, RF; Tu, WQ; Guo, HQ; Zhang, YP; Li, ZR; Liu, Y; Mai, BX	Spatiotemporal distribution, partitioning behavior and flux of per- and polyfluoroalkyl substances in surface water and sediment from Poyang Lake, China	2022	Chemosphere. 2022 May:295:133855. doi: 10.1016/j.chemosphere.2022.133855.	Thirty-five legacy and emerging per- and polyfluoroalkyl substances (PFAS) were analyzed in surface water and sediments collected from Poyang Lake, the largest freshwater lake in China. The x1a9;PFAS concentrations ranged from 23 to 1000 ng/L in water dissolved phase, 1.3-9.8 ng/L in suspended particulate matters, and 0.26-2.9 ng/ g dry weight in sediments. Short-chain and emerging PFAS were predominant in surface water and sediments, rather than legacy perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). Hexafluoropropylene oxide dimer/trimer acid (HFPO-DA/TA), 6:2 and 8:2 chlorinated polyfluorinated ether sulfonic acids (6:2 and 8:2 Cl-PFESAs), 6:2 fluorotelomer sulfonate (6:2 FTS), and sodium p-perfluorous nonenoxybenzene sulfonate (OBS) were detected in all samples, indicating that these emerging PFAS have been widely produced and used in this region. The high concentrations of HFPO-DA/TA, 6:2 FTS, 6:2, 8:2 Cl-PFESAs, and OBS in sediments and their higher water-sediment distribution coefficients than those of predecessors (PFOA or PFOS) suggest that lake sediments could be an important long-term sink for these emerging alternatives. The positive matrix factorization model demonstrated that food packaging and textile treatments (50%) and fluoropolymer manufacturing (26% for alternative sources and 8.2% for legacy sources) were the two major sources of PFAS in Poyang Lake. The influx and outflux of total PFAS in Poyang Lake were 9.0 and 12.8 ton/year, respectively, and the OBS flux was estimated for the first time. The results provide insights into the environmental behavior and fate of emerging PFAS in freshwater ecosystems.					1			B	-		
D529	ばく露	Qu, YX; Jiang, XS; Cagnetta, G; Liu, LQ; Bao, YX; Li, WC; Wang, Q; Liang, CR; Huang, J; Yang, HW; Yu, G	Poly- and perfluoroalkyl substances in a drinking water treatment plant in the Yangtze River Delta of China: Temporal trend, removal and human health risk	2019	Sci. Total Environ. 2019 Dec:696:133949. doi: 10.1016/j.scitotenv.2019.133949.	Poly- and perfluorinated substances (PFASs) have been found ubiquitously all over the world in drinking water, thus attracting concern of public opinion and regulators. The present study was carried out in a drinking water treatment plant (DWTP) located in the city of Changzhou (China), near the Yangtze River Delta. 31 PFASs concentrations were analyzed in the DWTP process water flows, as well as in its upstream source water (Yangtze River and Desheng River) and downstream public supply water. 13 PFASs were detected in source and drinking water with total concentration of 25-38 ng/L, which were higher for Yangtze River than Desheng River. The predominant contaminants were perfluorobutanesulfonate, perfluorooctanoic acid and perfluorobutanoic acid. In addition, HFPO-TA was identified for the first time in Yangtze River. Data indicate that PFASs discharge in Yangtze River is remarkable, with amass flow in the wet season (i.e. summer) up to 83 kg/d. However, oxidizable precursors (quantified by total oxidizable precursor assay) were 21-88% of total PFASs, constituted mainly by short-chain homologues. Taking these precursors into account, an opposite picture is observed: Desheng River had higher concentration of total PFASs than Yangtze River. Results for the DWTP indicate that PFASs concentration was not affected by conventional treatment processes and remained unchanged also in the downstream public water supply pipelines. More importantly, granular activated carbon removed effectively only sulfonated and carboxylated congeners, but was inefficacious with oxidizable precursors. The present study demonstrates that, despite implementation of treatment by granular activated carbon, there is still a risk for citizens deriving from drinking water of Yangtze River.	1			1	1		B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D530	ばく露	Yu, L; Liu, XD; Hua, ZL; Zhang, Y; Xue, HQ	Spatial and temporal trends of perfluoroalkyl acids in water bodies: A case study in Taihu Lake, China (2009-2021)	2022	Environ. Pollut. 2022 Jan:293:118575. doi: 10.1016/j.envpol.2021.118575.	Perfluoroalkyl acids (PFAAs) have been ubiquitously detected in water bodies and are a cause of great public concern due to their adverse effects. This study investigated the long-term temporal-spatial trends of PFAAs in the water bodies of the entire Taihu Lake, and predicted PFAA concentrations for 2024. A field investigation conducted in 2021 and previous data allowed to derive trends over a broad temporal-spatial scale, which is often not feasible in short-term studies. In the 2009-2021 period, the most quantifiable PFAAs increased, among which perfluorooctanoic acid and perfluorohexanoic acid were predominant. As of 2021, the mean total concentration of ten PFAAs (n-ary sumation 10PFAA) showed a distinct spatial decreasing trend, moving from north to south within the lake, and similar spatial distribution patterns were also noted in other years. The main PFAA input and most serious contamination were concentrated in the northern region, due to the riverine inputs and clustering of PFAArelated industries. The n-ary sumation 10PFAA concentration in the wet season was greater and presented a more uniform distribution pattern than that in the dry season, possibly due to the combined effects of the degradation of PFAA precursors, water inflow, rainfall, shipping activities, and a shallow water column. From 2009 to 2021 the n-ary sumation 10PFAA concentration of the entire lake showed an increasing trend, but the rate of increase was significantly reduced. In addition, a grey model predicted that the mean n-ary sumation 10PFAA concentration in the entire Taihu Lake will reach 431 ng/L in 2024, and the northern region will be affected by a more serious PFAA pollution in the future because it exhibited a high mean n-ary sumation 10PFAA concentration of 426 ng/L in 2021. These findings provide novel insights into the temporal-spatial distribution of PFAAs in Taihu Lake, and could help regulators to formulate policy decisions in response to PFAA pollution.		1						B	-		
D531	ばく露	Zhao, N; Zhao, MR; Liu, WP; Jin, HB	Atmospheric particulate represents a source of C-8-C-12 perfluoroalkyl carboxylates and 10:2 fluorotelomer alcohol in tree bark	2021	Environ. Pollut. 2021 Mar:273:116475. doi: 10.1016/j.envpol.2021.116475.	In this study, we analyzed 30 legacy and emerging poly- and perfluoroalkyl substances (PFASs) in paired atmospheric particulate and bark samples collected around a Chinese fluorochemical manufacturing park (FMP), with the aim to explore the sources of PFASs in tree bark. The results showed that PFASs in atmospheric particulate and tree bark samples were consistently dominated by perfluorooctanoate (mean 73 ng/g; 44 pg/m(3)), perfluorohexanoate (47 ng/g; 36 pg/m(3)), perfluorononanoate (9.1 ng/g; 8.8 pg/m(3)), and 10:2 fluorotelomer alcohol (10:2 FTOH; 5.6 ng/g; 12 pg/m(3)). Spatially, concentrations of C-8-C-12 perfluoroalkyl carboxylates (PFCAs) and 10:2 FTOH all showed a similar and exponentially decreased trend in both bark and atmospheric particulate samples with the increasing distance from the FMP. For the first time, we observed strongly significant (Spearman's correlation coefficient = 0.53-0.79, $p < 0.01$) correlations between bark and atmospheric particulate concentrations for C-8-C-12 PFCAs and 10:2 FTOH over 1-2 orders of magnitude, suggesting that the continues trapping of atmospheric particulates resulted in the accumulation of these compounds in bark. Overall, this study provides the first evidence that atmospheric particulate is an obvious source of C-8-C-12 PFCAs and 10:2 FTOH in tree bark. This result may further contribute to the application of tree bark as an indicator of certain PFASs in atmospheric particulate.		1	1				B	-		
D532	ばく露	Codling, G; Hosseini, S; Corcoran, MB; Bonina, S; Lin, T; Li, A; Sturchio, NC; Rockne, KJ; Ji, K; Peng, H; Giesy, JP	Current and historical concentrations of poly and perfluorinated compounds in sediments of the northern Great Lakes - Superior, Huron, and Michigan	2018	Environ. Pollut. 2018 May:236:373-381. doi: 10.1016/j.envpol.2018.01.065	Current and historical concentrations of 22 poly- and perfluorinated compounds (PFASs) in sediment collected from Lake Superior and northern Lake Michigan in 2011 and Lake Huron in 2012 are reported. The sampling was performed in two ways, Ponar grabs of surface sediments for current spatial distribution across the lake and dated cores for multi-decadal temporal trends. Mean concentrations of the sum of PFASs (Sigma PFASs) were 1,5, 4.6 and 3.1 ng g(-1) dry mas (dm) in surface sediments for Lakes Superior, Michigan and Huron, respectively. Of the five Laurentian Lakes, the watersheds of Superior and Huron are the less densely populated by humans, and concentrations observed were typically less and from more diffuse sources, due to lesser urbanization and industrialization. However, some regions of greater concentrations were observed and might indicate more local, point sources. In core samples concentrations ranged from							B	-		
D533	ばく露	Young, AS; Sparer-Fine, EH; Pickard, HM; Sunderland, EM; Peaslee, GF; Allen, JG	Per- and polyfluoroalkyl substances (PFAS) and total fluorine in fire station dust	2021	J. Expo. Sci. Environ. Epidemiol. 2021 Sep:31(5):930-942. doi: 10.1038/s41370-021-00288-7.	Per- and polyfluoroalkyl substances (PFAS) are a class of over 4700 fluorinated compounds used in industry and consumer products. Studies have highlighted the use of aqueous film-forming foams (AFFFs) as an exposure source for firefighters, but little is known about PFAS occurrence inside fire stations, where firefighters spend most of their shifts. In this study, we aimed to characterize PFAS concentrations and sources inside fire stations. We measured 24 PFAS (using LC-MS/MS) and total fluorine (using particle-induced gamma ray emission) in dust from multiple rooms of 15 Massachusetts stations, many of which (60%) no longer use PFAS-containing AFFF at all and the rest of which only use it very rarely. Compared to station living rooms, turnout gear locker rooms had higher dust levels of total fluorine ($p < 0.0001$) and three PFAS: perfluorohexanoate (PFHxA), perfluoroheptanoate (PFHpA), and perfluorodecanoate (PFDoDA) ($p < 0.05$). These PFAS were also found on six wipes of station turnout gear. By contrast, the dominant PFAS in living rooms was N-ethyl perfluorooctane sulfonamidoacetic acid (N-MeFOSAA), a precursor to perfluorooctane sulfonate (PFOS) that still persists despite phase-outs almost two decades ago. The sigma(24) PFAS accounted for less than 2% of fluorine in dust (n = 39), suggesting the potential presence of unknown PFAS. Turnout gear may be an important PFAS source in stations due to intentional additives and/or contamination from firefighting activities.		1					B	-		
D534	ばく露	Liu, W; Qin, H; Li, JW; Zhang, Q; Zhang, HH; Wang, ZS; He, X	ATMOSPHERIC CHLORINATED POLYFLUORINATED ETHER SULFONATE AND IONIC PERFLUOROALKYL ACIDS IN 2006 TO 2014 IN DALIAN, CHINA	2017	Environ. Toxicol. Chem. 2017 Oct:36(10):2581-2586. doi: 10.1002/etc.3810.	Chlorinated polyfluorinated ether sulfonate (Cl-PFESA; trade name F-53B) is an alternative product for perfluorooctane sulfonate (PFOS) used in metal plating; little is known about its levels in the environment and its risks. To our knowledge, the present study constitutes the first report of Cl-PFESA in the atmosphere. In 2006 to 2014, C8 Cl-PFESA, along with ionic perfluoroalkyl acids (PFAAs), was detected in atmospheric particulate matter in Dalian, China. Concentrations of C8 Cl-PFESA increased from 140 pg/m(3) in 2007 to 722 pg/m(3) in 2014. Levels of 11 (total) ionic PFAAs increased in 2006 to 2008 and decreased afterward, with a range of 35.7 to 860 pg/m(3). The PFAAs in the particulate matter were dominated by perfluorocarboxylates, with perfluorooctanoate detected at the highest concentration at a mean level of 71.7 pg/m(3), followed by perfluoroheptanoate and perfluorohexanoate. Perfluorosulfonates were detected at lower levels, with mean concentrations of PFOS, perfluorobutanesulfonate, and perfluorohexane sulfonate of 5.73, 1.64, and 1.24 pg/m(3), respectively. Back-trajectory analysis suggested that the air mass approaching Dalian during the sampling originated from the northwest, where fluorochemical industry parks and metal plating industries are densely located. No significant correlation was observed between Cl-PFESA and the ionic PFAAs. The relatively high Cl-PFESA concentrations suggested that it possibly contributed largely to the previously reported exposure to undefined organic fluorine compounds, for which further research on emission and environmental risks is needed.		1		1			B	-		
D535	ばく露、蓄積性	Gao, C; Hua, ZL; Li, XQ	Distribution, sources, and dietetic-related health risk assessment of perfluoroalkyl acids (PFAAs) in the agricultural environment of an industrial-agricultural interaction region (IAIR), Changshu, East China	2022	Sci. Total Environ. 2022 Feb:809:152159. doi: 10.1016/j.scitotenv.2021.152159.	The exploration of the distribution and dietetic-related health risks of perfluoroalkyl acids (PFAAs) in industrial agricultural interaction regions (IAIRs) is of significant importance, due to the transfer of many PFAA-related factories to developing countries with intensive agricultural activities. In the present study, based on the local diet, edible parts of rice, vegetables, fish, and their corresponding soils and irrigation/aquaculture water were investigated in a typical Chinese city (Changshu). The concentrations of total perfluoroalkyl acids (sigma PFAAs) in the edible parts of rice /vegetables and fish tissues ranged from 26.69 to 37.09 ng/g dw, 12.93 to 40.77 ng/g dw, and 13.27 to 29.82 ng/g ww, with perfluorohexanoic acid (PFPeA) and perfluorooctane sulfonic acid (PFOS) as the most dominant compounds. The PFAA concentrations in the corresponding rice soils, vegetable soils, irrigation water, and aquaculture water ranged from 11.99 to 26.33 ng/g dw, 14.06 to 36.19 ng/g dw, 141.36 to 297.00 ng/L, and 179.23 to 235.82 ng/L, respectively. Biota-sediment accumulation factor (BSAF) values for the plant-soil system were far greater than those for bioaccumulation factor (BAF) values for the plant-irrigation water system. PFAAs were more inclined to accumulate in the gills of fish as determined by their highest BAF values. Correlation analysis showed that PFAAs in root vegetables had a stronger correlation with those in soil compared with those in irrigation water. Source analysis showed that emissions from fluoride industries, textiles, and food industries may be the dominant sources of PFAAs in agricultural environments. The estimated dietary intake (EDI) for the selected diet was lower than that for rice/vegetables but was higher than that found in fish. Toddlers (2-5 years) had the highest exposure risk, and rural residents were more exposed to PFAAs than urban residents under the selected diet.		1					B	-		
D536	ばく露	Gallen, C; Drage, D; Eaglesham, G; Grant, S; Bowman, M; Mueller, JF	Australia-wide assessment of perfluoroalkyl substances (PFASs) in landfill leachates	2017	J. Hazard. Mater. 2017 Jun:331:132-141. doi: 10.1016/j.jhazmat.2017.02.006	Leachate from 27 landfills was analysed for nine perfluoroalkyl substances (PFASs). Five PFASs were detected ubiquitously, with perfluorohexanoate (PFHxA) the predominant PFAS (mean 1700 ng/L; range 73-25,000 ng/L). Despite the complexity of landfill-specific factors, some general trends in PFAS concentrations were observed. Mean concentrations of eight PFASs were higher in operating landfills (or landfill cells) accepting primarily municipal waste, compared to closed municipal landfills. Landfills accepting primarily construction and demolition wastes produced leachate that had higher mean PFAS concentrations than municipal landfills. Younger landfills appeared to have a higher burden of waste containing PFASs (or their precursors), as significant relationships ($p < 0.05$) were observed between selected PFAS concentrations and landfill age. Increasing pH and total organic carbon (TOC) in leachate were associated with increased concentrations of several PFASs. Eight landfills discharged leachate to wastewater treatment plants (WWTPs). Estimated masses of PFASs discharged reached a maximum of 62 g annually (PFHxA), with a national estimate reaching 31 kg (PFHxA) annually. The practise of treating leachate at WWTPs allows redistribution of PFASs between the solid and liquid waste streams, although the contribution of leachate to the total load of PFASs entering WWTPs is minor compared to domestic waste water sources.		1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D537	ばく露	Falk, S; Stahl, T; Fliedner, A; Rudel, H; Tarricone, K; Brunn, H; Koschorreck, J	Levels, accumulation patterns and retrospective trends of perfluoroalkyl acids (PFAAs) in terrestrial ecosystems over the last three decades	2019	Environ. Pollut. 2019 Mar:246:921-931. doi: 10.1016/j.envpol.2018.12.095	As a result of their ubiquitous presence in the environment perfluoroalkyl acids (PFAAs) have been demonstrated in numerous organisms worldwide, in particular in those of higher trophic levels. The fact that PFAAs have been detected in various human matrices, together with the resultant potential human health risks, knowledge of possible paths of entry and distribution in various ecosystems, is of great importance. In this context pooled samples of terrestrial ecosystems - roe deer liver (n = 141), earthworms (n = 44) as well as leaves from beech and poplar trees (n = 70) from the year 1989-2015 were obtained from the German Environmental Specimen Bank and examined for the presence of 11 PFAAs for the first time. In addition to determining individual and total PFAA concentrations, temporal trends have been deduced in order to determine the effectiveness of regulatory measures. The highest total mean concentration of PFAAs (sum of the concentrations of the 11 analytes) were 9.9 mu g/kg in the roe deer liver samples, followed by earthworm samples with a mean PFAA concentration of 3.5 mu g/kg and leaves with a mean total concentration of 2.5 mu g/kg. In regard to temporal trends there was a significant reduction of concentrations for perfluorooctane sulfonate, perfluorooctanoic acid, perfiuorononanoic acid and perfluorodecanoic acid in roe deer liver from 2003 to 2015, an indication of the effectiveness of regulatory measures. The same is true for the perfluorooctane sulfonate concentrations in earthworms and for perfluorooctanoic acid concentrations in the leaves. In contrast, an increase in perfluorobutanoic acid concentrations was observed from 2003 to 2015 in all three matrices. In summary it must be noted that in spite of the discernible effectiveness of minimization strategies, PFAAs are still detectable in terrestrial matrices and concentrations of other PFAAs as perfluorobutanoic acid appear to be increasing.	1							B	-		
D538	ばく露	Moneta, BG; Feo, ML; Torre, M; Tratzi, P; Aita, SE; Montone, CM; Taglioni, E; Mosca, S; Balducci, C; Cerasa, M; Guerriero, E; Petracchini, F; Cavaliere, C; Lagana, A; Paolini, V	Occurrence of per- and polyfluorinated alkyl substances in wastewater treatment plants in Northern Italy	2023	Sci. Total Environ. 2023 Oct:894:165089. doi: 10.1016/j.scitotenv.2023.165089.	Wastewater treatment plants are known to be relevant input sources of per- and polyfluoroalkyl substances (PFAS) in the aquatic environment. This study aimed to investigate the occurrence, fate, and seasonal variability of twenty-five PFAS in four municipal wastewater treatment plants (WWTP A, B, C, and D) surrounding the city of Milan (Northern, Italy). Composite 24-h wastewater samples were collected in July and October 2021 and May and February 2022 from influents and effluents of the four WWTPs. PFAS were detected at concentrations ranging between 24.1 and 66.9 & mu;g L-1 for influent and 13.4 and 107 & mu;g L-1 for effluent wastewater samples. Perfluoropentanoic acid was the most abundant (1.91-30.0 & mu;g L-1) in influent samples, whereas perfluorobutane sulfonic acid predominated (0.80-66.1 & mu;g L-1) in effluent samples. In sludge, PFOA was detected in plant A at concentrations in the range of 96.6-165 ng kg-1 dw in primary sludge samples and 98.6-440 ng kg-1 dw in secondary treatment sludge samples. The removal efficiency of total PFAS varied between 6 % and 96 %. However, an increase of PFAS concentrations was observed from influents to effluents for plant D (during July and October), plant A (during October and May), and plant C (during May) indicating that biotransformation of PFAS precursors can occur during biological treatments. This was supported by the observed increase in concentrations of PFOA from primary to secondary treatment sludge samples in plant A. Moreover, the plant operating at shorter hydraulic retention times (plant D) showed lower removal efficiency (<45 %). Seasonal variation of PFAS in influent and effluent appears rather low and more likely due to pulse release instead of seasonal factors.				1				B	-		
D539	ばく露	Busch, J; Ahrens, L; Xie, ZY; Sturm, R; Ebinghaus, R	Polyfluoroalkyl compounds in the East Greenland Arctic Ocean	2010	J. Environ. Monit. 2010 ;12:1242-1246. doi: 10.1039/c002242j	Polyfluoroalkyl compounds (PFCs) can be found ubiquitously in the marine environment. The transport of PFCs to remote locations is assumed to be by direct transport via oceanic water currents or indirectly via atmospheric transport of volatile precursor compounds. This study investigates the influence of ocean currents and atmospheric transport to the East Greenland Arctic Ocean (67.5-80.4 degrees N). In this study, 38 water samples were collected in the Arctic summer in 2009 and analyzed by liquid chromatography-electrospray ionization-tandem mass spectrometry (LC-ESI-MS/MS). Concentrations of three PFC classes could be quantified (i.e., perfluoroalkyl carboxylic acids (PFCAs), perfluoroalkyl sulfonates (PFSAs) and perfluoroalkyl sulfonamides) predominantly in a low pg L-1 range. Dominating compounds were PFOSA and PFOA with mean concentrations of 61 pg L-1 and 51 pg L-1, respectively. Statistically significant higher concentrations for PFOSA and PFHxA in the samples taken north of 75 degrees N indicate an atmospheric influence on the concentrations found in the water samples. Significant differences in concentrations of PFHxS, PFHxA, PFHpA and PFOA for samples taken in coastal areas indicate an influence from the Greenlandic mainland.		1						B	-		
D540	ばく露	Han, TZ; Chen, JH; Lin, K; He, XP; Li, SJ; Xu, TF; Xin, M; Wang, BD; Liu, CG; Wang, JT	Spatial distribution, vertical profiles and transport of legacy and emerging per- and polyfluoroalkyl substances in the Indian Ocean	2022	J. Hazard. Mater. 2022 Sep:437:129264. doi: 10.1016/j.jhazmat.2022.129264.	The contamination status and transport of per- and polyfluoroalkyl substances (PFASs) in the seawater of the Indian Ocean (IO) and an adjacent subregion of the Northwest Pacific Ocean (NWPO) were investigated. Eight legacy PFASs were widely distributed in the surface seawater, and perfluoroheptanoic acid (PFHpA) and perfluorooctanoic acid (PFOA) were the two predominant PFASs. Sigma PFAS concentration decreased in the following order: NWPO>Joining area of Asia and Indian-Pacific Oceans (JAIPO)>Northeast Indian Ocean>Southwest Indian Ocean. Hexafluoropropylene oxide-dimer acid, a replacement surfactant for PFOA was extensively detected in the IO (~34.8 pg/L) for the first time, showing an early sign of emerging PFAS spread in global open oceans. Eight depth profiles across the JAIPO (down to 5433 m depth) revealed a surface-enrichment and depth-depletion pattern for PFASs in the water column, and two noticeable fluctuations were mainly located at depths of 150-200 and 200-500 m. Physical processes, including eddy diffusion, and the origin and trajectory of water mass were crucial factors for structuring PFAS vertical profiles. Mass transport estimates revealed a remarkable PFOA contribution through the JAIPO to IO carried by the Indonesian Throughflow, and anonnegligible PFHpA contribution from Antarctic Immediate Water to deep water of the JAIPO driven by thermohaline circulation.								B	-		
D541	ばく露	Shi, YL; Vestergren, R; Xu, L; Song, XW; Niu, XM; Zhang, CH; Cai, YQ	Characterizing direct emissions of perfluoroalkyl substances from ongoing fluoropolymer production sources: A spatial trend study of Xiaoqing River, China	2015	Environ. Pollut. 2015 Nov:206:104-112. doi: 10.1016/j.envpol.2015.06.035	The spatial trend of perfluoroalkyl substances (PFASs) along Xiaoqing River and its tributaries was studied to characterize isomer profiles and quantify emissions from fluoropolymer (FP) manufacturers in China. Substantially elevated Sigma PFAS concentrations downstream of tributary 4 demonstrated that the emissions from this FP manufacturer dominated total riverine discharges. Isomer profiles of perfluorooctanoic acid (PFOA) in water displayed a stepwise increase in percentage branched PFOA downstream of tributary 3 (14.0%) and 4 (22.7%) reflecting the importance of FP sources. Strong positive correlations between PFOA isomers in water downstream of tributary 4 indicated that isomer profiles were conserved from emission sources to the final reservoir. Riverine discharges of PFOA (23-67 t/yr) were in agreement with theoretical emission calculations from FP production (68 t/yr) whereas large discrepancies between the two methodologies were observed for perfluorobutanoic acid and perfluoropentanoic acid. Collectively, this study fills critical knowledge gaps for understanding ongoing global sources of PFASs.	1							B	-		
D542	ばく露	Yao, JZ; Sheng, N; Guo, Y; Yeung, LWY; Dai, JY; Pan, YT	Nontargeted Identification and Temporal Trends of Per- and Polyfluoroalkyl Substances in a Fluorochemical Industrial Zone and Adjacent Taihu Lake	2022	Environ. Sci. Technol. 2022 Jun:56(12):7986-7996. doi: 10.1021/acs.est.2c00891.	Various per- and polyfluoroalkyl substances (PFASs) remain undiscovered and unexplored in the environment. The goals of this study were to discover new species of PFASs in effluent and surface waters from a fluorochemical industrial zone, and to assess their concentration, distribution, and temporal trends in the adjacent natural environment. In total, 83 emerging PFASs from 14 classes were identified, 22 of which were reported for the first time. Authentic standards were synthesized for 13 per- and polyfluoroalkyl ether carboxylic acids (PFECAs), thereby greatly expanding the scope of PFAS-targeted monitoring. The newly identified compounds accounted for 27%-95% of the total PFAS concentrations. Of note, a novel diether carboxylic acid, 2-[2(trifluoromethoxy)hexafluoropropoxy]tetrafluoropropanoic acid (C7 HFPO-TA) was detected at an extremely high concentration in the fluorochemical zone effluent (447 000 ng/L) and at a median concentration in the fluorochemical zone surface water (670 ng/L), with detectable levels also found in the natural environment, that is, Wangyu River (23 ng/L) and Taihu Lake (5.6 ng/L). The distinct geographic distribution of C7 HFPO-TA suggests transport from the industrial point source to Taihu Lake via the Wangyu River. The concentration of C7 HFPO-TA in Taihu Lake, along with that of many other emerging PFASs, continued to grow in three sampling campaigns from 2016 to 2021. Considering the environmental persistence and toxicity of structurally similar PFECAs (e.g., HFPO-DA), studies on C7 HFPO-TA are urgently needed.					1			B	-		
D543	ばく露	Surma, M; Zielinski, H; Piskula, M	Levels of Contamination by Perfluoroalkyl Substances in Honey from Selected European Countries	2016	Bull. Environ. Contam. Toxicol. 2016 Jul:97(1):112-118. doi: 10.1007/s00128-016-1840-5.	Perfluoroalkyl substances (PFASs) are man-made chemicals manufactured for numerous applications. The aim of this study was to assess the levels of 10 PFASs in selected types of honey samples from selected eastern, northern and southern European countries. A total of 26 samples of honey were analyzed. PFCAs (perfluoroalkyl carboxylic acids) were detected in almost all (92 %) analyzed samples in the range of 0.124-0.798 ng g(-1) ww (wet weight). The average concentrations of particular PFCAs (ng g(-1) ww) in honey samples increased in the following order: perfluorononanoic acid (0.164) < perfluorooctanoic acid (0.189) < perfluoroheptanoic acid (0.271) < perfluorodecanoic acid (0.278). Amongst perfluoroalkane sulfonates, only perfluorohexane sulfonate (PFHxS) was identified in four of 26 analyzed samples, and its concentrations ranged from 0.080 to 0.191 ng g(-1) ww. Italian eucalyptus honey contained the highest total content of PFASs (0.878 ng g(-1) ww). Samples originating from an industrial region of Poland showed 20 % higher concentrations of PFCAs compared to those from non-industrial regions.			1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D544	ばく露	Wang, RM; Zhang, J; Yang, YY; Chen, CE; Zhang, DC; Tang, JH	Emerging and legacy per-and polyfluoroalkyl substances in the rivers of a typical industrialized province of China: Spatiotemporal variations, mass discharges and ecological risks	2022	Front. Environ. Sci. 2022 Oct:10:986719. doi: 10.3389/fenvs.2022.986719.	Per- and polyfluoroalkyl substances (PFAS) contamination has drawn considerable attention in the rivers of Shandong, China. However, their seasonal variations have not been well addressed due to the geographic scale. Here, surface waters were collected seasonally at estuaries of 13 major rivers in Shandong to investigate the spatiotemporal variations, mass discharges and ecological risks of PFAS. Two novel perfluoroalkyl ether carboxylic acids, hexafluoropropylene oxide-dimer acid (HFPO-DA) and hexafluoropropylene oxide-trimer acid (HFPO-TA), and 10 legacy PFAS were all detectable and their total concentrations (sigma PFAS) ranged largely from 23 to 25,400 ng/L. Elevated levels of all target compounds were found in the Xiaoqing River but Majia and Jiaolai Rivers were also of concern. Perfluorooctanoic acid (PFOA) was dominant in all the rivers. Its concentration in the Xiaoqing River estuary increased 6-fold from 2011 to 2014 and reached a plateau during 2014-2020. The nonsignificant seasonality of the PFAS concentrations in rivers with seasonal flows may indicate their different emission patterns (i.e., higher emission in the wet season and lower emission in the dry season). The ratio of maximum to minimum concentration (C-max/C-min) was proposed to characterize the influence of local point sources, with C-max/C-min ranging from 10 to 14,000. Xiaoqing and Yellow Rivers discharged similar to 98% of sigma PFAS flux to the sea, which was estimated to be 28.0 t in 2020. This study raises attention to the industrial emission patterns of PFAS. Further investigations with higher time resolution were needed to understand the emission patterns of PFAS in Shandong.					1			B	-		
D545	ばく露	Bjornsdotter, MK; Yeung, LWY; Karrman, A; Jogsten, IE	Mass Balance of Perfluoroalkyl Acids, Including Trifluoroacetic Acid, in a Freshwater Lake	2022	Environ. Sci. Technol. 2022 Jan:56(1):251-259. doi: 10.1021/acs.est.1c04472.	Perfluoroalkyl acids (PFAAs) are highly persistent chemicals that are ubiquitously found in the environment. The atmospheric degradation of precursor compounds has been identified as a source of PFAAs and might be an important pathway for contamination. Lake Vattern is one of Sweden's largest lakes and is an important source for drinking water. In addition to contamination via atmospheric deposition, the lake is subject to several potential contamination sources via surface water inflow. The relevance of different sources is not well understood. A mass balance of selected PFAAs was assembled based on measured concentrations in atmospheric deposition, surface water from streams that constitute the main inflow and outflow, and surface water in the lake. The largest input was seen for trifluoroacetic acid (150 kg/year), perfluoropropanoic acid (1.6 kg/year), perfluorobutanoic acid (4.0 kg/year), and perfluoro-octanoic acid (1.5 kg/year). Both atmospheric deposition and surface water inflow was found to be important input pathways. There was a positive correlation between the input of most perfluoroalkyl carboxylic acids via atmospheric deposition and global radiation and between the input via surface water inflow and catchment area. These findings highlight the importance of atmospheric oxidation of volatile precursor compounds for contamination in surface waters.	1							B	-		
D546	ばく露	Richards, LA; Guo, SZ; Lapworth, DJ; White, D; Civil, W; Wilson, GJL; Lu, CH; Kumar, A; Ghosh, A; Khamis, K; Krause, S; Polya, DA; Gooddy, DC	Emerging organic contaminants in the River Ganga and key tributaries in the middle Gangetic Plain, India: Characterization, distribution & controls	2023	Environ. Pollut. 2023 Jun:327:121626. doi: 10.1016/j.envpol.2023.121626.	The presence and distribution of emerging organic contaminants (EOCs) in freshwater environments is a key issue in India and globally, particularly due to ecotoxicological and potential antimicrobial resistance concerns. Here we have investigated the composition and spatial distribution of EOCs in surface water along a similar to 500 km segment of the iconic River Ganges (Ganga) and key tributaries in the middle Gangetic Plain of Northern India. Using a broad screening approach, in 11 surface water samples, we identified 51 EOCs, comprising of phar-maceuticals, agrochemicals, lifestyle and industrial chemicals. Whilst the majority of EOCs detected were a mixture of pharmaceuticals and agrochemicals, lifestyle chemicals (and particularly sucralose) occurred at the highest concentrations. Ten of the EOCs detected are priority compounds (e.g. sulfamethoxazole, diuron, atra-zine, chlorpyrifos, perfluorooctane sulfonate (PFOS), perfluorobutane sulfonate, thiamethoxam, imidacloprid, clothianidin and diclofenac). In almost 50% of water samples, sulfamethoxazole concentrations exceeded pre-dicted no-effect concentrations (PNECs) for ecological toxicity. A significant downstream reduction in EOCs was observed along the River Ganga between Varanasi (Uttar Pradesh) and Begusarai (Bihar), likely reflecting dilution effects associated with three major tributaries, all with considerably lower EOC concentrations than the main Ganga channel. Sorption and/or redox controls were observed for some compounds (e.g. clopidol), as well as a relatively high degree of mixing of EOCs within the river. We discuss the environmental relevance of the persistence of several parent compounds (notably atrazine, carbamazepine, metribuzin and fipronil) and asso-ciated transformation products. Associations between EOCs and other hydrochemical parameters including excitation emission matrix (EEM) fluorescence indicated positive, significant, and compound-specific correla-tions between EOCs and tryptophan-, fulvic-and humic-like fluorescence. This study expands the baseline characterization of EOCs in Indian surface water and contributes to an improved understanding of the potential sources and controls on EOC distribution in the River Ganga and other large river systems.				1				B	-		
D547	ばく露	Chen, WB; Yang, F; Hu, E; Yang, CH; Sun, CS; Li, M	Occurrence, fate and risk assessment of per- and polyfluoroalkyl substances in wastewater treatment plants in Shaanxi, China	2022	Environ. Pollut. 2022 Dec:314:120226. doi: 10.1016/j.envpol.2022.120226.	Wastewater treatment plants (WWTPs) are considered as major sinks for per-and polyfluoroalkyl substances (PFASs). However, conventional WWTPs with low efficiency are also a secondary point source of PFASs entering the environment. Herein, a large-scale investigation of PFASs was conducted in 44 WWTPs throughout Shaanxi Province in the transitional zone between North and South China. The composition profiles of target PFASs differed between wastewater and sludge samples. Perfluorobutanoic acid was dominant in wastewater influent and effluent samples, with maximum concentrations of 59.8 and 11.4 ng/L, respectively. Perfluorooctane sulfonic acid occurred predominantly in sludge samples, with a maximum concentration of 73.2 ng/g. Through wastewater treatment, short-chain PFASs with an even number of carbon atoms were mostly removed, whereas short-chain PFASs with an odd number of carbon atoms were primarily discharged into receiving water. Long-chain PFASs (perfluoroalkyl carboxylic acids: C >= 8; perfluoroalkane sulfonic acids: C >= 6) were not removed efficiently and secondary production might occur during treatment. Based on the risk quotient, PFASs residues in wastewater effluent posed minimal ecological risk, but the residues in sludge posed low to high potential risk. The mass loadings of PFASs discharged through wastewater and sludge were 15.5 and 3.74 kg/year, respectively, from all WWTPs in Shaanxi Province.	1							B	-		
D548	ばく露	Reberski, JL; Selak, A; Lapworth, DJ; Maurice, LD; Terzic, J; Civil, W; Stroj, A	Emerging organic contaminants in springs of the highly karstified Dinaric region	2023	J. Hydrol. 2023 Jun:621:129583. doi: 10.1016/j.jhydrol.2023.129583.	Emerging organic contaminants (EOCs) have become of increasing interest due to concerns about their impact on humans and the wider environment. Karst aquifers are globally widespread, providing critical water supplies and sustaining rivers and ecosystems, and are particularly susceptible to pollution. However, EOC distributions in karst remain quite poorly understood. This study looks at the occurrence of EOCs in the Croatian karst, which is an example of the classical karst, a highly developed type of karst that occurs throughout the Dinaric region of Europe. Samples were collected from 17 karst springs and one karst lake used for water supply in Croatia during two sampling campaigns. From a screen of 740 compounds, a total of 65 compounds were detected. EOC compounds from the pharmaceutical (n = 26) and agrochemical groups (n = 26) were the most frequently detected, while industrials and artificial sweeteners had the highest concentrations (range 8-440 ng/L). The number of detected compounds and the frequency of detection demonstrate the vulnerability of karst to EOC pollution. Concentrations of 5 compounds (acesulfame, sucralose, perfluorobutane sulfonate, emamectin B1b, and triphenyl phosphate) exceeded EU standards and occurred at concentrations that are likely to be harmful to ecosystems. Overall, most detections were at low concentrations (50 % <1 ng/L). This may be due to high dilution within the exceptionally large springs of the Classical karst, or due to relatively few pollution sources within the catchments. Nevertheless, EOC fluxes are considerable (10 to 106 ng/s) due to the high discharge of the springs. Temporal differences were observed, but without a clear pattern, reflecting the highly variable nature of karst springs that occurs over both seasonal and short-term timescales. This research is one of a handful of regional EOC investigations in karst groundwater, and the first regional study in the Dinaric karst. It demonstrates the need for more frequent and extensive sampling of EOCs in karst to protect human health and the environment.				1				B	-		
D549	ばく露	Phung, TV; Nguyen, TN; Thi, LAP; Pham, HV; Duong, HA	Determination of Per- and Polyfluoroalkyl Substances in Craft Villages and Industrial Environments of Vietnam	2021	J. Anal. Methods Chem. 2021 Apr:2021:5564994. doi: 10.1155/2021/5564994.	Per- and polyfluoroalkyl substances (PFASs) have attracted great concern because of their great recalcitrant nature and harmful environmental health effects. Eight PFASs in wastewater from craft villages and industrial environments of Vietnam were analyzed using liquid chromatography triple quadrupole mass spectrometry (LC-MS/MS) with negative electrospray ionization interface. For analysis of PFASs, percent recoveries ranged from 87 to 112, and MQL varied from 0.19 ng/L to 0.49 ng/L. Treated wastewater samples from eight metal-plating and eight textile-dyeing factories were collected for analysis of PFASs. Concentrations of PFOS in wastewater samples obtained from metal-plating factories with decorative plating stage were found at a range of 0.73-18.91 ng/L. For textile-dyeing factories, PFOA and/or PFHxA, which were present in all effluent wastewater samples, varied from 0.37 to 15.96 ng/L and 1.07 to 43.58 ng/L, respectively. Sixty surface water samples in four locations of the textile dyeing craft villages, a recycling plastic village, a paper recycling village, and 10 river water samples in the control area (a rural area without specific waste sources) were collected and analyzed for PFASs. The total concentrations of eight PFASs in surface water samples of craft villages ranged from 0.83 to 58.2 ng/L, which were significantly higher than those in the control area. PFOA, PFHxA, and PFOS are the three most dominant congeners in wastewater taken from craft villages with the highest concentrations of 27.4, 23.8, and 7.36 ng/L, respectively. The environmental risks posed by PFASs in surface water from craft villages were mainly in a range of extremely low to low level, particularly a few points have high ecological risks of PFDoA.		1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D550	ばく露	Liu, YF; Zhang, QH; Li, YM; Hao, YF; Li, JG; Zhang, L; Wang, PL; Yin, YH; Zhang, S; Li, T; Wang, YX; Dong, SJ; Wei, SL; Zhang, W; Su, XO; Li, XM	Occurrence of per- and polyfluoroalkyl substances (PFASs) in raw milk and feed from nine Chinese provinces and human exposure risk assessment	2022	Chemosphere. 2022 Aug:300:134521. doi: 10.1016/j.chemosphere.2022.134521.	The per- and polyfluoroalkyl substances (PFASs) are substantially produced and applied in industrial and domestic products, which have recently aroused great public concern for their potential toxicity to humans. In the present study, raw milk (n = 107) and cow feed samples (n = 70) were collected across nine Chinese provinces, in order to investigate the occurrence of PFASs in milk and feed, and the human exposure risk to milk. The concentrations of PFASs are in the range of < method detection limit -9.82 ng/g dw (average: 1.03 ng/g dw) for milk and 0.99-144 ng/g dw (7.68 ng/g dw) for feed. Perfluorobutanoic acid (34.0%) dominates in feed, while perfluorooctanesulfonic acid (67.5%) dominates in milk. No significant positive correlations of PFASs are observed between paired feed and milk (p > 0.05). However, feeds collected around fluorination production area show relatively higher PFAS levels than those from other areas, which also increase PFAS levels in milk. Risk assessment of PFASs through milk consumption is carried out according to evolving reference doses (RfDs). The hazard quotient is more than one for both adults and children when the strictest RfDs are applied. The Monte Carlo Simulation shows that children face higher PFAS exposure risk than adults.	1							B	-		
D551	ばく露	Zhang, LC; Wang, MY; Zhang, MQ; Yang, DJ	Per- and polyfluoroalkyl substances in Chinese surface waters: A review	2023	Ecotox. Environ. Safe. 2023 Sep:262:115178. doi: 10.1016/j.ecoenv.2023.115178.	The contamination of surface waters in China with Per- and polyfluoroalkyl (PFASs) has been extensively studied in recent decades, however, almost all studies have been conducted in small areas and/or limited samples, which are not representative of the nationwide contamination of surface water environments with PFASs. In this study, attempt was made to provide a comprehensive report about PFASs pollution in Chinese surface water based on the PRISMA. By analyzing 111 papers published between 2006 and 2022, we provide a systematic review of the pollution of PFASs in surface water environments in China. The results show that 26 PFASs contaminants were detected at least once in China's surface water environment and were mainly concentrated in the eastern part of China. Most surface water environments in China had mean PFASs concentrations below 100 ng/L. The most polluted place was the Xiaoqing River, where sampling results in 2020 showed PFASs concentrations as high as 25,429 ng/L, followed by the Tangxun Lake, the Xi River, the Daling River, the Majia River, the Baiyangdian Lake, the Liuxi River, the Jiaolai River, the Tuo River and the Zhimai River. The Xiaoqing River also has the highest concentration of the novel pollutant, with concentrations of HFPO-TA and HFPO-DA as high as 1039 ng/ L and 164 ng/L. Based on the source analysis, fluoropolymer manufacturing plants are the main source of PFASs pollutants in surface water. The results of the base risk analysis using risk quotients value (RQ) method show that the RQ values of the Xiaoqing River, the surface water near Bohai Bay, the Majia River and the Tuo River PFOA are 36.9, 7.7, 3.6 and 2.1 respectively, which are high risk areas and require enhanced control. This study provides information on surface waters contaminated by PFASs nationwide, and the results can be used as a reference for the development of pollution control and management strategies for PFASs in surface waters in China.					1			B	-	総説	
D552	ばく露	Du, MJ; Li, XX; Cai, DS; Zhao, YY; Li, Q; Wang, JJ; Gu, WW; Li, Y	In-silico study of reducing human health risk of POP residues' direct (from tea) or indirect exposure (from tea garden soil): Improved rhizosphere microbial degradation, toxicity control, and mechanism analysis	2022	Ecotox. Environ. Safe. 2022 Sep:242:113910. doi: 10.1016/j.ecoenv.2022.113910.	The accumulation of potentially harmful substances in tea garden soils and tea leaves, especially persistent organic pollutants (POPs), is a special concern for tea consumers worldwide. However, their potential health and ecological risks in tea gardens have rarely been investigated. This study proposed measures to improve the degradation ability of POPs by the tea rhizosphere and to reduce the human health risks caused by POPs after tea consumption. In this study, the binding energy values of six types of POPs and the degraded protein were used to reflect the degradation ability and calculated using molecular dynamic simulations. The main root secretions (i. e., catechin, glucose, arginine, and oxalic acid) were selected and applied with a combination of tea fertilizer and trace element combination (i.e., urea, straw, and copper element), leading to an improved degradation ability (49.59 %) of POPs. To investigate the mechanisms of the factors that affect the degradation ability, molecular docking, tensor singular value decomposition methods, multivariate correlation analysis and 2D-QSAR model were used. The results showed that the solvation energy and solvent accessible surface area are the main forces, and the molecular weight, boiling point, and topological radius of the POPs were the key molecular features affecting their degradation ability. Based on the three key characteristics, a diet avoidance scheme (i.e., avoiding lysine, maslinic acid, ethanol, perfluorocaproic acid, and cholesterol with tea), which can reduce the binding ability of POP residues to aromatic hydrocarbon receptors by 506.13 %. This work will provide theoretical strategies to improve the quality and safety of tea production and reduce the potential risks of harmful substance residues in tea garden soils and tea leaves.		1						B	-		
D553	ばく露	Hall, SM; Patton, S; Petreas, M; Zhang, SR; Phillips, AL; Hoffman, K; Stapleton, HM	Per- and Polyfluoroalkyl Substances in Dust Collected from Residential Homes and Fire Stations in North America	2020	Environ. Sci. Technol. 2020 Nov:54(22):14558-14567. doi: 10.1021/acs.est.0c04869.	Over the past few years, human exposure to per- and polyfluoroalkyl substances (PFAS) has garnered increased attention. Research has focused on PFAS exposure via drinking water and diet, and fewer studies have focused on exposure in the indoor environment. To support more research on the latter exposure pathway, we conducted a study to evaluate PFAS in indoor dust. Dust samples from 184 homes in North Carolina and 49 fire stations across the United States and Canada were collected and analyzed for a suite of PFAS using liquid and gas chromatography-mass spectrometry. Fluorotelomer alcohols (FTOHs) and di-polyfluoroalkyl phosphoric acid esters (diPAPs) were the most prevalent PFAS in both fire station and house dust samples, with medians of approximately 100 ng/g dust or greater. Notably, perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulfonate, perfluorononanoic acid, and 6:2 diPAP were significantly higher in dust from fire stations than from homes, and 8:2 FTOH was significantly higher in homes than in fire stations. Additionally, when comparing our results to earlier published values, we see that perfluoroalkyl acid levels in residential dust appear to decrease over time, particularly for PFOA and PFOS. These results highlight a need to better understand what factors contribute to PFAS levels in dust and to understand how much dust contributes to overall human PFAS exposure.			1					B	-		
D554	ばく露	Kim, MJ; Park, J; Luo, L; Min, J; Kim, JH; Yang, HD; Kho, Y; Kang, GJ; Chung, MS; Shin, S; Moon, B	Effect of washing, soaking, and cooking methods on perfluorinated compounds in mackerel (Scomber japonicus)	2020	Food Sci. Nutr. 2020 Aug:8(8):4399-4408. doi: 10.1002/fsn3.1737.	Perfluorinated compounds (PFCs) are environmental pollutants, and dietary intake is a major route of human exposure to them. We aimed to see the effects of washing, soaking, and cooking (grilling, braising, frying, and steaming) on the change of PFCs in mackerel fillets and PFCs before and after each treatment were analyzed using LC-MS/MS. Washing resulted in a decrease in the PFC content of mackerel (average 74%) comparing to control. Among the 19 PFCs detected, perfluorobutanoic acid and perfluorotridecanoic acid (PFTrDA) were found to be abundant after washing. Soaking mackerel in sake reduced its PFC content by 51%, whereas soaking in rice-washed solution reduced by 80% comparing to control. All the four cooking methods were effective in reducing the PFC content of mackerel. The degree by which the PFC content decreased varied with the cooking method: grilling (91%), steaming (75%), frying (58%), and braising (47%) comparing to uncooked sample. In addition, when mackerel was braised with potato, PFCs decreased more in fillet than the ones without potato. PFCs in potato increased after cooking with mackerel. The excessive consumption through the mackerel was 0.1997 ng/kg bw/day and 0.7987 ng/kg bw/day, respectively. These exposure levels were well below the tolerable daily intake values of both compounds (PFOS, 150 ng/kg bw/day; PFOA, 1,500 ng/kg bw/day). The results of this study indicated that employing appropriate pretreatment and cooking methods could be an effective way to reduce the dietary exposure to PFCs in mackerel.	1							B	-		
D555	ばく露	Zhao, Z; Cheng, XH; Hua, X; Jiang, B; Tian, CG; Tang, JH; Li, QL; Sun, HW; Lin, T; Liao, YH; Zhang, G	Emerging and legacy per- and polyfluoroalkyl substances in water, sediment, and air of the Bohai Sea and its surrounding rivers	2020	Environ. Pollut. 2020 Aug;263(Pt A):114391. doi: 10.1016/j.envpol.2020.114391.	Per- and polyfluoroalkyl substances (PFASs) contamination in the Bohai Sea and its surrounding rivers has attracted considerable attention in recent years. However, few studies have been conducted regarding the distribution of PFASs in multiple environmental media and their distributions between the suspended particles and dissolved phases. In this study, surface water, surface sediment, and air samples were collected at the Bohai Sea to investigate the concentration and distribution of 39 targeted PFASs. Moreover, river water samples from 35 river estuaries were collected to estimate PFAS discharge fluxes to the Bohai Sea. The results showed that total ionic compound (Sigma i-PFASs) concentrations ranged from 19.3 to 967 ng/L (mean 125 +/- 152 ng/L) in the water and 0.70-4.13 ng/g dw (1.78 +/- 0.76 ng/g) in surface sediment of the Bohai Sea, respectively. In the estuaries, Sigma i-PFAS concentrations were ranged from 10.5 to 13500 ng/L (882 +/- 2410 ng/L). In the air, SPFAS (Sigma i-PFASs thorn Sigma n-PFASs) concentrations ranged from 199 to 678 pg/m(3) (462 +/- 166 pg/m(3)). Perfluorooctanoic acid (PFOA) was the predominant compound in the seawater, sediment, and river water; in the air, 8:2 fluorotelomer alcohol was predominant. Xiaoqing River discharged the largest Sigma i-PFAS flux to the Bohai Sea, which was estimated as 12,100 kg/y. Some alternatives, i.e., 6:2 fluorotelomer sulfonate acid (6:2 FTSA), hexafluoropropylene oxide dimer acid (HFPO-DA), and chlorinated 6:2 polyfluorinated ether sulfonic acid (Cl- 6:2 PFESA), showed higher levels than or comparable concentrations to those of the C8 legacy PFASs in some sampling sites. The particle-derived distribution coefficient in seawater was higher than that in the river water. Using high resolution mass spectrometry, 29 nontarget emerging PFASs were found in 3 river water and 3 seawater samples. Further studies should be conducted to clarify the sources and ecotoxicological effects of these emerging PFASs in the Bohai Sea area.					1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D556	ばく露	Hu, XC; Ge, B; Ruyle, BJ; Sun, J; Sunderland, EM	A Statistical Approach for Identifying Private Wells Susceptible to Perfluoroalkyl Substances (PFAS) Contamination	2021	Environ. Sci. Technol. Lett. 2021 Jul:8(7):596-602. doi: 10.1021/acs.estlett.1c00264.	Drinking water concentrations of per- and polyfluoroalkyl substances (PFAS) exceed provisional guidelines for millions of Americans. Data on private well PFAS concentrations are limited in many regions, and monitoring initiatives are costly and time-consuming. Here, we examine modeling approaches for predicting private wells likely to have detectable PFAS concentrations that could be used to prioritize monitoring initiatives. We used nationally available data on PFAS sources, and geologic, hydrologic and soil properties that affect PFAS transport as predictors, and trained and evaluated models using PFAS data (n similar to 2300 wells) collected by the state of New Hampshire between 2014 and 2017. Models were developed for the five most frequently detected PFAS: perfluoropentanoate, perfluorohexanoate, perfluoroheptanoate, perfluorooctanoate, and perfluorooctanesulfonate. Classification random forest models that allow nonlinearity in interactions among predictors performed the best (area under the receiver operating characteristics curve: 0.74-0.86). Point sources such as the plastics/rubber and textile industries accounted for the highest contribution to accuracy. Groundwater recharge, precipitation, soil sand content, and hydraulic conductivity were secondary predictors. Our study demonstrates the utility of machine learning models for predicting PFAS in private wells, and the classification random forest model based on nationally available predictors is readily extendable to other regions.		1						B	-		
D557	ばく露	Alghamdi, W; Marchiandi, J; Szabo, D; Samandra, S; Clarke, BO	Release of per- and polyfluoroalkyl substances (PFAS) from a waste management facility fire to an urban creek	2022	J. Hazard. Mater. Adv. 2022 Nov:8:100167. doi: 10.1016/j.hazadv.2022.100167.	This study examined the release of per-and poly fluoroalkyl substances (PFAS) into an urban freshwater stream and sediments due to a large-scale industrial fire in Melbourne, Australia. The fire occurred at an industrial warehouse which was illegally storing excessive amounts of unknown chemicals and industrial waste. The runoff of the waste and used firefighting foam was contained in the adjacent freshwater creeks. The concentration of 50 PFAS in freshwater samples and 16 PFAS in sediment samples were determined by HPLC-MS/MS. Of the fifty targeted PFAS in the freshwater samples, fluorotelomer sulfonates including (6:2 fluorotelomer sulfonamide alkylbetaine (6:2 FTAB or 6:2 FTSA-PrB; CAS NO:34455-29-3), Perfluorocarboxylates (PFCAs: C4-C12), Perfluo-roalkane sulfonates (PFSAs: C4-C8) and perfluoroalkanesulfonyl fluorides including perfluorobutane sulfonamide (FBSA) were the most elevated PFAS. There were clear differences in & sigma;50PFAS mean concentrations detected on the day of the fire (3843 ng/L) relative to one month post fire (352 ng/L), indicating the effect of the fire on freshwater system. The concentration of & sigma;50PFAS at the point source was 3400 & PLUSMN; 324 ng/L on the day of the ignition and decreased significantly to 93 & PLUSMN; 14 ng/L in the second campaign. This is the first study to document 6:2 FTAB and perfluorohexane sulfonamide (FHxSA; CAS NO 41997-13-1), perfluoro-4-methoxybutanoic acid (PFMBA; CAS NO 863090-89-5), perfluoro-3-methoxypropanoic acid (PFMPA; CAS NO 377-73-1), Hexafluoro-propylene oxide dimer acid (HFPO-DA; CAS NO 13252-13-6), Nonafluoro-3,6-dioxaheptanoic acid (NFDHA; CAS NO 151772-58-6) and Perfluoro(2-ethoxyethane) sulfonic acid (PFEESA CAS NO 113507-82-7) in Australian sur-face waters. Only three PFAS were detected in the sediment samples which collected from five sites in the second campaign which could be negligible based on the detection. In the meanwhile, the concentration of PFAS were also compared to the available guideline values in Australia for freshwater, recreational water, and sediments. The analysed water samples indicated that PFOS contamination level might have a short-term risk to the aquatic organisms. Further monitoring is in need to evaluate the contamination and the long-term risk in freshwater and sediments in the region.					1			B	-		
D558	ばく露	Joo, G; Kim, Y; Kim, G; Song, J; Lee, M; Choe, JK; Choi, Y	Perfluorochemicals in Korean Wastewater Treatment Plants: Implications on Sources and Monitoring	2021	KSCE J. Civ. Eng. 2021 Jun:25(6):1931-1938. doi: 10.1007/s12205-021-0956-2.	The occurrence of perfluorochemicals (PFCs) in two wastewater treatment plants (WWTPs) in Korea, Plant I and G2, is investigated from a year-round sampling campaign. Plant I influent is characterized by the dominance of perfluorohexanesulfonate showing 10.8-fold higher per capita mass discharge value in the service area than that of Plant G2 service area. Plant G2 influent shows the dominance of perfluorooctanote and perfluorohexanoate, whose per capita mass discharge values are 3.7- and 11.8-fold higher than those of Plant I, respectively. Contrary to the dramatic difference of concentration and per capita mass discharge pattern of PFCs, the per capita mass discharge values for typical wastewater quality indicators are nearly identical for two WWTPs. This result implies that industrial contribution is significant for the PFC loading at the two WWTPs despite the fact that Plant I and G2 influents are officially reported to include only 0.4% and 7.5% of industrial wastewater in flowrate, respectively. This disagreement between the implication from the PFC data and the official report suggests the need to improve our knowledge on the impact of industrial sources on PFCs in WWTP influents, including those sources that are not officially registered or are poorly managed. The PFC fate during the wastewater treatment is slightly different between the two WWTPs, which can be partially explained by the different biological treatment processes applied. Seasonal variations in PFC concentrations observed in this study suggest that any monitoring program should be performed at least on a seasonal basis.		1						B	-		
D559	ばく露	Wang, MM; Guo, WH; Gardner, S; Petreas, M; Park, JS	Per- and polyfluoroalkyl substances in Northern California cats: Temporal comparison and a possible link to cat hyperthyroidism	2018	Environ. Toxicol. Chem. 2018 Oct:37(10):2523-2529. doi: 10.1002/etc.4239.	The indoor environment and dietary intake are considered to be major human exposure pathways to per- and polyfluoroalkyl substances (PFASs). Cats have similar exposures to humans by sharing their residential environments, although they have different diet, body sizes, and indoor activities. In the present study, we report PFAS levels in the serum of 2 groups of Northern California cats (>10yr old) collected during 2 time periods: 2008 to 2010 (n=21) and 2012 to 2013 (n=22). Levels of Sigma PFAS (geometric mean) were lower in the second period (geometric mean=8.10ng/mL) than the first time period (geometric mean=15.8ng/mL), although PFAS profiles remained similar. We also analyzed PFAS levels in human serum collected in the same time period (2008-2010) and geographic area, and compared the profiles and Sigma PFAS levels (15.8 vs 14.3ng/mL for cat and human, respectively). Long chain perfluorinated carboxylic acids, especially perfluorononanoic acid and perfluoroundecanoic acid, were significantly higher in cat serum than in humans. Furthermore, serum from hyperthyroid cats in the second time period showed higher Sigma PFAS level (9.50ng/mL) compared to nonhyperthyroid cats (7.24ng/mL), and it is the perfluorooctanoic acid levels that were statistically significantly higher in hyperthyroid cats' serum (p<0.05). This result may indicate a possible link between PFAS levels and cat hyperthyroid, warranting a larger study for further investigation.			1					B	-		
D560	ばく露	Bangma, JT; Bowden, JA; Brunell, AM; Christie, I; Finnell, B; Guillette, MP; Jones, M; Lowers, RH; Rainwater, TR; Reiner, JL; Wilkinson, PM; Guillette, LJ	PERFLUORINATED ALKYL ACIDS IN PLASMA OF AMERICAN ALLIGATORS (ALLIGATOR MISSISSIPPIENSIS) FROM FLORIDA AND SOUTH CAROLINA	2017	Environ. Toxicol. Chem. 2017 Apr:36(4):917-925. doi: 10.1002/etc.3600.	The present study aimed to quantitate 15 perfluoroalkyl acids (PFAAs) in 125 adult American alligators at 12 sites across the southeastern United States. Of those 15 PFAAs, 9 were detected in 65% to 100% of samples: perfluorooctanoic acid, perfluorononanoic acid, perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnA), perfluorododecanoic acid, perfluorotridecanoic acid (PFTriA), perfluorotetradecanoic acid, perfluorohexanesulfonic acid (PFHxS), and perfluorooctane sulfonate (PFOS). Males (across all sites) showed significantly higher concentrations of 4 PFAAs: PFOS (p-0.01), PFDA (p-0.0003), PFUnA (p-0.021), and PFTriA (p-0.021). Concentrations of PFOS, PFHxS, and PFDA in plasma were significantly different among the sites in each sex. Alligators at both Merritt Island National Wildlife Refuge (FL, USA) and Kiawah Nature Conservancy (SC, USA) exhibited some of the highest PFOS concentrations (medians of 99.5 ng/g and 55.8 ng/g, respectively) in plasma measured to date in a crocodilian species. A number of positive correlations between PFAAs and snout-vent length were observed in both sexes, suggesting that PFAA body burdens increase with increasing size. In addition, several significant correlations among PFAAs in alligator plasma may suggest conserved sources of PFAAs at each site throughout the greater study area. The present study is the first to report PFAAs in American alligators, to reveal potential PFAA hot spots in Florida and South Carolina, and to provide a contaminant of concern when assessing anthropogenic impacts on ecosystem health. Published 2016 Wiley Periodicals Inc. on behalf of SETAC.This article is a US government work and, as such, is in the public domain in the United States of America.			1					B	-		
D561	ばく露	Long, ER; Dutch, M; Weakland, S; Chandramouli, B; Benskin, JP	Quantification of pharmaceuticals, personal care products, and perfluoroalkyl substances in the marine sediments of Puget Sound, Washington, USA	2013	Environ. Toxicol. Chem. 2013 Aug:32(8):1701-1710. doi: 10.1002/etc.2281.	Concentrations of 119 pharmaceuticals and personal care products (PPCPs) and 13 perfluoroalkyl substances (PFASs) in marine sediments measured throughout Puget Sound (n=10) and Bellingham Bay (n=30), Washington, USA, are reported. These data are among the first measurements of PPCPs and PFASs in marine sediments from the Pacific Northwest and provide a comparison to previous measurements of these chemicals in influent, effluent, and biosolids from municipal wastewater treatment plants throughout the region. The concentrations of both PPCPs and PFASs in sediments from Puget Sound and Bellingham Bay ranged from very low to non-detectable for most compounds. Only 14 of the 119 PPCPs and 3 of 13 PFASs were quantifiable in sediments. Diphenhydramine (an antihistamine) was most frequently detected (87.5% of samples), with a maximum concentration of 4.81ng/g dry weight and an estimated mean detected concentration of 1.68ng/g. Triclocarban (an antibacterial) was detected in 35.0% of the samples, with a maximum concentration of 16.6ng/g dry weight. Perfluoroalkyl substances were detected in 2.5% of analyses. Perfluorobutanoate, perfluorooctane sulfonate, and perfluorooctane sulfonamide were detected in 7, 5, and 1 sample(s) each, respectively, with the highest concentrations observed for perfluorooctane sulfonate (1.5ng/g). Detected concentrations were often highest within the industrial harbor in Bellingham Bay and near the cities of Seattle and Bremerton.								B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D562	ばく露	Zhou, J; Li, SJ; Liang, XX; Feng, X; Wang, TC; Li, Z; Zhu, LY	First report on the sources, vertical distribution and human health risks of legacy and novel per- and polyfluoroalkyl substances in groundwater from the Loess Plateau, China	2021	J. Hazard. Mater. 2021 Feb;404(Pt A):124134. doi: 10.1016/j.jhazmat.2020.124134.	In this study, legacy and novel per and polyfluoroalkyl substances (PFASs) were measured in groundwater samples collected from the Loess Plateau of China to understand their occurrence, sources and health risks. The total concentration of PFASs ranged from 2.78 to 115 ng/L, with perfluorooctanoic acid (PFOA) as the dominant compound. Many emerging PFASs, including 6:2 fluorotelomer sulfonates (FTS), 6:2 chlorinated polyfluorinated ether sulfonic acid (Cl-PFESAs), ammonium 4,8-dioxa-3H-perfluorononanoate (ADONA), and hexafluoropropylene oxide (HFPO) homologues were frequently detected in 96.7-100% of the samples. Multiple source apportionment analyses indicated that the PFASs in the groundwater mainly originated from industrial activities, but in rural areas, agricultural activities also contributed. The total oxidizable precursor (TOP) assay indicated that there were substantial unknown precursors of perfluoroalkyl acids (PFAAs) in the groundwater samples. The total concentration of PFASs decreased with the well depth, while the PFAA-precursors displayed contrasting vertical profile trends, which might be due to the suppressed microbial transformation in the groundwater. The potential human health risk caused by PFAS exposure via drinking groundwater in the Loess Plateau was low, except for one site that was close to the industry bases.			1		1			B	-		
D563	ばく露	Diao, JY; Chen, ZW; Su, CH; Wang, JW; Zheng, ZX; Sun, QP; Wang, L; Bi, R; Wang, TY	Legacy and novel perfluoroalkyl substances in major economic species of invertebrates in South China Sea: Health implication from consumption	2023	Mar. Pollut. Bull. 2023 Jul:192:115112. doi: 10.1016/j.marpolbul.2023.115112.	Continuously release of perfluoroalkyl substances (PFASs) would pose non-negligible impacts on environment, organisms, and human health. In present study, 18 PFASs in 7 typical economic invertebrates and their habitats were investigated from the South China Sea. The higher concentrations of PFASs in the nearshore water (6.61-15.54 ng/L) and sediment (0.82-8.84 ng/g) obviously due to frequent human activities. Long-chain PFASs have tendency to accumulate in sediment, however, short-chain PFASs dominated in biota. The acute reference dose (%ARfD) and hazard ratios (HR) of major PFASs in biota were all <100 %, and also below 1, respectively, which means that consumption of PFASs from seafood does not pose risk and threat to human health. However, it should be taken into account that the HR of PFHxA in Mimachlamys nobilis reached 0.82. Potential adverse effects toward human health induced by short-chain PFASs (such as <6 C) via invertebrate seafood consumption should be concerned.		1					B	-		
D564	ばく露	Lang, JR; Allred, BM; Peaslee, GF; Field, JA; Barlaz, MA	Release of Per- and Polyfluoroalkyl Substances (PFASs) from Carpet and Clothing in Model Anaerobic Landfill Reactors	2016	Environ. Sci. Technol. 2016 May:50(10):5024-5032. doi: 10.1021/acs.est.5b06237.	Discarded carpet and clothing are potential sources of per- and polyfluoroalkyl substances (PFASs) in landfill leachate, but little is known about their release when disposed in landfills. The concentrations of 70 PFASs in the aqueous phase of anaerobic model landfill reactors filled with carpet or clothing were monitored under biologically active and abiotic conditions. For carpet, total PFAS release was greater in live than abiotic reactors, with an average of 8.5 nmol/L and 0.62 nmol/L after S52 days, respectively. Release in live carpet reactors was primarily due to 5:3 fluorotelomer carboxylic acid (FTCA - 3.9 nmol/L) and perfluorohexanoic carboxylic acid (PFHxA - 2.9 nmol/L). For clothing, release was more dependent on sample heterogeneity than the presence of biological activity, with 0.63, 21.7, 2.6, and 6.3 nmol/L for two live and two abiotic reactors after 519 days, respectively. Release in the clothing reactors was largely due to perfluorooctatonic carboxylic acid (PFOA), with low relative concentrations of measured biotransformation precursors (FTCAs). For carpet and clothing reactors, the majority of PFAS release was not measured until after day 100. Results demonstrate that carpet and clothing are likely sources of PFASs in landfill leachate.		1					B	-		
D565	ばく露	Ojemaye, CY; Petrik, L	Occurrences, levels and risk assessment studies of emerging pollutants (pharmaceuticals, perfluoroalkyl and endocrine disrupting compounds) in fish samples from Kalk Bay harbour, South Africa	2019	Environ. Pollut. 2019 Sep;252(Pt A):562-572. doi: 10.1016/j.envpol.2019.05.091.	A comprehensive analysis of 15 target chemical compounds (pharmaceuticals and personal care product, perfluoroalkyl compounds and industrial chemicals) were carried out to determine their concentrations in selected commercially exploited, wild caught small and medium sized pelagic fish species and their organs (Thyrsites atun (snoek), Sarda orientalis (bonito), Pachymetopon blochii (panga) and Pterogymnus laniarius (hottentot)) obtained from Kalk Bay harbour, Cape Town. Solid phase extraction (SPE) method based on Oasis HLB cartridges were used to concentrate and clean-up the samples. Liquid chromatography-mass spectrometry analysis of these chemical compounds revealed the simultaneous presence of at least 12 compounds in different parts of the selected fish species in nanogram-per-gram dry weight (ng/g dw) concentrations. The results revealed that perfluorodecanoic acid, perfluorononanoic acid and perfluoroheptanoic acid were the most predominant among the perfluorinated compounds and ranged between: (20.13-179.2 ng/g), (21.22-114.0 ng/g) and (40.06-138.3 ng/g). Also, diclofenac had the highest concentration in these edible fish species out of all the pharmaceuticals detected (range: 551.8-1812 ng/g). The risk assessment values were above 0.5 and 1.0 for acute and chronic risk respectively which shows that these chemicals have a high health risk to the pelagic fish, aquatic organisms and to humans who consume them. Therefore, there is an urgent need for a precautionary approach and the adequate regulation of the use and disposal of synthetic chemicals that persist in aquatic/marine environment in this province and other parts of South Africa, to prevent impacts on the sustainability of our marine environment, livelihood and lives.			1				B	-		
D566	ばく露	Jurikova, M; Dvorakova, D; Pulkrabova, J	The occurrence of perfluoroalkyl substances (PFAS) in drinking water in the Czech Republic: a pilot study	2022	Environ. Sci. Pollut. Res. 2022 Aug:29(40):60341-60353. doi: 10.1007/s11356-022-20156-7.	Drinking water is one of the main contributors to overall human exposure to per- and polyfluoroalkyl substances (PFAS), a broad group of environmental contaminants with arising concerns on the impact on human health; therefore, it is necessary to monitor its quality. Here, we present a solid-phase extraction-based method to determine 22 PFAS in water, using 100 mL of the sample. The instrumental analysis employing an ultra-high-performance liquid chromatography coupled with tandem mass spectrometry achieved low limits of quantification (0.025-0.25 ng/L). The validated method (recoveries 70-120% and repeatabilities <= 20% at tested concentrations (0.05, 0.1 and 0.5 ng/L)) was applied to 67 tap water and 31 bottled water samples collected in the Czech Republic. The most abundant compounds were perfluorononanoic acid (88% positives; 0.034-13.3 ng/L) and perfluoroheptanoic acid (23% positives; 0.035-0.106 ng/L), respectively. Sigma PFAS in positive samples ranged from 0.029 to 300 ng/L (99% positives, median 2.34 ng/L) in tap water data and 0.033 to 4.48 ng/L (32% positives, median 0.097 ng/L) in bottled water samples. Current-use fluoroalkyl ethers, dodecafluoro-3H-4,8-dioxanonanoate and 11-chloroeicosafluoro-3-oxaundecane-1-sulfonate, were occasionally detected in tap. Based on the median data, PFAS intake by an adult from a tap or bottled water represented units of % of the tolerable weekly intake set by the European Food Safety Authority and therefore did not represent a severe risk. The described method and obtained first data on PFAS in the Czech drinking water provided a solid basis for an ongoing national study on the presence of PFAS in tap water.			1				B	-		
D567	ばく露	Schwichtenberg, T; Bogdan, D; Carignan, CC; Reardon, P; Rewerts, J; Wanzek, T; Field, JA	PFAS and Dissolved Organic Carbon Enrichment in Surface Water Foams on a Northern US Freshwater Lake	2020	Environ. Sci. Technol. 2020 Nov:54(22):14455-14464. doi: 10.1021/acs.est.0c05697.	Information is needed on the concentration of per- and polyfluoroalkyl substances (PFAS) in foams on surface waters impacted by aqueous film-forming foam (AFFF). Nine pairs of foam and underlying bulk water were collected from a single freshwater lake impacted by PFAS and analyzed for PFAS by liquid chromatography quadrupole time-of-flight mass spectrometry (LC-QToF) and for dissolved organic carbon (DOC). The DOC of two foam:bulk water pairs was characterized by H-1 NMR. Foams were comprised of 16 PFAS with concentrations as high as 97 000 ng/L (PFOS) along with longer-chain, more hydrophobic PFAS. Only five PFAS (PFOS and shorter chain lengths) were quantified in underlying bulk waters. Enrichment factors (foam:bulk water) ranged from 10 (PFHxA) up to 2830 (PFOS). Foams impacted by AFFF gave the greatest concentrations and number of PFAS classes with PFOS concentrations exceeding the EPA health advisory level (70 ng/L). PFAS concentrations were significantly below published critical micelle concentrations and constituted <0.1% of overall DOC concentrations in foam, indicating that PFAS are a minor fraction of DOC and that DOC likely plays a central role in foam formation. Estimates indicate that foam ingestion is a potentially important route of exposure for children and adults when they are in surface waters where foam is present.		1					B	-		
D568	ばく露	Semerad, J; Horka, P; Filipova, A; Kukla, J; Holubova, K; Musilova, Z; Jandova, K; Frouz, J; Cajthaml, T	The driving factors of per- and polyfluorinated alkyl substance (PFAS) accumulation in selected fish species: The influence of position in river continuum, fish feed composition, and pollutant properties	2022	Sci. Total Environ. 2022 Apr:816:151662. doi: 10.1016/j.scitotenv.2021.151662.	Per- and polyfluorinated alkyl substances (PFASs) represent a group of highly recalcitrant micropollutants, that continuously endanger the environment. The present work describes the geographical trends of fish contamination by individual PFASs (including new compounds, e.g., Gen-X) assessed by analyzing the muscle tissues of 5 separate freshwater fish species from 10 locations on the Czech section of the Elbe River and its largest tributary, the Vltava River. The data of this study also showed that the majority of the detected PFASs consisted of long chain representatives (perfluorooctane sulfonate (PFOS), perfluorononanoic acid, perfluorodecanoic acid, and perfluoroundecanoic acid), whereas short-chain PFASs as well as other compounds such as Gen-X were detected in relatively small quantities. The maximum concentrations of the targeted 32 PFASs in fish were detected in the lower stretches of the Vltava and Elbe Rivers, reaching 289.9 ng/g dw, 140.5 ng/g dw, and 162.7 ng/g dw for chub, roach, and nase, respectively. Moreover, the relationships between the PFAS (PFOS) concentrations in fish muscle tissue and isotopic ratios (delta N-15 and delta C-13) were studied to understand the effect of feed composition and position in the river continuum as a proxy for anthropogenic activity. Redundancy analysis and variation partitioning showed that the largest part of the data variability was explained by the interaction of position in the river continuum and delta N-15 (delta C-13) of the fish. The PFAS concentrations increased downstream and were positively correlated with delta N-15 and negatively correlated with delta C-13. A detailed study at one location also demonstrated the significant relationship between delta N-15 (estimated trophic position) and PFASs (PFOS) concentrations. From the tested physicochemical properties, the molecular mass and number of fluorine substituents seem to play crucial roles in PFAS bioaccumulation.			1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D569	ばく露	Dreyer, A; Thuens, S; Kirchgeorg, T; Radke, M	Ombrotrophic Peat Bogs Are Not Suited as Natural Archives To Investigate the Historical Atmospheric Deposition of Perfluoroalkyl Substances	2012	Environ. Sci. Technol. 2012 Jul:46(14):7512-7519. doi: 10.1021/es204175y.	As ombrotrophic peat bogs receive only atmospheric input of contaminants, they have been identified as suitable natural archives for investigating historical depositions of airborne pollutants. To elucidate their suitability for determining the historical atmospheric contamination with perfluoroalkyl substances (PFAS), two peat cores were sampled at Mer Bleue, a bog located close to Ottawa, Canada. Peat cores were segmented, dried, and analyzed in duplicate for 25 PFASs (5 perfluororalkyl sulfonates (PFSAs), 13 perfluoroalkyl carboxylates (PFCAs), 7 perfluororalkyl sulfonamido substances). Peat samples were extracted by ultrasonication, cleaned up using a QuEChERS method, and PFASs were measured by HPLC-MS/MS. Twelve PFCAs and PFSAs were detected regularly in peat samples with perfluorooctane sulfonate (85-655 ng kg(-1)), perfluorooctanoate (150-390 ng kg(-1)), and perfluorononanoate (45-320 ng kg(-1)) at highest concentrations. Because of post depositional relocation processes within the peat cores, true or unbiased deposition fluxes (i.e., not affected by post depositional changes) could not be calculated. Apparent or biased deposition rates (i.e., affected by post depositional changes) were lower than measured/calculated deposition rates for similar urban or near urban sites. Compared to PFAS production, PFAS concentration and deposition maxima were shifted about 30 years toward the past and some analytes were detected even in the oldest segments from the beginning of the 20th century. This was attributed to PFAS mobility in the peat profile. Considerable differences were observed between both peat cores and different PFASs. Overall, this study demonstrates that ombrotrophic bogs are not suited natural archives to provide authentic and reliable temporal trend data of historical atmospheric PFAS deposition.			1					B	-		
D570	ばく露	Lu, GH; Gai, N; Zhang, P; Piao, HT; Chen, S; Wang, XC; Jiao, XC; Yin, XC; Tan, KY; Yang, YL	Perfluoroalkyl acids in surface waters and tapwater in the Qiantang River watershed-Influences from paper, textile, and leather industries	2017	Chemosphere 2017 Oct:185:610-617. doi: 10.1016/j.chemosphere.2017.06.139	Perfluoroalkyl acids (PFAAs) are widely used as multi-purpose surfactants or water/oil repellents. In order to understand the contamination level and compositional profiles of PFAAs in aqueous environment in textile, leather, and paper making industrial areas, surface waters and tap waters were collected along the watershed of the Qiantang River where China's largest textile, leather, and paper making industrial bases are located. For comparison, surface water and tapwater samples were also collected in Hangzhou and its adjacent areas. 17 PFAAs were analyzed by solid phase extraction-high performance liquid chromatography-tandem mass spectrometry. The results show that the total concentrations of PFAA5 (Sigma PFAAs) in the Qiantang River waters ranged from 106.1 to 322.9 ng/L, averaging 164.2 ng/L. The contamination levels have been found to be extremely high, comparable to the levels of the most serious PFAA contamination in surface waters of China. The PFAA composition profiles were characterized by the dominant PFOA (average 58.1% of the total PFAAs), and PFHxA (average 18.8%). The PFAAs in tap water ranged from 9.5 to 174.8 ng/L, showing PFAA compositional pattern similar to the surface waters. Good correlations between PFAA composition profiles in tap waters and the surface waters were observed.		1					B	-		
D571	ばく露	Han, TZ; Gao, LY; Chen, JH; He, XP; Wang, BD	Spatiotemporal variations, sources and health risk assessment of perfluoroalkyl substances in a temperate bay adjacent to metropolis, North China	2020	Environ. Pollut. 2020 Oct;265(Pt A):115011. doi: 10.1016/j.envpol.2020.115011.	Fourteen perfluoroalkyl substances (PFASs) in fishery organism, surface seawater, river water, rainwater, and wastewater samples collected from Jiaozhou Bay (JZB) in China and its surrounding area were determined to understand their contamination status, sources, health risk, and causes of spatiotemporal variations in the aquatic environment of a temperate bay adjacent to a metropolis. The total concentration of PFASs in 14 species of fishery organisms ranged from 1.77 ng/g to 31.09 ng/g wet weight, and perfluorooctane sulfonate (PFOS) was the dominant PFAS. Sigma PFASs concentration in surface seawater ranged from 5.54 ng/L to 48.27 ng/L over four seasons, and dry season (winter and spring) had higher levels than wet season (summer and autumn). Perfluorooctanoic acid (PFOA) was the predominant individual PFAS in seawater, indicating that notorious C8 homologs remained the major PFASs in this region. The seasonal variation in seawater concentrations of three major PFASs, namely, PFOA, perfluoroheptanoic acid, and perfluorononanoic acid, was similar to that of Sigma PFASs. However, the seasonal variation of PFOS concentration was different from that of Sigma PFASs, with the lowest in winter and the highest in spring. In general, seasonal variations of terrigenous input and water exchange capacity were the main reasons for the spatiotemporal variation of PFASs in the aquatic environment of JZB. Moreover, bioselective enrichment for individual PFAS affected the partition of PFASs in different environment medium. Wet precipitation, sewage discharge, and surface runoff were the main sources of PFASs in this area. Nevertheless, the contribution of different sources to individual PFAS indicated a clear difference, and wastewater and river water were not consistently the most important source for every PFAS. Preliminary risk assessment revealed that the consumption of seafood, especially fish, from JZB might pose a certain extent of health risk to local consumers based on their estimated daily intake of PFASs.			1					B	-		
D572	ばく露	Guo, MM; Zheng, GC; Peng, JX; Meng, D; Wu, HY; Tan, ZJ; Li, FL; Zhai, YX	Distribution of perfluorinated alkyl substances in marine shellfish along the Chinese Bohai Sea coast	2019	J. Environ. Sci. Health Part B-Pestic. Contam. Agric. Wastes. 2019 Apr:54(4):271-280. doi: 10.1080/03601234.2018.1559570.	Perfluorinated alkyl substances (PFASs) are emerging persistent organic pollutants, which pose a threat to human health primarily by dietary exposure, especially through seafood. Bohai Sea (a semi-closed sea located north of China) is an important shellfish aquaculture area that is possibly highly-polluted with PFASs. In this study, we first evaluated contamination by PFASs in a total of 230 samples of marine shellfish from the Bohai Sea. Samples included five important shellfish species, collected from important aquaculture spots distributed around the Bohai Sea. Samples were analyzed by an ultra-fast liquid chromatography-tandem mass spectrometry method, which could simultaneously detect 23 PFASs in shellfish. Our research verified that PFASs have become a threat to the safety of shellfish products in this area. Furthermore, contamination by PFASs in shellfish changed depending on the components of PFASs, the species of shellfish, and the sampling sites. Many of the 23 target compounds contributed to the high detection ratio (>50%) as follows: perfluorooctanoic acid (PFOA) > perfluorononanoic acid > perfluorodecanesulfonic acid > perfluorooctanesulfonic acid (PFOS). Compared with other dominant components, PFOA not only had the highest detection percentage in shellfish samples (98.3%), but its detection level contributed to 87.2% of total PFASs concentrations, indicating that PFOA is the major threat to the safety of shellfish products. The highest level of PFAS was found in clams (62.5 ng g(-1) wet weight of PFOA). The concentration of total PFAS in different shellfish species showed the following trend: clams > mussels > scallops > whelks > oysters. The maximum concentration of total PFAS or PFOA was found in Shouguang. The total concentration of PFOS and its precursor were highest in Cangzhou, possibly due to local industrial activities. The results presented in this paper provide new data on the contamination of marine shellfish along the Bohai Sea coasts in China, and constitute a reference for future monitoring of contamination by emerging contaminants in Bohai coast.			1					B	-		
D573	ばく露	Essumang, DK; Eshun, A; Hogarh, JN; Bentum, JK; Adjei, JK; Negishi, J; Nakamichi, S; Habibullah-Al-Mamun, M; Masunaga, S	Perfluoroalkyl acids (PFAAs) in the Pra and Kakum River basins and associated tap water in Ghana	2017	Sci. Total Environ. 2017 Feb:579:729-735. doi: 10.1016/j.scitotenv.2016.11.035	Perfluoroalkyl acids (PFAAs) are persistent environmental pollutants that have been detected in various media including human serum. Due to concerns regarding their bioaccumulation and possible negative health effects, an understanding of routes of human exposure is necessary. PFAAs are recalcitrant in many water treatment processes, making drinking water a potential source of human exposure. This study presents the first report on contamination from PFAAs in river and drinking water in Ghana. The targeted PFAAs were perfluoroalkyl carboxylic acids (PFCAs) with C4-14 carbon chain and perfluoroalkane sulphonic acids (PFSAs) with C-6,C- 8,C- 10. Five PFAA congeners - PFOA, PFOS, PFHxA, PFDA and PFPeA - were commonly detected in river and tap water. The mean concentrations of Sigma PFAAs in the Kakum and Pra Rivers were 281 and 398 ng/L, while tap water (supplied from the treatment of water from those rivers) contained concentrations of 197 and 200 ng/L, respectively. PFOA and PFOS constituted about 99% of the Sigma PFAAs. The risk quotient (RQ) attributed to drinking of tap water was estimated at 1.01 and 1.74 for PFOA and PFOS, respectively. For a country that has not produced these compounds, the RQs were unexpectedly high, raising concerns particularly about contamination from such emerging pollutants in local water sources. The study revealed limitations of local tap water treatment in getting rid of these emerging pollutants.		1					B	-		
D574	ばく露	Zhao, LJ; Zhou, M; Zhang, T; Sun, HW	Polyfluorinated and Perfluorinated Chemicals in Precipitation and Runoff from Cities Across Eastern and Central China	2013	Arch. Environ. Contam. Toxicol. 2013 Feb:64(2):198-207. doi: 10.1007/s00244-012-9832-x.	Twenty-three polychlorinated and perfluorinated compounds (PFCs) were investigated in water phase and particulate matters of 19 precipitation samples (18 snow samples and 1 rain sample) from different cities across eastern and central China collected in February 2010. The PFCs in samples of 9e precipitation events during more than half a year at 1 site in Tianjin and 6 successive samples during 1 precipitation event were measured to elucidate the change of PFC in precipitation. In addition, PFCs in 3 runoffs at different kinds of sites in Tianjin were compared with those in the corresponding precipitation. The results showed that the particulate matters separated from the precipitation contained undetectable PFCs. The total PFC concentration ranged between 4.7 and 152 ng L-1 in water phase of the precipitation samples, with perfluorooctanoic acid (PFOA) being detected at all of the sampling sites and the dominant PFC at most of the sampling sites. Some potential precursors of environmentally concerned PFCs and their degradation intermediates were measured simultaneously, among which 6:2 fluorotelomer unsaturated carboxylic acid (6:2 FTUCA), 8:2 FTUCA, and x (3, 4, 5, 7):3 acid [F(CF2)xCH(2)CH(2)COOH] were measured for the first time in Chinese precipitations; however, their concentrations were all lower than the limits of detection except that 6:2 FTUCA and 8:2 FTUCA could be detected in 3 and 8 precipitation samples, respectively. No clear seasonal variation in PFC concentrations in precipitation was observed during half a year; however, a relatively greater average concentration of total PFCs was observed during winter and summer compared with spring. The concentration of individual PFCs showed an obvious descending trend in the successive samples of the precipitation event. PFOA and perfluorononanoic acid in runoffs collected from different sites showed the following similar pattern-gas station > highway > university campus-whereas the other detected PFCs had no concurrent trend.			1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D575	ばく露	Ali, AM; Higgins, CP; Alarif, WM; Al-Lihaibi, SS; Ghandourah, M; Kallenborn, R	Per- and polyfluoroalkyl substances (PFASs) in contaminated coastal marine waters of the Saudi Arabian Red Sea: a baseline study	2021	Environ. Sci. Pollut. Res. 2021 Jan:28(3):2791-2803. doi: 10.1007/s11356-020-09897-5.	Per- and polyfluoroalkyl substances (PFASs) are today considered important constituents of the continuously growing substance group of persistent contaminants of emerging environmental concern (PCEC). Here, we report for the first time the concentrations of 12 relevant PFASs in 28 marine water samples from the Saudi Arabian coastal waters of the Red Sea. The sum levels of 12 PFASs (sigma(12)PFAS) in surface seawater ranged from								B	-		
D576	ばく露	Pico, Y; Belenguer, V; Corcellas, C; Diaz-Cruz, MS; Eljarrat, E; Farre, M; Gago-Ferrero, P; Huerta, B; Navarro-Ortega, A; Petrovic, M; Rodriguez-Mozaz, S; Sabater, L; Santin, G; Barcelo, D	Contaminants of emerging concern in freshwater fish from four Spanish Rivers	2019	Sci. Total Environ. 2019 Apr:659:1186-1198. doi: 10.1016/j.scitotenv.2018.12.366	This study investigated the occurrence of 135 contaminants of emerging concern (CECs) - pharmaceuticals, pesticides, a set of endocrine disrupting compounds (EDCs) (parabens, bisphenols, hormones, triazoles, organophosphorus flame retardants and triclosan), UV-filters, perfluoroalkyl substances (PFASs) and halogenated flame retardants (HFRs) - in 59 fish samples, collected in 2010 in 4 Spanish Rivers (Guadalquivir, Jucar, Ebro and Llobregat). Of the 135 CECs, 76 including 8 pharmaceuticals, 25 pesticides, 10 EDCs, 5 UV-filters, 15 PFASs and 13 HFRs were detected. Pharmaceuticals were the less frequently found and at lower concentrations. Pesticides, EDCs, UV-filters, PFASs and HFRs were detected more frequently (>50% of the samples). The maximum concentrations were 15 ng/g dry weight (dw) for pharmaceuticals (diclofenac), 840 ng/g dw for pesticides (chlorpyrifos), 224 ng/g dw for EDCs (bisphenol A), 242 ng/g dw for UV-filters (EHMC), 1738 ng/g dw for PFASs (PFHxA) and 64 ng/g dw for HFRs (Dec 602). The contaminants detected in fish are commonly detected also in sediments. In light of current knowledge, the risk assessment revealed that there was no risk for humans related to the exposure to CECs via freshwater fish consumption. However, results provide detailed information on the mixtures of CECs accumulated that would be very useful to identify their effects on aquatic biota.		1						B	-		
D577	ばく露	Cai, LL; Hu, JR; Li, J; Cao, XQ; Lyu, YT; Sun, WL	Occurrence, source apportionment, and pollution assessment of per- and polyfluoroalkyl substances in a river across rural and urban areas	2022	Sci. Total Environ. 2022 Aug:835:155505. doi: 10.1016/j.scitotenv.2022.155505.	Forty-three novel and legacy per-and polyfluoroalkyl substances (PFASs) in water and sediments from the Chaobai River (Beijing) were quantified. The total PFASs concentrations varied from 0.04 to 31.3 ng/L in water with significant spatial but insignificant seasonal variations, and changed from 0.03 to 4.29 ng/g in sediment with insignificant spatial but significant seasonal variations. The PFASs concentrations in water from the upstream across the rural area reflected the background level due to the extremely low concentration and very few detected PFASs. The consumer products and metal plating/textile were the predominant pollution sources of PFASs in winter and summer, respectively, for both water and sediment samples. Integrating the determined baseline value, the distribution of PFASs concentrations, and the ecological risks of PFASs, three criteria were proposed, which divide the PFASs concentrations in water into four pollution levels, i.e., insignificant, low, medium, and high. According to the suggested criteria, 96.4% of the PFASs levels in upstream was insignificant pollution, which decreased to 50.4% in downstream and 50.8% in reservoirs. The PFASs in China's and world's surface waters demonstrated similar pollution patterns, with PFOA, PFOS, and PFHxA being the top 3 polluted PFASs. This study makes a small step forward the development of water quality standard for PFASs, which is of great importance for pollution control and risk management of PFASs.		1						B	-		
D578	ばく露	Nguyen, HT; McLachlan, MS; Tscharke, B; Thai, P; Braeunig, J; Kaserzon, S; O'Brien, JW; Mueller, JF	Background release and potential point sources of per- and polyfluoroalkyl substances to municipal wastewater treatment plants across Australia	2022	Chemosphere. 2022 Apr:293:133657. doi: 10.1016/j.chemosphere.2022.133657.	Wastewater treatment plants (WWTPs) are known to be significant sources of per-and polyfluoroalkyl substances (PFAS) to the environment. In this study, PFAS were measured in the influent of 76 municipal wastewater treatment plants (WWTPs) serving approximately 53% of the Australian population. Of fourteen target PFAS, twelve analytes including six C5-C10 perfluoroalkyl carboxylic acids (PFCAs), four C4-10 perfluoroalkyl sulfonic acids (PFSAs) and two fluorotelomer sulfonates (6:2 and 8:2 FTS) were detected. Of these, PFOS, PFHxS and PFHxA had the highest median concentrations. The per capita background release of Sigma(12) PFAS to WWTP influent in Australia was estimated to be 8.1-24 mu g/d/per person. The background release was supplemented by contributions from catchment specific point sources (i.e., industry, airports, military bases, and landfills), whereby the number of industrial sites positively correlated with the per capita mass load of Sigma(12) PFAS ($r = 0.5$-0.63, $p < 0.01$). The per capita mass loads were extrapolated to the entire Australian population, with estimates suggesting that approximately 1 kg/d of Sigma(12) PFAS reach WWTPs in Australia (300-400 kg annually), with more than half of the PFAS (similar to 59%) attributed to background release and the remaining (similar to 41%) to catchment specific point sources. These data provide insight into the release of major PFAS to wastewater at a national scale in Australia.		1						B	-		
D579	ばく露	Abafe, OA; Macheka, LR; Abafe, OT; Chokwe, TB	Concentrations and human exposure assessment of per and polyfluoroalkyl substances in farmed marine shellfish in South Africa	2021	Chemosphere. 2021 Oct:281:130985. doi: 10.1016/j.chemosphere.2021.130985.	Although the consumption of seafood is a major route of human exposure to perfluomalkyl substances (PFAS), data on their concentrations in marine shellfish and the exposure of the African population to PFAS through the consumption of shellfish is lacking. In this study, the concentrations of 15 PFAS were measured in four species of farmed marine shellfish by using a validated UHPLC-MS/MS method. These concentrations were used to determine the human daily intake of PFAS through the consumption of marine shellfish and the hazard quotient thereof. PFPeA, PFOS, PFHxA and PFTeDA were the most prevalent compounds with detection frequencies of 94, 88, 76 and 71%, respectively. The Sigma(11)PFAS concentrations (in ng g(-1) wet weight (ww)) ranged from 0.12 to 0.49, 4.83-6.43, 0.64-0.66 and 0.22 ng g(-1) ww in abalone, mussel, oyster and lobster, respectively. The prevalence of PFCAs reflects the current contamination profile of PFAS in farmed shellfish. The estimated daily intake for Sigma(10) PFAS through the consumption of marine shellfish ranged from 0.05 to 1.58 ng kg(-1) bw d(-1). Overall, the hazard quotients for these compounds were low, indicating that these compounds do not pose a health risk to the South African population through shellfish consumption. This study provides background data for future studies on the occurrence of PFAS and other emerging contaminants in the African coastal environment.		1						B	-		
D580	ばく露	Selvaraj, KK; Murugasamy, M; Nikhil, NP; Elaiyaraja, A; Sampath, S; Krishnamoorthi, V; He, H; Ramaswamy, BR	Investigation of distribution, sources and flux of perfluorinated compounds in major southern Indian rivers and their risk assessment	2021	Chemosphere. 2021 Aug:277:130228. doi: 10.1016/j.chemosphere.2021.130228.	Perfluorinated compounds (PFCs) are a group of emerging contaminants still less reported in rivers, particularly southern India. Therefore, we investigated the fate of 13 PFCs in three major rivers in southern India during post-monsoon and summer seasons. Twelve PFCs were detected, with an average total PFCs of 1853 +/- 1463 pg/l. However, the total PFCs recorded in ppost-monsoon and summer seasons ranged from ND (none detected) to 10,545 pg/l and ND to 4960 pg/l, respectively. Among the individual congeners, perfluoro-n-hexanoic acid (PFHxA) had the highest detection average (929 +/- 710 pg/l). The higher detection of short chain PFCs signifies their increasing wide usage as an alternative to perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). Higher levels of PFCs were observed in summer than post-monsoon season in the river Kaveri, which is mainly attributed to the decrease in river flow. A multidimensional source identification revealed domestic and commercial wastewater as the major source. A correlation analysis showed that most of the detected PFCs share the common source and undergo co-migration into rivers. The flux of PFCs into the Bay of Bengal, loaded by the Kaveri (15 kg/yr) and the Tamiraparani (2.2 kg/yr) rivers, signifies lower per capita emissions than other rivers in India and other countries. Further, the PFC levels found in the rivers can be considered safe for human consumption and aquatic organisms based on international guidelines. Being the first hand report in southern Indian rivers, the results warrant further investigation to understand the exact sources, fate and removal in detail.		1						B	-		
D581	ばく露	Rankin, K; Mabury, SA; Jenkins, TM; Washington, JW	A North American and global survey of perfluoroalkyl substances in surface soils: Distribution patterns and mode of occurrence	2016	Chemosphere 2016 Oct:161:333-341. doi: 10.1016/j.chemosphere.2016.06.109	The distribution of 32 per/polyfluoroalkyl substances (PFASs) in surface soils was determined at 62 locations representing all continents (North America n = 33, Europe n = 10, Asia n = 6, Africa n = 5, Australia n = 4, South America n = 3 and Antarctica n = 1) using ultra performance liquid chromatography tandem mass spectrometry (UPLC-MS/MS) systems. Quantifiable levels of perfluoroalkyl carboxylates (PFCAs: PFHxA-PFTeDA) were observed in all samples with total concentrations ranging from 29 to 14,300 pg/g (dry weight), while perfluoroalkane sulfonates (PFSAs: PFHxS, PFOS and PFDS) were detected in all samples but one, ranging from		1						B	-		
D582	ばく露	Gong, XX; Liu, RX; Li, B; Song, YH; Liu, YY	Perfluoroalkyl acids in Daliao River system of northeast China: determination, distribution and ecological risk	2016	Environ. Earth Sci. 2016 MAR;75(6):469. doi: 10.1007/s12665-016-5345-7.	Perfluoroalkyl acids (PFAAs) in Daliao River system were simultaneously determined by UPLC-MS/MS coupled with SPE for water samples and with ultrasonication extraction for sediments. All samples were collected from the mainstreams of Hun River (HR) and Daliao River (DLR), as well as urban canal Xi River (XR) in Shenyang City, located in northeast China. Under the optimal conditions, the recoveries of most selected PFAAs were 61-131 % with RSD below 30 % for spiked water and sediment samples. The total average concentrations of PFAAs in surface water were 1.76-9.47 ng/L in the HR, 9.54-13.0 ng/L in the DLR and 33.5-50.7 ng/L in the XR. As the dominant PFAAs, perfluorooctanoic acid (PFOA) was detected at levels from 1.52 to 7.12 ng/L in the HR and DLR. PFOA, perfluoropentanoic acid (PFPA) and perfluorooctane sulfonic acid (PFOS) were the most abundant compounds detected in the XR with concentration ranges of 6.71-18.1, 9.7-26 and 0.81-13 ng/L, respectively. The average concentration of PFAAs in the sediments followed the sequence of the XR > DLR > HR. Perfluorodecanoic acid (PFHxA) was the dominant PFAA detected in 76.5 % of the sediment samples from the three rivers, with the concentrations of 0.07-0.49 ng/g dry mass. Both PFOS and PFOA were measurable in the sediments on very few occasions, with the concentration up to 0.84 ng/g dry mass. The calculated average partition coefficients (Log K-d, L/kg) of PFOA and PFOS between the sediment and water were 1.18 and 2.21, respectively. Given their exposure levels and risk quotient (RQ) values, PFOS and PFOA had no significant risk to aquatic organisms in the DLR system.		1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D583	ばく露	Subedi, B; Codru, N; Dziewulski, DM; Wilson, LR; Xue, JC; Yun, SH; Braun-Howland, E; Minihane, C; Kannan, K	A pilot study on the assessment of trace organic contaminants including pharmaceuticals and personal care products from on-site wastewater treatment systems along Skaneateles Lake in New York State, USA	2015	Water Res. 2015 Apr 1:72:28-39. doi: 10.1016/j.watres.2014.10.049.	On-site wastewater treatment systems (OWTSs or septic systems) are designed to treat and dispose effluents on the same property that produces the wastewater. Approximately 25% of the U.S. population is served by such facilities. Nevertheless, studies on the treatment efficiency and discharge of organic contaminants through septic effluents are lacking. This pilot study showed the occurrence of organic contaminants including pharmaceuticals and personal care products (PPCPs), perfluoroalkyl surfactants (PFASs), polybrominated diphenyl ethers (PBDEs), and polychlorinated biphenyls (PCBs) in septic effluents, adjacent lake water samples, household drinking water in homes that use lake water or a well adjacent to the lake as a source of drinking water, and offshore lake water samples. Septic effluent as well as lake and tap water samples were collected from several households with OWTSs around Skaneateles Lake located in central New York. The advanced on-site systems were installed in some households for the purpose of limiting nutrient levels in the effluent to protect the local surface water. Additionally, because many of these systems serve homes with limited land, advanced treatment systems were needed. The median concentrations of ten PPCPs (ranged from 0.45 to 388 ng/L) and eleven PFASs (ranged from 0.20 to 14.6 ng/L) in septic water were significantly higher (p <= 0.01) than in lake water samples. The Median concentrations of PPCPs and PFASs in lake and tap water samples were not significantly different (p >= 0.65). The median concentrations of Sigma PBDEs in septic, lake, and tap water samples were 7.47, 3.49, and 2.22 ng/L, respectively, and those for Sigma PCBs were 33.1, 29.2, and 28.6 ng/L, respectively. The mass flux of PPCPs (i.e. the mass flow of PPCPs per unit area per unit time) through the disposal of treated septic effluent from textile biofilter and aerobic treatments to the dispersal unit ranged from 12 (carbamazepine) to 66900 mu g/m(2)/day (caffeine) whereas that for PFASs ranged from 7.0 (perfluorobutanesulfonate) to 833 mu g/m(2)/day (perfluorooctanoic acid). Based on the ratio of measured concentrations and method detection limit, triclocarban, perfluorooctanoic acid, and perfluorooctanesulfonate have the potential to be used as chemical tracers of septic water contamination in Skaneateles Lake. The median concentrations of atenolol, a beta-blocker drug, in septic water were significantly (rho = 0.86, p = 0.01) correlated with enterococci counts.				1				B	-		
D584	ばく露	Ericson I, Marti-Cid R, Nadal M, Van Bavel B, Lindström G, Domingo JL.	Human exposure to perfluorinated chemicals through the diet: intake of perfluorinated compounds in foods from the Catalan (Spain) market	2008	J Agric Food Chem. 2008 Mar 12;56(5):1787-94. doi: 10.1021/jf0732408. Epub 2008 Feb 6.	The aim of this study was to determine the dietary intake of perfluorinated chemicals (PFCs) by the population of Tarragona County (Catalonia, Spain). PFC levels were determined in 36 composite samples of foodstuffs randomly purchased in various locations. Exposure to PFCs through the diet was estimated for various age/gender groups. Perfluorooctane sulfonate (PFOS), perfluorocarboxylate perfluorooctanoate (PFOA), and perfluoroheptanoic acid (PFHpA) were the only detected PFCs in foodstuffs. On average, for a standard adult man (70 kg of body weight), the dietary intake of PFOS was estimated to be 62.5 or 74.2 ng/day (assuming ND=0 or ND=1/2 LOD, respectively). Fish, followed by dairy products and meats, were the main contributors to PFOS intake. For an adult man, the intake of PFOS (1.07 ng/kg/day) and those of PFOA and PFHpA were lower than that recently reported for Canada (4.0 ng/kg/day), and considerably lower than that previously found in the United Kingdom, the only two countries where, to date, results concerning this issue have been reported. A correlation between dietary intake and blood levels of PFOS is suggested. However, the current results do not justify dietary intake as the main route of exposure governing blood concentrations of other PFCs.								B	-		
D585	ばく露	Rostkowski P, Taniyasu S, Yamashita N, Falandysz J.	[Perfluorinated compounds in potable water]	2008	Rocz Panstw Zakl Hig. 2008;59(3):283-92.	In a pilot study perfluorinated compounds such as perfluorobutane sulfonate (PFBS), perfluorohexane suflonate (PFHS), perfluorooctane sulfonate (PFOS), perfluorooctane sulfonamide (PFOSA), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluorotetradecanoic acid (PFTeDA), perfluorohexadecanoic acid (PFHxDA) and perfluorooctadecanoic acid (PFOcDA) have been determined in the Japanese and Polish brands of bottled mineral water and in tap water. Bottled mineral water from both countries contained ultratrace amounts of some perfluorinated compounds, and higher degree of contamination showed tap water. PFOS and PFOA concentrations were much below threshold level for toxic effects, and Hazard Quotient (HQ) was much < 1.		1	1	1				B	-		
D586	ばく露	Chen QW, Zhang H, Chai ZF, Shen JC, Yang B.	[Residue characteristics and distributions of perfluorinated compounds in surface seawater along Shenzhen coastline]	2012	Huan Jing Ke Xue. 2012 Jun;33(6):1795-800.	In order to explore the residue characteristics and distributions of 15 perfluorinated compounds (PFCs) in 18 surface seawater samples along Shenzhen coastline, high performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS) combined with solid phase extraction enrichment was applied in this research. The results indicated that residue level of PFCs in coastal surface seawater samples was significantly affected by human activities. Sigma PFCs residue levels in surface seawater from Shenzhen west coast, which locates below the estuary of Pearl River and Donghao River, are much higher than those from the east coast, which has low development and sparse population (P<0.05). Under natural conditions, sigma PFCs residue levels in coastal surface seawater samples from Shenzhen Bays are higher than those out of bays. The major residue species in surface seawater samples along Shenzhen coast were medium- and short-chain PFCs, including perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorohexanoic acid and perfluoropentanoic acid. Their similar environmental behavior (P<0.05, P<0.01) is likely associated with the production process of PFCs-related products. Furthermore, cluster analysis results show that PFOS (R2 = 0.4092) level can be used as a representative parameter for evaluating PFCs contamination status in surface seawater along Shenzhen coast.		1						B	-		
D587	ばく露	Meng J, Wang TY, Wang P, Lü YL.	[Spatial distribution and composition of perfluorinated compounds in soils around the Huaihe River]	2013	Huan Jing Ke Xue. 2013 Aug;34(8):3188-94.	In order to analyze the occurrence and composition of perfluorinated compounds (PFCs), 18 topsoil samples were collected around the Huaihe River in October, 2008. Total fluoride (TF) and extractable organic fluorine (EOF) were determined using combustion ion chromatography (CIC), and PFCs were quantified by HPLC/MS-MS. Among the sixteen PFCs analyzed, eleven PFCs were detected. Concentrations of PFCs ranged from n. d. to 1.22 ng x g(-1), and perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorooctane sulfonate (PFOS) were the predominant PFCs. Concentrations of PFCs showed no significant difference, but compositions varied from soil to soil. PFCs mainly came from emissions of local small chemical plants and atmospheric dry and wet deposition. The results from mass balance analysis indicated that PFCs only accounted for 0.3% of EOF and EOF comprised 0.02% of TF. There was still a large amount of organic fluorine besides PFCs, and inorganic fluorine and non-extractable organic fluorine comprised the major portion of TF. Furthermore, the current analysis method could not detect all kinds of PFCs and related unknown organic fluorine.			1					B	-		
D588	ばく露	Rice PA.	C6-Perfluorinated Compounds: The New Greaseproofing Agents in Food Packaging	2015	Curr Environ Health Rep. 2015 Mar;2(1):33-40. doi: 10.1007/s40572-014-0039-3.	Due to their oleophobic and hydrophobic properties and stability, perfluorinated compounds (PFCs) are used in many applications, particularly as greaseproofing agents for food contact. However, PFCs 8-carbons in length or greater (C8-PFCs) have raised concerns regarding environmental biopersistence, bioaccumulation in humans, and potent toxicity that have resulted in their gradual phase-out for food contact use. Industry has replaced C8-PFCs with shorter-chained C6-based greaseproofing agents, which are intended to have the same favorable physicochemical properties without the problematic toxicological effects in humans and wildlife. Compared with the large body of data available for C8 compounds, however, the available database on toxicity and exposure to the C6 compounds is fairly limited. This article summarizes the information in this database, focusing on aspects of human exposure and potential health risks associated with two types of C6 PFCs found in food packaging: perfluorohexanoic acid (PFHxA) and 6-2 fluorotelomer alcohol (C6-FTOH).		1						B	-		
D589	ばく露	He PF, Zhang H, Li J, He L, Luo J, Liu GQ, Shen JC, Yang B, Cui XY.	[Residue Characteristics of Perfluorinated Compounds in the Atmosphere of Shenzhen]	2016	Huan Jing Ke Xue. 2016 Apr 15;37(4):1240-7.	In order to explore the residual characteristics of perfluorinated compounds (PFCs) in the atmosphere of Shenzhen, passive air samplers consisting of polyurethane foam (PUF) disks impregnated with XAD-4 power were deployed at 12 sites in Shenzhen from November 2014 to February 2015. Seven volatile and fifteen ionic PFCs were analyzed. The results indicated that ΣPFCs concentration ranged from 23.7 pg x m(-3) to 157 pg x m(-3) (mean: 79.0 pg x m(-3)), dominated by volatile PFCs, with 8:2 FTOITI, 6:2 FTOH, PFPeA, PFOA being the dominant compounds. The spatial distribution of volatile and ionic PFCs concentrations was the same, displaying the characteristic of "the northwest being higher than the southeast ". Furthermore, the concentrations of 6:2 FTOHs, 8:2 FTOHs, PFPeA, PFHxA and PFOA had positive correlations with PM2.5 and PM10 (P < 0.05, P < 0.01) and were more positively correlated with the levels of PM10 than those of PM2.5.		1						B	-		
D590	ばく露	Wang XX, Zhang H, Wang YP, Luo J.	[Contamination Levels and Exposure Risk via Drinking Water from Perfluoroalkyl Acids in Seven Major Drainage Basins of China]	2018	Huan Jing Ke Xue. 2018 Feb 8;39(2):703-710. doi: 10.13227/j.hjkx.201705100.	To study the perfluoroalkyl acid (PFAAs) contamination in seven major drainage basins of China and the exposure risk to resident populations via drinking water sourced from these basins, a risk assessment model of the US EPA and a scenario-based risk assessment method were applied to analyze the PFAA pollution characteristics and to evaluate the average daily dose and health risk to adults, adolescents, and children. In the intermediate-exposure scenario, results showed that the ΣPFAAs median for the seven major drainage basins was 14 ng·L-1, with perfluorooctanoic acid (PFOA), perfluorobutanoic acid (PFBA), and perfluorooctane sulfonic acid (PFOS) the main contaminants, and that the contamination levels were the highest in the Songliao River and Taihu Lake basins. In the high-exposure scenario, the discharge proportion of perfluoroalkyl carboxylic acids with ≤ 6 carbon chains among the ΣPFAAs was higher than that in the intermediate-exposure scenario. In addition, certain sections tended to be more polluted than others in the Yellow River and Yangtze River basins. Risk assessment showed that PFOA and PFOS exposure via drinking water posed no health risk to Chinese residents, and that the average daily ingestion of drinking water of Chinese adolescents was below the suggested amount.	1							B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D591	ばく露	Fang SH, Zhu HX, Ye ZX, Yin HL, Sun J.	[Pollution Characteristics and Exposure Risk Assessment of Perfluoroalkyl Substances in Road Dust, Chengdu]	2019	Huan Jing Ke Xue. 2019 Dec 8;40(12):5265-5271. doi: 10.13227/j.hjkx.201906186.	To study the pollution characteristics and exposure health risk of perfluoroalkyl substances (PFASs) in road dust, 12 PFASs were analyzed by ultra-performance liquid chromatography tandem mass spectrometry (UPLC-MS/MS) in this study. PFAS concentrations in road dust ranged from 0.95 to 111 ng·g-1, with an average concentration of (25.6±37.2) ng·g-1, suggesting large spatial differences between PFASs in road dust. PFAS concentrations on the main roads were significantly higher than on minor roads, and the minor roads downtown displayed higher concentration levels than suburban minor roads. Perfluorobutanoic acid (PFBA) was the predominant compound in Section 1 of Jie-fang Road, Jin-niu-ba Road and Shui-nian-he Road, while perfluorooctantanoic acid (PFOA, 24.8%) and perfluorooctane sulfonate (PFOS, 24.1%) were the main PFASs on other roads, indicating different sources of PFASs in these areas. The total daily dose of PFASs in road dust for children and adults were 0.168 ng·(kg·d)-1 and 0.028 ng·(kg·d)-1, respectively, suggesting higher exposure risk for children than adults. Therefore, more attention should be paid to children's health risk assessment. Daily doses of PFOA and PFOS in road dust for Chengdu residents were lower than the maximum daily intakes recommended by the European Authority, indicating that there was no immediate health risk to local residents.	1							B	-		
D592	ばく露	Sun LT, Zhao Z, Tang JH.	[Distribution Characteristics of Per-/polyflouralkyl Substances in River Sediments Around Typical Fluorine Industrial Parks]	2020	Huan Jing Ke Xue. 2020 Sep 8;41(9):4069-4075. doi: 10.13227/j.hjkx.202001034.	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are a group of manmade chemicals and are ubiquitously detected in aquatic environments. China is a major producer and consumer of PFASs. In this study, we investigated the occurrence and characteristics of PFASs in the surface sediments from three fluorine industrial parks in North China, the Xihe River in Liaoning Province (Fuxin Section), the Xiaoqing River in Shandong Province (Zibo Section), and the Yangtze River in Jiangsu Province (Changshu Section), using the UPLC/MS-MS method. The total concentration of PFASs (ΣPFASs) in surface sediments of the Xihe River ranged from 15.8 to 2770 ng·g-1, and PFTeDA and HFPO-DA were the dominant pollutants. In the surface sediments of the Xiaoqing River, ΣPFASs ranged from 12.2 to 7853 ng·g-1, and PFOA and HFPO-DA were the dominant pollutants. In the surface sediments of the Yangtze river, ΣPFASs ranged from 9.20 to 35.9 ng·g-1, and PFTeDA and 6∶2 FTS were the main pollutants. Sewage discharge from the industrial parks (point source pollution) was the main source of PFASs in three regions in this study. The PFAS content and composition in three regions varied significantly depending on the production capacity and industry type. There was no significant correlation between the content of PFASs and its components and the particle size and TOC of the sediments. The correlations between the components of PFASs indicated that the enrichment process of PFASs in sediments was impacted by various factors.					1			B	-		
D593	ばく露	Wu QQ, Wu Q, Song S, Ren JG, Yang SJ, Wu YQ.	[Distribution, Sources, and Risk Assessment of Polyfluoroalkyl Substances in Main Rivers and Soils of Tianjin]	2021	Huan Jing Ke Xue. 2021 Aug 8;42(8):3682-3694. doi: 10.13227/j.hjkx.202012044.	Rapid urbanization and industrialization may potentially impact the spatial distribution and transmission of polyfluoroalkyl substances (PFASs). Tianjin, a typical industrialized city with a high urbanization level around Bohai Bay, was selected to evaluate the spatial distribution and ecological risks of PFASs. Water and soil samples were systematically collected and analyzed by using solid-phase extraction and high-performance liquid chromatography-tandem mass spectrometry (HPLC/MS-MS) methods. The results showed that all 12 PFASs were detected in water and soils, and the detection rates of the other congeners were low. The concentrations of ΣPFASs in water ranged from 3.93 to 357.85 ng·L-1, and the levels of ΣPFASs in soils ranged from 4.60 to 63.85 ng·g-1. PFBA was the major component in water and soils, and the contribution of PFBA was 37% and 67% in water and soils, respectively. The spatial difference in ΣPFASs in the water bodies was significant. ΣPFAS concentrations in the surface water were higher in the north (mean value of 63.83 ng·L-1) than in the south (mean value of 51.71 ng·L-1) and higher in the eastern coastal area (mean value of 71.36 ng·L-1) than in the western area (mean value of 36.08 ng·L-1). ΣPFAS concentrations from upstream to downstream of the rivers showed an increasing trend. The highest PFAS concentration was found in the Chaobai River, and the lowest was detected in the South Canal. The spatial distribution of PFASs in soils was higher in the south (mean value of 13.33 ng·g-1) than in the north (mean value of 6.38 ng·g-1) and higher in the eastern coastal region (mean value of 11.45 ng·g-1) than in the western region (mean value of 6.94 ng·g-1). The soil concentrations of ΣPFASs in the Haihe River Basin were the highest. The source analysis results showed that the emulsification of rubber products, food packaging process, paper surface treatment, fire extinguishing agent use, and electrochemical fluorination process in industrial production were the main sources of PFASs in the soils in the study area. PFOS/PFOA, PFOA/PFNA, and PFHpA/PFOA analyses showed that the main source of PFASs in water bodies was the degradation of precursors. ΣPFASs in a few areas originated from the direct emissions from production, but the atmospheric deposition was small. The results of the ecological risk evaluation indicated that the exposure concentrations of PFASs in water and soils in the study area were at a low ecological risk level. However, the long-term ecological effects of PFASs cannot be ignored because of their long-distance transport capability and high food chain (web) accumulation capability.	1		1					B	-		
D594	ばく露	Li BJ, Chen JY, Liu ZZ, Wang J, He SC.	[Pollution Characteristics and Health Risk Assessment of Perfluorinated Compounds in PM(2.5) in Zhejiang Province]	2022	Huan Jing Ke Xue. 2022 Feb 8;43(2):639-648. doi: 10.13227/j.hjkx.202104054.	As typical new pollutants, perfluorinated compounds (PFCs) have been widely concerned by environmental workers in recent years. This study was carried out to investigate the pollution characteristics of perfluorinated compounds in atmospheric particulate matter (PM2.5) in Zhejiang Province. The chemical extraction of PM2.5 was performed using the accelerated solvent extraction (ASE) method with mixed dichloromethane and acetone (2:1). The chemical analysis was implemented by ultra-performance liquid chromatography-tandem mass spectrometry (UPLC-MS/MS). The results showed that the daily average concentration of the sum of 12 PFCs (Σ12 PFCs) ranged from 131.63 pg·m-3 to 578.53 pg·m-3, which was slightly higher in winter compared to that in autumn. The concentrations of perfluorosulfonic acids (PFSAs) were much lower than those of perfluorocarboxylic acids (PFCAs). PFOS was the primary contaminant among PFASs, with an average concentration of 12.90 pg·m-3. The content of PFCAs exhibited a trend of PFOA>PFHxA>PFHpA, and the detection rate of long-chain PFCs was much lower than that of short-chain PFCs. The hysplit-4 model was used to calculate the QZ air mass transport trajectory. The results indicated that the backward trajectory of this point was significantly different along time, and the source of air mass rarely affected the concentration. The forward trajectory confirmed that PFCs can be transmitted over long distances in the atmosphere in a short time. The correlation coefficient between PFUdA and PFTeDA was evaluated to be 0.68, and that between PFHxS and PFOS was 0.66, suggesting the same sources of these chemicals. The content of PFCs was positively correlated with PM2.5, indicating that people might suffer from higher health risks on haze days. The risk quotient estimation implied no health risk of PFCs in PM2.5 in Zhejiang Province.		1						B	-		
D595	ばく露	Wen XJ, Chen ZH, Xu WX, Wu XJ, Hao YQ, Liu W, Yin HL, Fang SH.	[Distribution Characteristics and Source Apportionment of Perfluoroalkyl Substances in Surface Soils of the Northeast Tibetan Plateau]	2022	Huan Jing Ke Xue. 2022 Jun 8;43(6):3253-3261. doi: 10.13227/j.hjkx.202110139.	Surface soil samples collected at 18 sites from the northeast Tibetan Plateau were used to analyze perfluoroalkyl substances (PFASs) via ultra-performance liquid chromatography-tandem mass spectrometry (UPLC-MS/MS) to study the concentration levels and sources of PFASs. The results showed that 11 PFASs were detected in the soil, and the ω(Σ11PFASs) ranged from 0.043-1.573 ng·g-1 with an average concentration of 0.398 ng·g-1. PFBA displayed the highest concentration level with a mean content of 0.164 ng·g-1, whereas PFHxA was at the lowest level (0.005 ng·g-1). The concentrations of the other PFASs were similar to each other (0.011-0.057 ng·g-1). Generally, PFASs contents in the west and north were higher than that in the southeast, and the alpine condensation effect existed for PFBA. The principal component analysis showed that PFASs in surface soils in the northeast Tibetan Plateau region mainly originated from the atmospheric transport of PFASs and their precursors. Few areas were affected by direct emissions of point source pollution, and the main sources were the industrial production of metals/minerals and other human activities.	1	1						B	-		
D596	ばく露	Huang JH, Wu W, Huang TY, Cheng SQ, Xiang S, Pang Y.	[Characteristics, Sources, and Risk Assessment of Perlyfluoroalkyl Substances in Surface Water and Sediment of Luoma Lake]	2022	Huan Jing Ke Xue. 2022 Jul 8;43(7):3562-3574. doi: 10.13227/j.hjkx.202108335.	hrough the investigation and detection of the surface water and sediments of Luoma Lake, the structure and occurrence characteristics of PFASs (perlyfluoroalkyl substances) in the two types of media were analyzed, and the principal component analysis method was used to analyze the characteristics of such substances in the surface water. The source was analyzed, and the potential health risks of such substances were evaluated using the risk quotient method. The results showed that a total of 13 PFASs were detected in the surface sediments of Luoma Lake, and one more species was detected in the surface water (PFTeA); ρ(ΣPFASs) in the surface water ranged from 46.09 to 120.34 ng·L-1, and ω(ΣPFASs) in sediments ranged from 2.22 to 9.55 ng·g-1. PFPeA was the major component in surface water, and the mass fraction of PFPeA was 38%. PFBA was the major component in sediment, and the mass fraction of PFPeA was 61%. The multi-media PFASs in Luoma Lake were mainly short-chain substances; the high concentration area of PFASs in the surface water of Luoma Lake was concentrated and distributed at the mouth of the northern rivers. Its concentration showed a decreasing trend from north to south, and the content of PFASs in the sediments showed a decreasing trend from southwest to northeast. The distribution of ΣPFASs, PFBA, and PFOS in the sediments of Luoma Lake and the TOC content in the sediment were related; the principal component analysis showed that the PFASs in the surface water of Luoma Lake were mainly from textile flame retardant, rubber product emulsification, food packaging processes and paper surface treatment industries, the metal electroplating industry, and leather and textile manufacturing industries. PFASs in the surface water of Luoma Lake were at a relatively low health risk level.	1							B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D597	ばく露	Li PF, Wang Y, Yang C, Shi YL, Cui JS.	[Pollution Characteristics and Health Risk Assessment of Per- and Polyfluoroalkyl Substances and Emerging Alternatives in Road Dust, Shijiazhuang]	2023	Huan Jing Ke Xue. 2023 Mar 8;44(3):1593-1601. doi: 10.13227/j.hjkx.202205030.	Per- and polyfluoroalkyl substances (PFASs, n=22), including emerging alternatives, in dust samples were analyzed using high-performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS) to study their pollution characteristics. These samples were collected from main and minor roads in Shijiazhuang. Some of the roads were located near sewage treatment plants and fire stations. The results showed that PFASs were ubiquitous in the road dust of Shijiazhuang; in particular, hexafluoropropylene oxide dimer acid (HFPO-DA), an alternative, was measured for the first time in China. The total concentrations of PFASs ranged from 2.62 to 137.65 ng·g-1. Perfluorooctanoic acid (PFOA) was the dominant PFAS, followed by perfluorobutanoic acid (PFBA), HFPO-DA, and perfluorooctane sulfonic acid (PFOS). The highest and lowest levels of PFASs were observed in the northwest and southeast regions of Shijiazhuang, respectively. The compositions of PFASs were obviously different in road dust near sewage treatment plants and fire stations, especially for the types of emerging alternatives. Health risk assessment indicated that road dust intake had a low risk of human exposure to PFASs and emerging alternatives. Among the three routes (ingestion intake, inhalation intake, and dermal contact), ingestion intake was the main route for PFASs and emerging alternatives in road dust to enter the human body. Under the same exposure route, the exposure dose of children was higher than that of adults.	1				1			B	-		
D598	ばく露	Sapozhnikova Y, Taylor RB, Bedi M, Ng C.	Assessing per- and polyfluoroalkyl substances in globally sourced food packaging	2023	Chemosphere. 2023 Oct;337:139381. doi: 10.1016/j.chemosphere.2023.139381. Epub 2023 Jun 29.	The purpose of this study was to investigate the presence and levels of per- and polyfluoroalkyl substances (PFAS) in food packaging originating from different geographic locations. Food packaging samples were extracted and analyzed by targeted analysis with liquid chromatography-mass spectrometry (LC-MS/MS) before and after a total oxidizable precursor (TOP) assay. Additionally, full-scan high resolution MS (HRMS) was used to screen for PFAS not included in the targeted list. Of the 88 food packaging samples, 84% had detectable levels of at least one PFAS prior to oxidation with a TOP assay, with 6:2 fluorotelomer phosphate diester (6:2 diPAP) found most frequently and at the highest levels (224 ng/g). Other frequently detected substances (in 15-17% of samples) were PFHxS, PFHpA and PFDA. Shorter chain perfluorinated carboxylic acids PFHpA (C7), PFPeA (C5) and PFHxS (C6) were present at levels up to 51.3, 24.1 and 18.2 ng/g, respectively. Average ΣPFAS levels were 28.3 ng/g and 381.9 ng/g before and after oxidation with the TOP assay. The 25 samples with highest frequency of detection and amounts of measured PFAS were selected for migration experiments with food simulants to better understand potential dietary exposure. PFHxS, PFHpA, PFHxA and 6:2 diPAP were measured in the food simulants of five samples at concentrations ranging from 0.04 to 12.2 ng/g and at increasing concentrations over the 10-day migration period. To estimate potential exposure to PFAS that had migrated from food packaging samples, weekly intake was calculated and ranged from 0.0006 ng/kg body weight/week for PFHxA exposure in tomato packaging to 1.1200 ng/kg body weight/week for PFHxS exposure in cake paper. These values were below the established EFSA maximum tolerable weekly intake (TWI) of 4.4 ng/kg body weight/week for the sum of PFOA, PFNA, PFHxS and PFOS.		1	1					B	-		
D599	ばく露	Xingchun J, Wei Z, Jing P, Guohui L, Dian C, Zhaohe Z, Yiran Z.	The occurrence, spatial distribution, and well-depth dependence of PFASs in groundwater from a reclaimed water irrigation area	2023	Sci Total Environ. 2023 Jul 30;901:165904. doi: 10.1016/j.scitotenv.2023.165904. Online ahead of print.	With the growing development of modern agriculture and industry, groundwater is facing more and more complex contaminants. One such contaminant is per- and polyfluoroalkyl substances (PFASs), which pose a potential risk to human health, particularly for those who rely on groundwater as their primary source of drinking water. In this study, we conducted a comprehensive investigation on the occurrence, spatial distribution, and source apportionment of PFASs in shallow (<60 m) and deep (>80 m) groundwater samples from a reclaimed water irrigation area in Beijing's suburbs. Our results showed that the average total PFAS concentration (Σ10PFAS) for all samples was 10.55 ± 7.77 ng/L, ranging from 1.05 to 34.28 ng/L. The dominant congeners were PFBA, PFOA, and PFBS. No significant linear relationship was observed between PFAS concentrations and the well depth. However, the averaged ΣPFASs in groundwater were highest in the uppermost layer and declined sharply to a few ng/L in the deep aquifer below 80 m. PFASs showed elevated concentration in shallow aquifers in 9 out of 11 paired wells, indicating an overall descending trend of PFASs with increasing aquifer depth. The spatial distribution of PFASs was highly heterogeneous and showed different patterns in shallow and deep groundwater, which may be related to the complicated attenuation behavior of PFAS compounds when they transport and diffuse through overlapping aquifer layers. The influence of the landfill on groundwater PFASs was most pronounced within a 5 km radius. Source apportionment results indicated that reclaimed water irrigation is the main non-point source of PFASs in shallow groundwater. In contrast, deep groundwater is primarily subject to point sources and lateral recharge flow. This investigation of PFASs in shallow and deep wells provides a foundation for further exploration of PFASs transportation and risk prevention in regions where groundwater is a major water resource for domestic and industrial development.	1			1				B	-		
D600	ばく露	Dueñas-Mas MJ, Ballesteros-Gómez A, de Boer J.	Determination of several PFAS groups in food packaging material from fast-food restaurants in France	2023	Chemosphere. 2023 Oct;339:139734. doi: 10.1016/j.chemosphere.2023.139734. Epub 2023 Aug 4.	Per- and polyfluoroalkylated substances (PFAS) are a large group of toxic compounds which have been widely used in industrial and consumer applications, from where they can migrate into the environment. They can pose a risk to human health because they have been associated with several diseases. To obtain more information on the risk of PFAS in fast food packaging materials, several PFAS (perfluorocarboxylic acids or PFCAs (n = 16), perfluorosulfonic acids or PFSAs (n = 14), and a miscellaneous group constituted by sulfonamides (n = 5) and fluorotelomer phosphate esters or PAPs (n = 5)) were quantified in food contact materials (FCMs) from fast-food restaurants in France. Perfluorohexanoic acid (PFHxA), 6:2 fluorotelomer sulfonic acid (6:2 FTS) and 6:2/6:2 fluorotelomer phosphate diester (6:2/6:2 diPAP) were detected in all samples. PFCAs with shorter chain lengths (C4-C6) showed the highest concentrations compared to median (C7-C10) and longer chain length PFCAs (C11-C18). However, they had lower detection frequencies (DFs) (except for PFHxA, DF = 100%) with values of 36 and 34% for C4 and C5 PFCAs, respectively. The DF of longer chain length PFCAs was higher, especially those of the median chain length PFCAs (C8-C10, with DF = 79-98%). Analytes from the PFSA group with high DFs (70-98%) were perfluorobutane sulfonic acid (PFBS), perfluorohexane sulfonic acid (PFHxS), perfluorooctane sulfonic acid (PFOS, linear and branched) and 10:2 fluorotelomer sulfonic acid (10:2 FTS), with concentrations similar to some analytes from the PFCA group. 4:2 Fluorotelomer phosphate monoester (4:2 mPAP), 8:2 fluorotelomer phosphate monoester (8:2 mPAP) and 8:2/8:2 fluorotelomer phosphate diester (8:2/8:2 diPAP) were found with the highest concentrations (<0.006-42.7 ng g-1, <0.001-2.7 ng g-1 and <0.001-287 ng g-1, respectively) and the highest DFs (ranged 68-94%). Some correlations between analytes were found, indicating similar degradation routes or a common origin.		1		1				B	-		
D601	ばく露	Selak A, Reberski JL, Klobučar G.	Assessing the persistence, mobility and toxicity of emerging organic contaminants in Croatian karst springs used for drinking water supply	2023	Sci Total Environ. 2023 Aug 11;903:166240. doi: 10.1016/j.scitotenv.2023.166240. Online ahead of print.	Emerging organic contaminants (EOCs) are a vast group of often (very)persistent, (very)mobile and toxic (PMT/vPvM) substances that are continuously released worldwide, posing environmental and human health risks. Research on occurrence and behavior of EOCs in karst is in its infancy, thus policy measures and legislative control of these compounds in groundwater are still lacking. The Dinaric karst aquifers are an essential source of drinking water for almost half of Croatia's territory. Intense karstification, complex heterogeneous characteristics, and high fracture-cavernous porosity result in rapid, far-reaching groundwater flow and large karst springs, but also high intrinsic vulnerability due to low contaminant attenuation. To prioritize future monitoring and establish appropriate thresholds for EOCs detected in Croatian karst drinking water resources, in silico tools based on quantitative structure-activity relationships were used in PBT (persistence, bioaccumulation, and toxicity) and PMT/vPvM analyzes, while toxicological assessment helped identify potential threats to human health. In 33 samples collected during two sampling campaigns in 2019 at 16 karst springs and one lake used for water supply, we detected 65 compounds (EOCs and some legacy chemicals), of which 7 were classified as potentially PBT or vPvB compounds (PFOS, PFHxS, PFHpA, PFOA, PFNA, boscalid, and azoxystrobin), while only 2 compounds were assessed as not PMT/vPvM. This finding underlines that most of detected EOCs potentially endanger karst (ground)water ecosystems and important drinking water sources in Croatia. Comparison of maximum concentrations with existing or derived drinking water guideline values revealed how 2 of 65 detected compounds represent a potential risk to human health at lifelong exposure (sulfadiazine and hydrochlorothiazide), while 5 chemicals warrant additional human health impacts studies and groundwater monitoring. Although most compounds do not individually pose a significant risk to human health at current environmental levels, their potential synergistic and long-term effects remain unknown.			1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D602	ばく露	Chen X, Li J, Han L, Wu W, Chen M.	Human health risk-based soil generic assessment criteria of representative perfluoroalkyl acids (PFAAs) under the agricultural land use in typical Chinese regions	2023	Environ Pollut. 2023 Aug 14;335:122368. doi: 10.1016/j.envpol.2023.122368. Online ahead of print.	Perfluoroalkyl acid substances (PFAAs), such as perfluorobutanoic acid (PFBA), perfluorobutanoic sulfonic acid (PFBS), perfluorooctane acid (PFOA) and perfluorooctane sulfonic acid (PFOS) are frequently detected in the global environment and can cause potential health hazards even at low levels. In this study, quantitative human health risk assessment was undertaken to derive soil generic assessment criteria (GAC) for four PFAAs under the agricultural land scenario in the evaluated Chinese regions, which considered multiple exposure pathways including vegetables consumption, dermal absorption, ingestion of soil and dust, and exposure from non-soil sources. It is showed that the calculated GAC for four PFAAs in Guangdong and Shandong Provinces were less stringent than those in Zhejiang and Jiangsu Provinces, and Shanghai City, owing to the low exposure from non-soil sources in former two provinces. In addition, GAC of PFOS were the most stringent in the range of 0.28-0.50 μg kg-1 in the studied regions, followed by PFOA (1.36-2.20 μg kg-1), PFBA (42.59-68.03 μg kg-1) and PFBS (474.59-749.60 μg kg-1), mainly attributable to significantly more stringent toxicological values of PFOA and PFOS. Correspondingly, the potential health hazards exist for PFOA in the studied regions except Guangdong Province, and PFOS only in Zhejiang and Jiangsu Provinces as indicated by the hazard quotients ranging from 1.04 to 19.49, but no health hazards are identified for PFBA and PFBS. The dominant exposure pathway was found to be consumption of vegetables and attached soil for PFBA and PFBS, contributing to more than 93% of the total exposure, compared to 49.91-76.69% for PFOA and PFOS due to significant exposure from non-soil sources levels. Overall, this study provides a technical reference on how to derive scientifically justifiable soil GAC for representative PFAAs for maintaining and assessing soil quality and food safety internationally under the agricultural land use.	1			1				B	-		
D603	ばく露	D'Ambro EL, Murphy BN, Bash JO, Gilliam RC, Pye HOT.	Predictions of PFAS regional-scale atmospheric deposition and ambient air exposure	2023	Sci Total Environ. 2023 Aug 15:166256. doi: 10.1016/j.scitotenv.2023.166256. Online ahead of print.	Per- and polyfluoroalkyl substances (PFAS) are a large class of human-made compounds that have contaminated the global environment. One environmental entry point for PFAS is via atmospheric emission. Air releases can impact human health through multiple routes, including direct inhalation and contamination of drinking water following air deposition. In this work, we convert the reference dose (RfD) underlying the United States Environmental Protection Agency's GenX drinking water Health Advisory to an inhalation screening level and compare to predicted PFAS and GenX air concentrations from a fluorochemical manufacturing facility in Eastern North Carolina. We find that the area around the facility experiences ~15 days per year of GenX concentrations above the inhalation screening level we derive. We investigate the sensitivity of model predictions to assumptions regarding model spatial resolution, emissions temporal profiles, and knowledge of air emission chemical composition. Decreasing the chemical specificity of PFAS emissions has the largest impact on deposition predictions with domain-wide total deposition varying by as much as 250 % for total PFAS. However, predicted domain-wide mean and median air concentrations varied by <18 % over all scenarios tested for total PFAS. Other model features like emission temporal variability and model spatial resolution had weaker impacts on predicted PFAS deposition.					1			B	-		
D604	ばく露	Guo D, Zhou Y, Chen F, Wang Z, Li H, Wang N, Gan H, Fang S, Bao R.	Temporal variation of per- and polyfluoroalkyl substances (PFASs) abundances in Shenzhen Bay sediments over past 65 years	2023	Mar Pollut Bull. 2023 Aug 16;194(Pt B):115387. doi: 10.1016/j.marpolbul.2023.115387. Online ahead of print.	We examined the vertical distribution of per- and polyfluoroalkyl substances (PFASs) and total organic carbon in sediment cores located in Shenzhen Bay area. We investigated the 210Pbex specific activity of the sediments and calculated the flux of PFASs to understand the temporal variation of PFASs in the past 65 years. The results showed that the concentrations of PFASs generally decreased with depth, ranging from 13 to 251 pg/g dw. The highest PFASs detected were perfluorobutanesulfonic acid, perfluorooctanoic acid, and perfluorohexanoic acid, which correspond to raw materials used in fire-fighting foam and food packaging industries. The flux of PFASs in Shenzhen Bay showed varying growth after 1978 when China's GDP entered a rapid growth stage. Our findings suggest that the vertical distribution of PFASs in Shenzhen Bay is fluctuating with the changes in industrial types and economic development, with implications for studying the fate of other persistent pollutants in the oceans.		1		1				B	-		
D605	ばく露	田原 るり子, 山口 高志	北海道内の冬季中の有機フッ素化合物の沈着量調査	2014	環境化学, 2014年 24 巻 1 号 11-17. doi: 10.5985/jec.24.11	A survey of perfluorinated chemicals (PFCs) deposition during winter was performed at rural areas and hinterlands in Hokkaido (9 points). The depositions were calculated from the concentrations of PFCs in snow covers. The PFCs concentrations were 2.3 ~ 12 ng/kg. PFBA was the dominant compound, and PFOA and PFNA were also detected. The deposition amounts and amount rates of PFCs were 0.38 ~ 8.6 μg/m2 and 5.7 ~ 95 ng/m2/day, respectively. They were high in the area along the Sea of Japan. The concentrations of some of PFCs among detected PFCs were higher than those in the snowfall at metropolitan area. The result shows not only wet deposition but dry deposition and/or chemical reaction of precursors also contributed to the deposition during the winter.	1		1					B	-		
D606	ばく露	津田 泰三, 瀧野　昭彦, 居川　俊弘, 河原　　晶, 北川　典孝, 佐貫 典子, 卯田　　隆	琵琶湖とその周辺河川水質および琵琶湖底質における有機フッ素化合物	2015	環境化学, 2015年 25 巻 3 号 139-148. doi:10.5985/jec.25.139	The sum of 9 PFCs concentrations in water of Lake Biwa was 10.6 〜13.5 ng/L and little differences among 4 sites of northern basin of Lake Biwa (12B, 17A, 17B, 17C') in August 2011. The order of average PFCs composition in 7 sites of all over the Lake Biwa was PFOA ＞PFNA ＞PFHpA ≧PFHxA ＞PFOS ＞PFDA ＞PFHxS ＞PFUnDA ≧PFBS, little differences among the sites. The concentration range (average) in water of 12 rivers around Lake Biwa was 0.48 〜59.2(26.4) ng/L and large differences among the 12 rivers. The order of average PFCs composition in water of the 12 rivers was PFOA ＞PFNA ＞PFOS ＞PFHxA ≧PFHpA ＞PFDA ＞PFBS ＞PFHxS ＞PFUnDA, slightly different from that in Lake Biwa. Seasonal changes of PFCs concentrations and compositions in water of 3 sites of Lake Biwa (6B, 12B, 17B) were little in May, August, November 2012 and February 2013. The sum of 15 PFCs concentration range (average) in sediment of Lake Biwa was ND 〜4.42 (1.51) ng/g dry wt. in May 〜December 2013. The PFCs concentration was high in clay-like sediment of deep central area of northern basin of Lake Biwa. There were no differences between southern and northern basins of Lake Biwa in the PFCs composition of the water and the order of PFCs composition was PFOA ＞PFHxA ≧PFBA ≧PFNA ≧PFHpA ＞PFPeA ＞PFOS. However, there were differences for the PFCs composition of the sediment and the order was PFDoDA ＞PFTrDA ＞PFOS ＞PFDA in the southern basin and PFUnDA ＞PFTrDA ＞PFDoDA ＞PFOS in the northern basin. The ratio of short-middle chain carbon (C4 〜C9) PFCs was high and long chain carbon (C12 〜C14) PFCs were not detected in the water of Lake Biwa. However, the ratio of middle-long chain carbon (C10 〜C13) PFCS and PFOS was high and short-middle chain carbon (C4 〜C7) PFCs were not detected in the sediment of Lake Biwa.	1	1	1	1				B	-		
D607	ばく露	仲田 雅俊, 鈴木 裕識, 田中 周平, 雪岡 聖, 北尾 亮太, 藤井 滋穂	琵琶湖・淀川流域における環境水中の全有機フッ素および構成ペルフルオロ化合類の存在実態	2017	土木学会論文集G（環境）, 2017年 73 巻 7 号 III_9-III_16. doi:10.2208/jscejer.73.III_9	環境水中での有機フッ素化合物類の存在実態の把握を主目的とし，2016年8~10月に琵琶湖・淀川流域の68地点の環境水を対象に，15種 PFCs，15種 PFCs 生成ポテンシャル（PFC-FPs），全有機フッ素（TOF）を分析した．その結果，1）TOF濃度が67地点で検出下限（32 ng-F/L）以上で検出され，琵琶湖・淀川流域の濃度分布データが得られた．2）15種 PFCs濃度がTOF濃度に占める比率は下水処理水，河川水，湖水による顕著な差はなく全試料の平均値で22%であった．3）琵琶湖・淀川流域のTOF濃度は下水処理水，河川水，湖水の順に高く（各平均値748, 458, 175 ng-F/L），安威川流域のN下水処理場で115,000 ng-F/Lであったことから，特定汚染源からの負荷が示された．4）N下水処理場下流のTOFとPFC-FPs負荷量は，水量が47倍の淀川下流に対し各々2.2倍（30,700 g/日），3.2倍（8,800 g/日）となり，未知のPFCs関連物質の負荷が示唆された．								B	-		
D608	ばく露	Pattarawan CHULARUEANGAKSORN, Shuhei TANAKA, Chinagarn KUNACHEVA, Shigeo FUJII, Hidenori HARADA, Suwanna Kitpati BOONTANON	タイ・バンコク 7箇所の都市下水処理場における有機フッ素化合物類(PFCs)の汚染実態	2012	土木学会論文集G（環境）, 2012年 68 巻 7 号 III_341-III_349. doi: 10.2208/jscejer.68.III_341	有機フッ素化合物類(PFCs)は難分解性，毒性，生物濃縮性を持つ人工化学物質であり，都市下水処理場は水環境に対するPFCs負荷源として懸念される．本研究は，タイ・バンコクでの都市下水処理場において11種のPFCsの汚染実態を検討するものであり，7箇所の都市下水処理場において，主要な下水処理工程ごとに試料を採取した．なお，すべての下水処理場で標準活性汚泥法を用いていた．調査の結果，Chong Nonsi下水処理場放流水で総濃度63.6 ng/Lの最大値を検出した．放流水中，ペルフルオロオクタンスルホン酸(PFOS)とペルフルオロオクタンカルボン酸(PFOA)は他のPFCsに比べて高濃度で検出され，それぞれ2.7-5.6 ng/L，2.2-7.4 ng/Lであった．放流水中PFCs濃度は流入水中濃度より高く，標準活性汚泥法による下水処理ではPFCsを除去できていないことが示唆された．長い炭素鎖のPFCsは短い炭素鎖のPFCsに比べて，懸濁態の比率が高かった．他の国と比較すると，処理場流出水におけるPFOS，PFOA濃度はデンマーク，台湾，シンガポールより低かったが，数種類のPFCsが検出され，都市下水処理場が環境中におけるPFCs負荷源のひとつであることが示唆された．								B	-		
D609	ばく露	西野 貴裕, 上野 孝司, 高橋 明宏, 高澤 嘉一, 柴田 康行, 仲摩 翔太, 北野 大	多摩川水系における有機フッ素化合物の汚染実態の変化とその収支	2013	環境化学, 2013年 23 巻 4 号 177-186. doi: 10.5985/jec.23.177	13 kind of Perfluorinated compounds (PFCs) in the mainstream of Tamagawa River and its inflows (tributaries, and effluents from Sewage Treatment Plants) were analyzed, and the loads of PFOS, PFOA and other 4 compounds were evaluated. The concentrations of PFOS and PFOA were found to be much lower than those of 2005 since 2009. This result indicates that the Stockholm Convention on Persisitent Organic Pollutants (POPs) and 2010/2015 PFOA Stewardship Program are effective. The cumulative load of PFCs that was accumulated in the inflows sequentially from Nagata Bridge, as the uppermost point in this study, closely resembled the measured load at each sampling point in Tamagawa River. These results indicate that PFCs were scarcely degraded, volatilized, during flow down the river. The ratio of PFCs with longer chain length such as PFUnDA and PFTrDA in sediment samples were much higher than those of water ones.								B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D610	ばく露	Satoshi Asaoka, Ryosuke Yoshiki, Yuki Haga, Chisato Matsumura, Akira Umehara, Kazuhiko Takeda	Spatial Distribution of Perfluorinated Organic Compounds in Surface Marine Sediments from the Seto Inland Sea, Japan	2020	Journal of Water and Environment Technology, 2020 Volume 18 Issue 4 Pages 226-237. doi: 10.2965/jwet.19-146	Perfluoroalkyl substances (PFASs) such as perfluorocarboxylic acid (PFCAs) and perfluoroalkane sulfonates (PFSAs) are persistent, bioaccumulative, and toxic substances that are distributed worldwide. Here we investigated the current concentrations of PFASs in the surface sediments from the Seto Inland Sea, Japan. The concentrations of PFCAs in surface sediments from the Sea ranged from 0.05 to 0.67 ng g−1. Perfluoroundecanoic acid (PFUnDA) was detected at all 15 sampling stations; its concentration was 0.05–0.24 ng g−1. Perfluorohexanoic acid (PFHxA), which is used as an alternative to perfluorooctanoic acid (PFOA), was detected in Osaka Bay and Kii Channel. The contamination of PFCAs in the sediment from Osaka Bay and Kii Channel is shifting to PFHxA. In contrast, only perfluorooctanesulfonic acid (PFOS) was detected at the center part of the bays in the Sea. The significant positive correlation between the PFCAs concentrations in the sediment and the sedimentation rates was observed in the Sea. Hence, the concentration of PFCAs in surface sediments from the Sea was controlled by the sedimentation rate.		1						B	-		
D611	ばく露	金井 祐貴(千葉市環境保健研究所下水道営業課), 五木田 正, 平山 雄一, 宮本 廣	千葉市の水域におけるPFCs調査(第6報)	2014	千葉市環境保健研究所年報(1347-5053)21号 Page59-61(2014.12)	千葉市内の主要河川5地点でPFCs(有機フッ素化合物)17物質の調査を行い、以下の結果を得た。1)PFOS、PFOAのほかにPFBA、PFPeA、PFHxA、PFHpA、PFNA、PFDA、PFUdA、PFBS、PFHxSが検出された。2)5年前から継続的に測定しているPFOSは5地点とも減少傾向にあった。3)5年前から測定しているPFOAは概ね横ばい傾向にあり、PFOSと比べると高濃度であった。4)5地点のうち花見川の八千代芦太地点では前年度にPFNAが高濃度で検出されたが、今年度は急減し、他地点とほぼ同じ濃度となっていた。5)葭川の動物公園地点ではPFHxSが前年度に引き続き高濃度で検出された。								B	-		
D612	ばく露	鈴木 瑞穂(千葉市環境保健研究所環境科学課), 設楽 夕莉菜, 坂元 宏成	千葉市の水域における有機フッ素化合物調査(第10報)	2018	千葉市環境保健研究所年報(1347-5053)25号 Page48-50(2018.12)	12種の有機フッ素化合物について、千葉市内の水域5地点で夏季(2017年8月14日)と冬季(2018年3月5日)に実態調査を行った。対象物質は、Wellington Laboratories社製混合標準溶液PFAC-MXBに含まれるペルフルオロオクタン酸(PFOA)を含むペルフルオロカルボン酸類13物質、ペルフルオロオクタンスルホン酸(PFOS)を含むペルフルオロアルキルスルホン酸類4物質の計17物質のうち、一定程度感度が得られた12物質とした。鹿島川では、例年と同様、他の調査地点と比較してすべての物質について低濃度の傾向があり、濃度はおおむね横ばいであった。葭川では動物公園で、例年PFPeAおよびPFHxAが他の調査地点と比較して高濃度の傾向にあるが、今回も夏季調査でそれぞれ14ng/Lおよび11ng/Lと高い値であった。PFOSおよびPFOAについては、2008年度から継続して調査を行っているが、PFOSよりもPFOAのほうが高濃度の傾向にあった。	1	1	1	1			B	-		
D613	ばく露	鈴木 瑞穂(千葉市環境保健研究所環境科学課), 設楽 夕莉菜, 坂元 宏成, 五木田 正, 塚原 滋	千葉市の水域における有機フッ素化合物調査(第9報)	2017	千葉市環境保健研究所年報(1347-5053)24号 Page53-56(2017.12)	千葉市の主要河川である鹿島川から下泉、葭川から源町407番地地先(動物公園)と六方、花見川から汐留と八千代芦太の5地点を測定地点として選択した。ペルフルオロオクタンスルホン酸(PFOS)は平成26年から一部の地点でやや増加傾向が見られ、0.4～27ng/Lであった。ペルフルオロオクタン酸(PFOA)は横ばい傾向で3.9～50ng/Lであった。関東地方の河川14ヶ所の幾何平均値と比べて、PFOSに関しては下泉、動物公園、汐留の3地点で、PFOAに関しては全地点でこの値を超過していた。また、PFOS及びPFOAの合計濃度は8.2～53ng/Lで、全ての地点においてEPAの飲料水の健康勧告値70ng/Lを下回っていた。その他の有機フッ素化合物(PFCs)は、動物公園でペルフルオロヘキサンスルホン酸(PFHxS)及びペルフルオロヘキサン酸(PEHxA)、八千代芦太でPFNAが、それぞれ10ng/L以上の濃度で検出された。			1				B	-		
D614	ばく露	荒堀 康史(奈良県保健環境研究センター), 浅野 勝佳, 兎本 文昭	奈良県内河川の有機フッ素化合物濃度実態調査(第一報)	2012	奈良県保健環境研究センター年報(1348-3153)46号 Page46-50(2012.12)	2011年6月～2012年1月に、大和川水系10地点、飛鳥川7地点、紀の川水系5地点、新宮川水系3地点において有機フッ素化合物17種の濃度調査を行った。結果、大和川水系では全地点でPFOAが検出され、その濃度は7～140ng/Lであった。飛鳥川ではPFOAとPFHxAの濃度が急激に上昇する地点があり、これは、規制対象となりつつあるPFOAから代替物質であるPFHxAへの切り替えが進んでいることを示唆すると考えられた。紀の川水系ではPFOAやPFHxAが1～7ng/Lの濃度で検出され、新宮川水系では全く検出されなかった。		1					B	-		
D615	蓄積性	Zhang, W; Tran, N; Liang, Y	Uptake of per- and polyfluoroalkyl substances (PFAS) by soybean across two generations	2022	J. Hazard. Mater. Adv. 2022 Nov:8:100170. doi: 10.1016/j.hazadv.2022.100170.	The uptake of per- and polyfluoroalkyl substances (PFAS) by agricultural plants from contaminated soil poses a threat to human health and the ecosystem. The presence of PFAS in plant seeds could also affect their response to PFAS in the environment. In this study, the impact of PFAS exposure on soybean uptake of these compounds across generations was investigated. The results showed that the exposure of the first-generation soybean to a PFAS mixture led to accumulation of perfluorobutanoic acid (PFBA, 12.20 +/- 11.44 mu g/kg), perfluorohexanoic acid (PFHxA, 55.66 +/- 42.06 mu g/kg), and perfluorobutanesulfonic acid (PFBS, 3.24 +/- 2.06 mu g/kg) in the seeds. The progeny soybean plants grown from the first-generation seeds had a higher capability of taking up and accumulating perfluorocarboxylic acids (PFCAs), including PFBA, PFHxA, perfluoroheptanoic acid (PFHpA), and perfluorooctanoic acid (PFOA), when exposed to the same PFAS again. In contrast, the accumulation of perfluorosulfonic acids (PFSAs), including PFBS, perfluorohexane sulfonate (PFHxS), and perfluorooctanesulfonic acid (PFOS), in the second-generation soybean decreased compared to that in the first-generation. As an alternative to PFOA, GenX had a higher plant uptake compared to PFOA in the first-generation soybean, but its uptake by the second generation decreased significantly. Based on findings from this study and considering the widespread nature of PFAS, soybean seeds may need to be quantified regarding PFAS concentrations before their use in agricultural fields. The different uptake of different PFAS, especially increased accumulation of PFCAs by soybean derived from PFAS contaminated seeds, could be further explored for the benefit of phytoremediation.	1	1		1	1		B	-		
D616	蓄積性	Bao, J; Li, CL; Liu, Y; Wang, X; Yu, WJ; Liu, ZQ; Shao, LX; Jin, YH	Bioaccumulation of perfluoroalkyl substances in greenhouse vegetables with long-term groundwater irrigation near fluorochemical plants in Fuxin, China	2020	Environ. Res. 2020 Sep:188:109751. doi: 10.1016/j.envres.2020.109751.	The levels of perfluoroalkyl substances (PFASs) have been growing progressively in the groundwater beneath a fluorochemical industrial park (FIP) in Fuxin of China recently, however, lithe information is available about whether long-term irrigation with local groundwater could have a potential effect on the bioaccumulation of PFASs in greenhouse vegetables near the FIP. In the present study, groundwater, soil, and vegetable samples were collected from Fuxin with five sampling campaigns during a period of 40 days, and ten target analyzes of PFASs in all the samples were analyzed via high-performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS). As the dominant PFAS contaminants, perfluorooctanoic acid (PFOA) and perfluorobutane sulfonate (PFBS) in groundwater samples were determined with the maximum levels of 2.47 and 32.4 mu g L-1, respectively. Furthermore, perfluorobutanoic acid (PFBA), PFOA, and PFBS were the major PFASs in greenhouse samples of soil (up to 6.1, 6.8, and 46 ng g dry weight (dw)(-1)), tomato (up to 87, 1.7, and 13 ng g dw(-1)), and cucumber (up to 63, 2.6, and 15 ng g dw(-1)), which were significantly correlated with those in groundwater samples, indicating PFAS contaminations could be introduced into soil and vegetables in the greenhouse through long-term groundwater irrigation. In addition, all the levels of three main PFAS analyzes in soil and vegetables presented an overall increasing trend over the period of vegetable growth. The bioaccumulation efficiencies for PFAS contaminants from soil to vegetables were negatively associated with the carbon chain length in PFASs. According to the reference dose (RID) for PFBA, PFOA, and PFBS from the Minnesota Department of Health (MDH), daily intakes of those three analyzes by rural residents in Fuxin were lower than the respective RfD via consumption of greenhouse tomatoes and cucumbers so far. However, long-term surveillance would be focused on greenhouse vegetables near the Fuxin FIP to prevent potential health risks of local residents from increasing PFAS contaminations.	1			1			B	-		
D617	蓄積性	Wang, WT; Lee, J; Oh, JK; Lee, SJ; Choi, SD; Oh, JE	Per- and polyfluoroalkyl substances and their alternatives in black-tailed gull (Larus crassirostris) eggs from South Korea islands during 2012-2018	2021	J. Hazard. Mater. 2021 Jun:411:125036. doi: 10.1016/j.jhazmat.2020.125036.	The temporal and spatial trends of sixteen per- and polyfluoroalkyl substances (PFAS) and their three alternatives, chlorinated polyfluoroalkyl ether sulfonic acid (F-53B), hexafluoropropylene oxide dimer acid (GenX), and dodecafluoro-3H-4,8-dioxanonanoate (ADONA) in whole eggs of black-tailed gulls from two South Korean islands, Baengnyeongdo (BLD) and Hongdo (HD), were investigated during 2012?2018. A total of 16 analyzed compounds were detected at concentrations of 21.3?47.8 ng/g ww in BLD and 11.2?40.0 ng/g ww in HD. Meanwhile, the mean levels of perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) were detected at 6.92 ? 4.72 ng/g ww and 0.674 ? 0.993 ng/g ww, respectively. In particular, F-53B, a major alternative to PFOS was detected in each year of the study period with a level of up to 6.66 ng/g ww in all egg samples. Significant increasing temporal trends were observed for PFOS, perfluorononanoic acid (PFNA) and one alternative (F-53B) during the investigated period suggesting continuous use or accumulation of these in the Korean environment. Moreover, distinctive spatial distribution patterns such as a significantly higher F-53B level in HD and an increased PFAS (< C11) in BLD were also observed.			1		1		B	-		
D618	環境中運命	Thepaksorn, P; Lee, P; Shiwaku, Y; Zheng, B; Koizumi, A; Harada, KH	Formation and Degradability of Per- and Polyfluoroalkyl Substances in River Soils around a Fluoropolymer-Manufacturing Plant in Osaka, Japan	2023	Arch. Environ. Contam. Toxicol. 2023 May:84(4):427-435. doi: 10.1007/s00244-023-00998-z.	Our previous studies reported that perfluorooctanoic acid (PFOA) contamination decreased in well, tap, and surface water around a fluoropolymer plant in Osaka, Japan, between 2003 and 2016. In this study, we evaluated the degradability of PFOA and perfluorohexanoic acid in river soils to identify the influence of the degradation on the perfluorocarboxylic acids (PFCAs) in the Yodo River Basin. We also investigated the influence of abiotic oxidation on the formation of PFCAs in soils and measured the fluorotelomer alcohols (FTOHs) as precursors of PFCAs in the soil and air samples collected at Osaka and Kyoto. No major degradations were observed in soils contaminated with PFCA during the 24-week experimental period, while the PFOA levels increased only in the control group. The PFCA levels significantly increased after oxidation in this group. The dominant FTOH in soils was 10:2 FTOH, whereas 6:2 FTOH was dominant in the air samples. These findings suggest that PFOA was rapidly removed from water system but persist in soils. Moreover, the results indicate the need to evaluate not only the PFCAs, but also the FTOHs and other precursors for the accurate prediction of PFCA accumulation and fates in the environment.		1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D619	蓄積性	Ali, AM; Sanden, M; Higgins, CP; Hale, SE; Alarif, WM; Al-Lihaibi, SS; Raeder, EM; Langberg, HA; Kallenborn, R	Legacy and emerging per- and polyfluorinated alkyl substances (PFASs) in sediment and edible fish from the Eastern Red Sea	2021	Environ. Pollut. 2021 Jul:280:116935. doi: 10.1016/j.envpol.2021.116935.	Poly: and perfluorinated alkyl substances (PFASs) are ubiquitously detected all around the world. Herein, for the first time, concentrations of 16 selected legacy and emerging PFASs are reported for sediment and edible fish collected from the Saudi Arabian Red Sea. Mean concentrations varied from 0.57 to 2.6 mu g kg(-1) dry weight (dw) in sediment, 3.89-7.63 mu g kg(-1) dw in fish muscle, and 17.9-58.5 mu g kg(-1) dw in fish liver. Wastewater treatment plant effluents represented the main source of these compounds and contributed to the exposure of PFAS to biota. Perfluorooctane sulfonate (PFOS) was the most abundant compound in sediment and fish tissues analysed, comprising between 42 and 99% of the Sigma(16)PFAS. The short chain perfluorobutanoate (PFBA) was the second most dominant compound in sediment and was detected at a maximum concentration of 0.64 mu g kg(-1) dw. PFAS levels and patterns differed between tissues of investigated fish species. Across all fish species, Sigma(16)PFAS concentrations in liver were significantly higher than in muscle by a factor ranging from 3 to 7 depending on fish species and size. The PFOS replacements fluorotelomer sulfonate (6:2 FTS) and perfluorobutane sulfonate (PFBS) exhibited a bioaccumulation potential in several fish species and 6:2 FTS, was detected at a maximum concentration of 7.1 +/- 3.3 mu g kg(-1) dw in a doublespotted queenfish (Scomberoides lysan) liver. PFBS was detected at a maximum concentration of 2.65 mu g kg(-1) dw in strong spine silver-biddy (Genres longirostris) liver. The calculated dietary intake of PFOS, perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorohexane sulfonic acid (PFHxS) exceeded the safety threshold established by the European Food Safety Authority (EFSA) in 2020 in doublespotted queenfish muscle, indicating a potential health risk to humans consuming this fish in Jeddah, Saudi Arabia.	1		1	1				B	-		
D620	蓄積性	Sciancalepore, G; Pietroluongo, G; Centelleghe, C; Milan, M; Bonato, M; Corazzola, G; Mazzariol, S	Evaluation of per- and poly-fluorinated alkyl substances (PFAS) in livers of bottlenose dolphins (Tursiops truncatus) found stranded along the northern Adriatic Sea.	2021	Environ. Pollut. 2021 Dec:291:118186. doi: 10.1016/j.envpol.2021.118186.	Per-and poly-fluorinated alkyl substances (PFAS) are a group of chemicals used in a wide variety of commercial products and industrial applications. These chemicals are persistent, can accumulate in humans' and animals' tissues and in the environment, representing an increasing concern due to their moderate to highly toxicity. Their global distribution, persistence and toxicity led to an urgent need to investigate bioaccumulation also in marine species. In 2013 PFAS contamination was detected in a vast area in Veneto region, mainly in Adige and Brenta rivers. In order to investigate any relevant presence of these substances in marine vertebrates constantly living in the area, PFAS were measured in hepatic tissue samples of 20 bottlenose dolphins (Tursiops truncatus) stranded along the northern Adriatic Sea coastline between 2008 and 2020. Using high performance liquid chromatography-mass spectrometry, 17 target PFAS (PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA, PFTrDA, PFTeDA, PFBS, PFHxS, PFOS, PFDS, PFHpS, PFPeS), were quantified in the samples. PFAS profiles were generally composed of the same five dominant PFAS (PFOS > PFUnA > PFDA approximate to PFDoA approximate to PFTrDA). The greatest PFOS concentration found was 629,73 ng/g wet weight, and PFOS accounted until 71% in the PFAS profiles. No significant differences between sexes were found, while calves showing higher mean values than adults, possibly indicating an increasing ability in the elimination of PFAS with age. Finally, a temporal analysis was carried out considering three different periods of time, but no temporal differences in concentrations were found. The results suggest that long-chain PFAS are widespread in bottlenose dolphins along the North Adriatic Sea. Furthermore, they represent a baseline to investigate the impact of PFAS on marine mammals' conservation and health. Filling an important gap in the knowledge of PFAS accumulation in bottlenose dolphins, this study highlights the relevant role of Environmental and Tissue Banks for retrospective analyses on emergent contaminants.	1	1	1	1				B	-		
D621	環境中運命	Schaefer, CE; Nguyen, D; Meng, PP; Fang, YD; Knappe, DRU	Sorption of perfluoroalkyl ether carboxylic acids (PFECAs) at the air-water interface in porous media: Modeling perspectives	2022	J. Hazard. Mater. Adv. 2022 May:6:100062. doi: 10.1016/j.hazadv.2022.100062.	Perfluoroalkyl ether carboxylic acids (PFECAs) are a growing environmental concern, and thus their migration in unsaturated soils is receiving increased interest. In this study, sorption of four PFECAs at the air-water interface was measured in unsaturated sand columns under static (no flow) conditions following gravity drainage to assess the appropriateness of two commonly applied sorption models (Langmuir and Freundlich) in predicting interfacial uptake. This static method was employed to eliminate any potential artifacts due to flow bypassing and/or interfacial sorption kinetics that might occur in dynamic column experiments. The largest interfacial adsorption coefficient measured was 2.8 & PLUSMN; 1.6 x10 - 5 m for ammonium perfluoro(2-methyl-3-oxahexanoate) (GenX). A commonly employed Langmuir-based model based on interfacial tension data substantially underpredicted GenX and nonafluoro-3,6-dioxaheptanoic acid (PFO2HpA) interfacial sorption measured at low (& SIM;1,000 ng/L) aqueous concentrations in unsaturated sand columns, while a Freundlich-based model substantially overpredicted GenX and PFO2HpA interfacial sorption. These results highlight the need for improved interfacial modeling approaches to predict PFECA fate and transport at relatively low concentrations in unsaturated media.					1			B	-		
D622	蓄積性	Wang, XX; Zhang, WL; Lamichhane, S; Dou, FG; Ma, XM	Effects of physicochemical properties and co-existing zinc agrochemicals on the uptake and phytotoxicity of PFOA and GenX in lettuce	2023	Environ. Sci. Pollut. Res. 2023 Mar:30(15):43833-43842. doi: 10.1007/s11356-023-25435-5.	Even though the potential toxicity and treatment methods for per- and polyfluoroalkyl substances (PFAS) have attracted extensive attention, the plant uptake and accumulation of PFAS in edible plant tissues as a potential pathway for human exposure received little attention. Our study in a hydroponic system demonstrated that perfluorooctanoic acid (PFOA) and its replacing compound, 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy) propanoic acid (GenX) displayed markedly different patterns of plant uptake and accumulation. For example, the root concentration factor (RCF) of PFOA in lettuce is almost five times of that of GenX while the translocation factor (TF) of GenX is about 66.7% higher than that for PFOA. The co-presence of zinc amendments affected the phyto-effect of these two compounds and their accumulation in plant tissues, and the net effect on their plant accumulation depended on both the properties of Zn amendments and PFAS. Zinc oxide nanoparticles (ZnONPs) at 100 mg/L did not affect the uptake of PFOA in either lettuce roots or shoots; however, Zn2+ at the same concentration significantly increased PFOA accumulation in both tissues. In contrast, both Zn amendments significantly lowered the accumulation of GenX in lettuce roots, but only ZnONPs significantly hindered the GenX accumulation in lettuce shoots. The co-exposure to ZnONPs and PFOA/GenX resulted in lower oxidative stress than the plants exposed to PFOA or GenX alone. However, both zinc agrochemicals with or without PFAS led to lower root dry biomass. The results shed light on the property-dependent plant uptake of PFAS and the potential impact of co-existing nanoagrochemicals and their dissolved ions on plant uptake of PFOA and GenX.					1			B	-		
D623	蓄積性	Pan, X; Ye, J; Zhang, H; Tang, J; Pan, DD	Occurrence, Removal and Bioaccumulation of Perfluoroalkyl Substances in Lake Chaohu, China	2019	Int. J. Environ. Res. Public Health. 2019 May;16(10):1692. doi: 10.3390/ijerph16101692.	The perfluoroalkyl substances (PFAAs) have received growing attention in recent years as emerging contaminants in the aquatic environment. The occurrence, removal and bioaccumulation of fourteen PFAAs (C4-C14 carboxylate; C4, C6, C8 sulfonates) were investigated in Lake Chaohu, China. The concentrations of the selected PFAAs in inflowing river, lake water and sewage treatment plant (STP) samples were analyzed by ultra performance liquid chromatograph (UPLC-MS/MS). The results showed that perfluorohexanesulfonic acid (PFHxS), perfluorobutane sulfonate (PFBS), perfluorobutyric acid (PFBA) and perfluoropentanoic acid (PFPeA), instead of perfluorooctanoic acid (PFOA), were predominant PFAAs in the inflowing river and lake water with maximum concentrations in the ranges of 52.2-1866 and 27-236 ng L-1, respectively. The highest concentrations of total PFAAs were detected in the western rivers. The effluents from seven STPs were likely important sources of PFAAs in surface water, and the amount of the daily fluxes in the effluent were 132 g for short-chain PFAAs and 109 g for long-chain PFAAs. PFAAs were widely detected in Chinese icefish (Neosalanx tangkahkeii taihuensis) collected from Lake Chaohu, with maximal concentrations ranging from 1.79 ng g(-1) to 50.9 ng g(-1). The logarithmic bioaccumulation factors of perfluorodecanoic acid (PFDA, 3.5), perfluorooctane sulfonate (PFOS, 3.35) and perfluorononanoic acid (PFNA, 3.31) indicated the bioaccumulation of these long-chain PFAAs. This study is useful for enhancing our understanding of the pollution profiles of PFAAs and their environmental health risk in the freshwater lake.	1		1	1				B	-		
D624	環境中運命	Liao, SC; Arshadi, M; Woodcock, MJ; Saleeba, ZSSL; Pinchbeck, D; Liu, C; Capiro, NL; Abriola, LM; Pennell, KD	Influence of Residual Nonaqueous-Phase Liquids (NAPLs) on the Transport and Retention of Perfluoroalkyl Substances	2022	Environ. Sci. Technol. 2022 Jun:56(12):7976-7985. doi: 10.1021/acs.est.2c00858.	Per- and polyfluoralkyl substances (PFAS) are known to accumulate at interfaces, and the presence of nonaqueous-phase liquids (NAPLs) could influence the PFAS fate in the subsurface. Experimental and mathematical modeling studies were conducted to investigate the effect of a representative NAPL, tetrachloroethene (PCE), on the transport behavior of PFAS in a quartz sand. Perfluorooctanesulfonate (PFOS), perfluorononanoic acid (PFNA), a 1:1 mixture of PFOS and PFNA, and a mixture of six PFAS (PFOS, PFNA, perfluorooctanoic acid (PFOA), perfluoroheptanoic acid (PFHpA), perfluorohexanesulfonate (PFHxS), and perfluorobutanesulfonate (PFBS)) were used to assess PFAS interactions with PCE-NAPL. Batch studies indicated that PFAS partitioning into PCE-NAPL (K-nw < 0.1) and adsorption on 60-80 mesh Ottawa sand (K-d < 6 x 10(-5) L/g) were minimal. Column studies demonstrated that the presence of residual PCE-NAPL (similar to 16% saturation) delayed the breakthrough of PFOS and PFNA, with minimal effects on the mobility of PFBS, PFHpA, PFHxS, and PFOA. Breakthrough curves (BTCs) obtained for PFNA and PFOS alone and in mixtures were nearly identical, indicating the absence of competitive adsorption effects. A mathematical model that accounts for NAPL-water interfacial sorption accurately reproduced PFAS BTCs, providing a tool to predict PFAS fate and transport in co- contaminated subsurface environments.			1	1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D625	環境中運命	Lv, M; Xie, YY; Yu, H; Sun, T; Song, LP; Wang, FH	Effects of perfluoroalkyl substances on soil respiration and enzymatic activity: differences in carbon chain-length dependence	2022	J. Environ. Sci. Health Part B-Pestic. Contam. Agric. Wastes. 2022 Apr:57(4):284-296. doi: 10.1080/03601234.2022.2047563.	Perfluoroalkyl substances (PFASs) are anthropogenic compounds that exhibit ecotoxicity when discharged into the environment, causing increasing concern. An indoor experiment was conducted to investigate the effects of perfluoroalkyl carboxylic acids (PFCAs) and PFSAs on soil respiration, sucrase activity, and urease activity at 0, 7, 14, and 28 d for perfluorooctanoic acid (PFOA), perfluorohexanoic acid (PFHxA), and perfluorobutyric acid (PFBA), and at 14 and 28 d for perfluorooctane sulfonic acid (PFOS), perfluorohexanoic sulfonic acid (PFHxS), and perfluorobutyric sulfonic acid (PFBS). PFCAs significantly inhibited soil respiration, with a significant negative correlation between respiration and PFBA ($P < 0.05$) at 28 d. Sucrase activities were initially inhibited by PFCAs, and then recovered. Urease activities were inhibited by PFOA at 14 d and by PFHxA at 14 and 28 d, but not by PFBA. PFOS and PFBS briefly enhanced soil respiration. PFOS inhibited sucrase activity. PFSAs significantly decreased urease activity in a concentration- and time-dependent manner. The chain-length dependence of the ecotoxicity of PFASs varied depending on concentration and time. Toxicity demonstrated a trend of initial decrease followed by increase with carbon chain length. Our results first revealed that the chain-length dependences of PFASs were also related to concentrations and exposure time.	1	1		1				B	-		
D626	蓄積性	Lasee, S; Subbiah, S; Thompson, WA; Karnjanapiboonwong, A; Jordan, J; Payton, P; Anderson, TA	Plant Uptake of Per- and Polyfluoroalkyl Acids under a Maximum Bioavailability Scenario	2019	Environ. Toxicol. Chem. 2019 Nov:38(11):2497-2502. doi: 10.1002/etc.4571.	Although many studies have evaluated the fate of per- and polyfluoroalkyl acids (PFAAs) in aquatic environments, few have observed their fate in terrestrial environments. It has been proposed that ingestion could be a major PFAA exposure route for humans. We determined PFAA uptake in radish, carrot, and alfalfa under a maximum bioavailability scenario. Bioconcentration factors (BCFs) were determined in the edible tissue of radish (perfluorobutanesulfonate [PFBS] = 72; perfluorohexanesulfonate [PFHxS] = 13; perfluoroheptanoate [PFHpA] = 65; perfluorooctanoate [PFOA] = 18; perfluorooctanesulfonate [PFOS] = 2.9; and perfluorononanoate [PFNA] = 9.6), carrot (PFBS = 5.9; PFHxS = 1.1; PFHpA = 29; PFOA = 3.1; PFOS = 1; and PFNA = 1.4), and alfalfa (PFBS = 107; PFHxS = 12; PFHpA = 91; PFOA = 10; PFOS = 1.4; and PFNA = 1.7). Some of these PFAA BCFs are as much as 2 orders of magnitude higher than those measured previously in plants grown in biosolid-amended soils.			1	1				B	-		
D627	蓄積性	Menger, F; Pohl, J; Ahrens, L; Carlsson, G; Orn, S	Behavioural effects and bioconcentration of per- and polyfluoroalkyl substances (PFASs) in zebrafish (Danio rerio) embryos	2020	Chemosphere. 2020 Apr:245:125573. doi: 10.1016/j.chemosphere.2019.125573.	Per- and polyfluoroalkyl substances (PFASs) are contaminants of emerging concern (CECs) that cause concern regarding their environmental impact and risk to human health. In this study, zebrafish (Danio rerio) embryos were exposed to PFASs for six days, to investigate behaviour toxicity and bioconcentration factor (BCF). Nine individual PFASs (five C-4-C-8 perfluoroalkyl carboxylates (PFCAs) (PFPeA, PFHxA, PFHpA, PFOA, PFNA), three C-4, C-6 and C-8 perfluoroalkyl sulfonates (PFSAs) (PFBS, PFHxS, PFOS) and 6:2 fluorotelomersulfonate (6:2 FTSA)) and a mixture of these were investigated at seven concentrations ranging from environmentally relevant to acutely toxic levels. In exposed embryos, significant differences were found in total swimming distance (PFHpA, PFOA, PFNA, PFHxS, PFOS, 6:2 FTSA, PFAS mixture), burst activity (PFOA, PFNA, PFHxS, PFOS, PFAS mixture) and startle response (PFNA, PFHxS, PFOS, PFAS mixture). Toxicity was only observed at concentrations well above environmental levels. The toxicity of the PFAS mixture generally followed that of the individual substances, but the mixture reduced the potencies of individual PFASs. BCF was determined for all nine PFASs and ranged between 0.9 (PFPeA) and 2700 (PFOS). Long-chain PFASs (C-8) and PFASs with sulfonate as an active group showed the greatest toxic potential, while short-chain PFASs (C-6 and C-7) also caused significant behaviour alterations and accumulated in the embryos. To our knowledge, this is the first study to compare the behaviour toxicity of a PFAS mixture with that of the individual PFASs. Follow-up studies are needed to identify the mechanistic responses to PFAS mixtures.		1	1	1				B	-		
D628	環境中運命	Bizkarguenaga, E; Zabaleta, I; Prieto, A; Fernandez, LA; Zuloaga, O	Uptake of 8:2 perfluoroalkyl phosphate diester and its degradation products by carrot and lettuce from compost-amended soil	2016	Chemosphere 2016 Jun:152:309-317. doi: 10.1016/j.chemosphere.2016.02.130	The present work studied the uptake of 8:2 perfluoroalkyl phosphate diester (diPAP) by two different crops (lettuce and carrot) and two different amended soils. Firstly, the possible degradation of 8:2 diPAP in the absence of crop was studied and 8:2 monoPAP (monophosphate), 8:2 FTCA (saturated fluorotelomer carboxylate), 8:2 FTUCA (unsaturated fluorotelomer carboxylate), 7:3 FTCA (saturated fluorotelomer carboxylate), PFHpA (perfluoroheptanoic acid), PFHxA (perfluorohexanoic acid) and PFOA (perfluorooctanoic acid) were detected. In the presence of crops, different degradation products were detected in the soil and, while PFNA (perfluorononanoic acid), PFHpA, PFHxA, PFPeA (perfluoropentacoic acid), PFBA (perfluorobutanoic acid), 7:3 FTCA and PFOA were determined in the cultivation media when carrot was grown, PFOA was the only degradation product detected in the case of lettuce experiments. Regarding the uptake in carrot, all the degradation products except 7:3 FTCA were translocated from the soil to the carrot. Carrot core, peel and leaves bioconcentration factors, BCFs, were determined for 8:2 diPAP and its degradation products. Values lower than method detection limits for core and low BCFs in peel (0.025-0.042) and leaves (0.028-0.049) were achieved for 8:2 diPAP. Regarding to the degradation products, the higher their water solubility, the higher the plant translocation. In this sense, the lower the carbon chain length of PFCAs, the higher the BCFs determined (PFBA > PFHxA > PFHpA > PFOA > PFNA). In general, lower total BCFs were achieved when the total organic carbon of the soils increased. For lettuce experiments, 8:2 diPAP (0.04-0.18) and PFOA (0.28-1.57) were only determined in lettuce heart.	1	1	1					B	-		
D629	環境中運命	Wu, JY; Hua, ZL; Gu, L	Planktonic microbial responses to perfluorinated compound (PFC) pollution: Integrating PFC distributions with community coalescence and metabolism	2021	Sci. Total Environ. 2021 Sep:788:147743. doi: 10.1016/j.scitotenv.2021.147743.	The presence of perfluorinated compound (PFC) contamination in riverine ecosystems represents a novel challenge for environmental remediation. However, little attention has been paid to how PFCs affect planktonic microbial community coalescence. Here, the spatial profiles of fourteen PFCs and their contributions to community assembly were determined using field sampling in a natural river confluence. Overall, PFPeA (perfluorovaleric acid), PFBS (perfluorobutylsulfonate), PFHpA (perfluoroheptanoic acid) and PFHxA (perfluorohexanoic acid) were identified as important indicators of PFC pollution, accounting for the majority of the spatial heterogeneity in PFC pollution. PFPeA (perfluorovaleric acid) (9.39%) and PFTrDA (perfluorotridecanoate acid) (8.61%) contributed more to microbial taxonomic spatial heterogeneity than did other factors, such as pH, dissolved oxygen and velocity. PFOA (pentadecafluorooctanoic acid) (R-2 = 0.353) and PFBS (R-2 = 0.297) drove turnover in archaeal communities within river sections (transversely), while PFHpA (R-2 = 0.251) and PFOS (perfluorooctane sulphonate) (R-2 = 0.105) drove turnover in bacterial communities transversely and longitudinally, respectively. Phylogenetic nullmodeling suggested that archaeal (68.89-83.33%) community assembly was dominated by stochastic processes, and was balanced by PFHxA (R-2 = 0.349) and PFOA (R-2 = 0.290). Furthermore, PFOS inhibited the biosynthesis of several key amino acids in archaea, and PFBA enhanced the potential for bacterial infections in humans ($p < 0.05$), threatening water quality. In sum, this study provides new insights into riverine ecological risk management.	1	1		1				B	-		
D630	蓄積性	Wang, P; Zhang, M; Lu, YL; Meng, J; Li, QF; Lti, XT	Removal of perfluoalkyl acids (PFAAs) through fluorochemical industrial and domestic wastewater treatment plants and bioaccumulation in aquatic plants in river and artificial wetland	2019	Environ. Int. 2019 Aug:129:76-85. doi: 10.1016/j.envint.2019.04.072	The fluorochemical industry has shifted to the production of short chain homologues of perfluoalkyl acids (PFAAs) in recent years. Yet the effective removal of short-chain PFAAs from wastewater is still a major challenge. In this study, the removal efficiencies (RM) of short- and long-chain PFAAs emitted from two fluorochemical industrial parks were evaluated in one industrial and two domestic waste water treatment plants (WWTPs), and bioaccumulation factors (BAF) of PFAAs in various emerged and submerged aquatic plants in adjacent river and an artificial wetland were also calculated. Perfluorobutanoic acid (PFBA), perfluorobutane sulfonic acid (PFBS) and perfluorooctanoic acid (PFOA) were dominant in the whole area. The source water of the fluorochemical industrial WWTP (F-WWTP) gathered from the facilities in Park 2 contained total PFAAs (Sigma PFAAs) of 5,784 ng/L. Among the four main technologies, the biological aerated filter, combined with upflow sludge bed processes presented the greatest RM of Sigma PFAAs in the F-WWTP, respectively. The source water of the wetland from the river brought Sigma PFAAs to 21,579 ng/L, emerged plants showed higher BAF of PFBA and PFBS, while lower BAF of PFOA and PFOS than submerged plants. J. serotinus showed both the highest Sigma PFAAs and the highest BAF for short chain PFAAs. With the increasing production capacity, this study provided valuable information for risk assessment and management of PFAA emission from point sources.	1			1				B	-		
D631	環境中運命	Zhi, Y; Lu, HY; Grieger, KD; Munoz, G; Li, W; Wang, XM; He, Q; Qian, SH	Bioaccumulation and Translocation of 6:2 Fluorotelomer Sulfonate, GenX, and Perfluoroalkyl Acids by Urban Spontaneous Plants	2022	ACS ES&T Eng. 2022 Jul:2(7):1169-1178. doi: 10.1021/acsestengg.1c00423.	There is limited information available regarding the bioaccumulation potential of polyfluoroalkyl substances (PFAS) in urban vegetation. Using a controlled greenhouse exposure setting, we investigated the bioaccumulation and translocation of select PFAS in four common urban spontaneous plants. Target compounds included legacy PFAS (perfluoroalkyl carboxylic and sulfonic acids, PFCA/PFSA), a fluorotelomer sulfonate (6:2 FTS), and an emerging fluorinated ether (i.e., hexafluoropropylene oxide dimer acid (HFPO-DA), or GenX). Results from this study showed that bioaccumulation factors in root and shoot (BCF(root)and BCFshoot) ranged from 0.7 to 83.6 and 0.95 to 26.9, respectively. Phyllanthus urinaria harbored the highest PFAS bioaccumulation capacity among the four urban weed species. The log BCFroot of PFCA homologues showed a concave shape as a function of chain length, while log BCF(root)of PFSA increased with chain length. The BCFroot of GenX was lower than that of PFOA; likewise, 6:2 FTS bioaccumulated to a less extent than PFOS. Root uptake seemed to be the dominant accumulation mechanism for the shorter-chain compounds, whereas adsorption was the dominant mechanism for longer-chain compounds such as PFOA. BCF(root)and BCFshoot showed consistent trends in response to foliar and root characteristics. Leaf area and average root diameter were the most correlated traits with PFAS bioaccumulation factors, with higher BCF values for plants with smaller leaves and finer roots. This study also provides an important basis for the role and selection of urban weeds in future PFAS bioaccumulation and translocation studies within urban settings.	1	1	1		1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D632	蓄積性	Sun, X; Xie, YQ; Zhang, XY; Song, JB; Wu, YP	Estimation of Per- and Polyfluorinated Alkyl Substance Induction Equivalency Factors for Humpback Dolphins by Transactivation Potencies of Peroxisome Proliferator-Activated Receptors	2023	Environ Sci Technol. 2023 Mar 7;57(9):3713-3721. doi: 10.1021/acs.est.2c05044.	The potential risks of per-and polyfluoroalkyl substance (PFAS) accumulation in nearshore dolphins are not well understood. Here, transcriptional activities of 12 PFAS on peroxisome proliferator-activated receptors (PPAR-alpha, -beta/delta, and -gamma) in Indo-Pacific humpback dolphins (Sousa chinensis) were evaluated. All PFAS activated scPPAR-alpha in a dose-dependent manner. PFHpA exhibited the highest induction equivalency factors (IEFs). The order of IEFs for other PFAS was as follows: PFOA > PFNA > PFHxA > PFPeA > PFHxS > PFBA > PFOS > PFBuS approximate to PFDA >> PFUnDA and PFDoDA (not activated). The total induction equivalents (n-ary sumation IEQs, 5537 ng/g wet weight) indicated that more attention should be paid to investigating contamination levels in dolphins, especially in PFOS (82.8% contribution to the n-ary sumation IEQs). The scPPAR-beta/delta and -gamma were not affected by any PFAS, except for PFOS, PFNA, and PFDA. Furthermore, PFNA and PFDA could induce higher PPAR-beta/delta and PPAR-gamma-mediated transcriptional activities than PFOA. Compared to human beings, PFAS might be more potent PPAR-alpha activators in humpback dolphins, suggesting that the dolphins may be more susceptible to the adverse effects of PFAS. Our results may be instructive for understanding the impacts of PFAS on marine mammal health due to the identical PPAR ligand-binding domain.	1	1	1					B	-		
D633	蓄積性	Riebe, RA; Falk, S; Georgii, S; Brunn, H; Failing, K; Stahl, T	Perfluoroalkyl Acid Concentrations in Livers of Fox (Vulpes vulpes) and Chamois (Rupicapra rupicapra) from Germany and Austria	2016	Arch. Environ. Contam. Toxicol. 2016 Jul:71(1):7-15. doi: 10.1007/s00244-015-0250-8.	The concentrations of 11 perfluorinated alkyl acids (PFAAs) were measured in the livers of foxes (Vulpes vulpes) from Germany, a primarily carnivorous species, and chamois (Rupicapra rupicapra) from Austria, an herbivorous species. Perfluorooctanesulfonate (PFOS) at concentrations [all results refer to wet weight (ww)] of 3.2-320 A mu g/kg were detected in all 40 fox livers tested, yielding an arithmetic mean of 46.6 A mu g/kg and a median of 29.8 A mu g/kg. Long-chain PFAAs were detected at concentrations of 1.7 A mu g/kg perfluorononanoic acid (PFNA) to 2.4 A mu g/kg perfluorodecanoic acid (PFDA) and perfluorododecanoic acid (PFDoDA). Of the short-chain PFAAs tested, only perfluorohexanoic acid (PFHxA) was found in 1 fox liver at a concentration of 1.4 A mu g/kg, and perfluorohexane sulfonate (PFHxS) was found in 2 fox livers at a concentration of 1 A mu g/kg each. PFOS and PFNA concentrations higher than limit of quantification (LOQ) were detected in 90.9 and 81.8 % of chamois livers, respectively. The arithmetic mean for PFOS concentrations was 2.2 A mu g/kg (median 2.4 A mu g/kg), a factor of 21 (median factor of 12) lower than in fox livers. The arithmetic mean for PFNA concentrations was 2.0 A mu g/kg (median 1.9 A mu g/kg). Perfluorobutanoic acid, PFHxA, perfluorooctanoic acid, perfluorobutanesulfonate, and PFHxS were not detected at concentrations higher than the LOQ in any of the samples. The various results are compared with one another and with the results of other studies of herbivorous, carnivorous, and omnivorous wild animals. The highest concentrations of PFAA, in particular PFOS, were found in omnivorous animals followed by carnivores. The lowest levels were present in herbivores.	1	1	1	1				B	-		
D634	環境中運命	Lin, HJ; Taniyasu, S; Yamashita, N; Khan, MK; Masood, SS; Saied, S; Khwaja, HA	Per- and polyfluoroalkyl substances in the atmospheric total suspended particles in Karachi, Pakistan: Profiles, potential sources, and daily intake estimates	2022	Chemosphere. 2022 Feb;288(Pt 2):132432. doi: 10.1016/j.chemosphere.2021.132432.	Per- and polyfluoroalkyl substances (PFAS) have received continuous attention; however, there is limited understanding of their sources in the atmosphere and related human exposure risks. This study measured PFAS in the atmospheric total suspended particles collected from Karachi, Pakistan, during the winter. Among the quantified PFAS, perfluorobutanoic acid (PFBA) showed the highest average concentration (3.11 +/- 2.64 pg/m3), accounting for 32% of the total PFAS. Wind speed was positively correlated with perfluorohexanoic acid (PFHxA) and N-ethyl perfluorooctanesulfonamide (N-EtFOSA), while relative humidity was negatively correlated with perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). Weighted potential source contribution function (WPSCF) and concentration weighted trajectory (WCWT) analyses suggested that northwestern Pakistan and western Afghanistan areas were highly associated with the long-range atmospheric transport of PFAS. We also calculated the daily intake of PFAS via inhalation, which were in the range of 0.07-3.98 and 0.01-0.33 pg/ kg bw/d for children and adults, respectively. The calculated hazard quotient (HQ) of PFOS and PFOA was significantly lower than 1, indicating less or unlikely to cause non-carcinogenic effect via inhalation exposure. Overall, this study contributes to the understanding of geographic origins and human inhalation risks of airborne PFAS on a regional scale.	1	1						B	-		
D635	環境中運命	Xiao, SK; Wu, Q; Pan, CG; Yin, C; Wang, YH; Yu, KF	Distribution, partitioning behavior and potential source of legacy and alternative per- and polyfluoroalkyl substances (PFASs) in water and sediments from a subtropical Gulf, South China Sea	2021	Environ. Res. 2021 Oct:201:111485. doi: 10.1016/j.envres.2021.111485.	Legacy per- and polyfluoroalkyl acids (PFASs) have received global concern over the scientific and public community since this century. However, the information on alternative PFASs pollution in the marine environment, especially in the subtropical marine environment is extremely limited. This study investigated the occurrence, partitioning, potential sources, and ecological risks of PFASs, including perfluoroalkane sulfonic acids (PFSAs), perfluoroalkyl carboxylic acids (PFCAs), and alternative PFASs, in surface water and sediments from the subtropical Beibu Gulf, South China. Concentrations of total PFASs (n-ary sumation PFASs) were in the range of 0.98-2.64 ng/L in water and 0.19-0.66 ng/g (dry weight, dw) in sediment, respectively. Perfluorooctanoic acid (PFOA) was the most abundant PFAS in water, while PFASs in sediment were dominated by perfluorooctanesulfonic acid (PFOS) and PFOA. Among investigated environmental parameters (total organic carbon (TOC), grain size, water pH, sediment pH, and salinity), TOC and salinity were the dominant factors influencing the sediment-water distribution coefficient (Kd) of PFOA, perfluorodecanoic acid (PFDA), and perfluorononanoic acid (PFNA). Log Kd and log soil organic carbon-water distribution coefficient (Koc) both increase with increasing carbon chain length of PFASs. Significantly positive correlations between PFOS and perfluorohexanoic acid (PFHxA) ($p < 0.05$), PFOA and perfluoro-1-butane-sulfonamide (FBSA) were observed, suggesting that these PFASs might have similar sources and transport routes. Preliminary environmental risk assessment showed that PFOA and PFOS would not pose risks to the marine aquatic environment. This is the first comprehensive survey of legacy and alternative PFASs in a subtropical area of the Beibu Gulf, which provides significant data and scientific basis to better understand the fate of PFASs and pollution control management.		1	1					B	-		
D636	環境中運命	Schumm, CE; Loganathan, N; Wilson, AK	Influence of Soil Minerals on the Adsorption, Structure, and Dynamics of GenX	2023	ACS ES&T Wat. 2023 Jul:3(8):2659-2670. doi: 10.1021/acsestwater.3c00171.	Inrecent years, there have been increasing initiatives undertakenworldwide to employ alternative per- and polyfluoroalkyl substances(PFAS) molecules in order to minimize the environmental and healtheffects associated with legacy PFAS molecules. Hexafluoropropyleneoxide dimer acid (HFPO-DA), commonly known as GenX, is one of theimportant replacements currently used for PFOA. However, growing investigationssuggest that GenX is identified in natural settings, including soilsand groundwater, thus emphasizing the need to understand their sorptionbehavior in these environments. This study provides molecular-levelinsights into the impact of three different common soil constituents,namely, clay minerals, that vary in mineralogical composition andsurface charge distribution in dictating the adsorption and transportcharacteristics of GenX on a fundamental molecular level for the firsttime using molecular dynamics simulations. The surface complexationof GenX varies significantly between the three clay minerals, andthe factors that dictate the complexation are completely different.Depending upon the clay minerals, both surface-adsorbed and solution-phaseGenX are observed. Importantly, the interfacial structure, nearestneighbor coordination, and dynamic behavior of GenX and their correlationwith legacy PFAS in minerals systems are presented. This study unravels the critical interactionsthat dictatethe fate and the transport behavior of GenX in soil minerals.					1			B	-		
D637	蓄積性	Hassell, KL; Coggan, TL; Cresswell, T; Kolobaric, A; Berry, K; Crosbie, ND; Blackbeard, J; Pettigrove, VJ; Clarke, BO	Dietary Uptake and Depuration Kinetics of Perfluorooctane Sulfonate, Perfluorooctanoic Acid, and Hexafluoropropylene Oxide Dimer Acid (GenX) in a Benthic Fish	2020	Environ. Toxicol. Chem. 2020 Mar:39(3):595-603. doi: 10.1002/etc.4640.	Per- and poly-fluoroalkyl substances (PFAS) are ubiquitously distributed throughout aquatic environments and can bioaccumulate in organisms. We examined dietary uptake and depuration of a mixture of 3 PFAS: perfluorooctanoic acid (PFOA; C8HF15O2), perfluorooctane sulfonate (PFOS; C8HF17SO3), and hexafluoropropylene oxide dimer acid (HPFO-DA; C6HF11O3; trade name GenX). Benthic fish (blue spot gobies, Pseudogobius sp.) were fed contaminated food (nominal dose 500 ngg(-1)) daily for a 21-d uptake period, followed by a 42-d depuration period. The compounds PFOA, linear-PFOS (linear PFOS), and total PFOS (sum of linear and branched PFOS) were detected in freeze-dried fish, whereas GenX was not, indicating either a lack of uptake or rapid elimination (< 24h). Depuration rates (d(-1)) were 0.150 (PFOA), 0.045 (linear-PFOS), and 0.042 (linear+branched-PFOS) with corresponding biological half-lives of 5.9, 15, and 16d, respectively. The PFOS isomers were eliminated differently, resulting in enrichment of linear-PFOS (70-90%) throughout the depuration period. The present study is the first reported study of GenX dietary bioaccumulation potential in fish, and the first dietary study to investigate uptake and depuration of multiple PFASs simultaneously, allowing us to determine that whereas PFOA and PFOS accumulated as expected, GenX, administered in the same way, did not appear to bioaccumulate.					1			B	-		
D638	蓄積性	Szabo, D; Nuske, MR; Lavers, JL; Shimeta, J; Green, MP; Mulder, RA; Clarke, BO	A baseline study of per- and polyfluoroalkyl substances (PFASs) in waterfowl from a remote Australian environment	2022	Sci. Total Environ. 2022 Mar:812:152528. doi: 10.1016/j.scitotenv.2021.152528.	Elevated concentrations of PFASs in the liver may pose a toxicological risk to bird species and humans that consume them. This study aimed to determine concentrations of 43 per- and polyfluoroalkyl substances (PFASs) in livers (n = 80) of Australian Shelducks (Tadorna tadornoides), Pacific Black Ducks (Anas superciliosa), and Teals (Anas sp.), as well as water and sediment from a remote Australian environment. Maximum concentrations of PFBA (1.9 ng L-1), PFOA (1.7 ng L-1) and PFOS (0.99 ng L-1) in water were consistent with long-range atmospheric and oceanic transport. PFOS (30%) and PFNA (22%) were the most frequently detected PFASs in Australian Shelduck livers (0.31 +/- 0.68 ng g-1 ww and 0.16 +/- 0.15 ng g-1 ww respectively). Maximum concentrations of PFOS in Pacific Black Ducks (50%) and Teals (44%) was 2.4 ng g-1 ww and 5.3 ng g-1 ww respectively. While PFAS levels in birds from this remote environment were below current animal consumption guidelines, continued monitoring of this ecosystem is recommended to assess the human health risk of consumption of wild game.	1		1					B	-		

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D639	環境中運命	Pike, KA; Edmiston, PL; Morrison, JJ; Faust, JA	Correlation Analysis of Perfluoroalkyl Substances in Regional US Precipitation Events	2021	Water Res. 2021 Feb:190:116685. doi: 10.1016/j.watres.2020.116685.	Per- and polyfluoroalkyl substances (PFAS) are transported in the atmosphere, leading to both wet and dry deposition to the surface. The concentrations of 15 PFAS were measured at six locations in the Ohio-Indiana region of the U.S. during the summer of 2019 and compared to samples collected at a distant site in NW Wyoming. Sigma PFAS concentrations ranged from 50-850 ng L-1, with trifluoroacetic acid (TFA) being the dominant compound (similar to 90%). Concentrations of perfluorooctanoic acid (PFOA) and perfluorosulfonic acid (PFOS) were similar to amounts observed over the past 20 years, indicating persistence in the atmosphere despite regulatory action, and the newer species HFPO-DA (GenX) was also widely detected in rainwater. ANOVA modeling and correlation matrices were used to determine association of PFAS concentrations, location, and functional group and chain length. Statistically significant differences ($p < 0.05$) in PFAS profiles across sites separated by 10-100 km indicate that local point sources strongly contribute to wet deposition. This work introduces correlation plots for PFAS that allow rapid visual comparison of multi-analyte and multi-site data sets.					1			B	-		
D640	環境中運命	MacInnis, JJ; VandenBoer, TC; Young, CJ	Development of a gas phase source for perfluoroalkyl acids to examine atmospheric sampling methods	2016	Analyst 2016 :141(12):3765-3775. doi: 10.1039/c6an00313c	An inability to produce environmentally relevant gaseous mixing ratios of perfluoroalkyl acids (PFAAs), ubiquitous global contaminants, limits the analytical reliability of atmospheric chemists to make accurate gas and particulate measurements that are demonstrably free of interferences due to sampling artefacts. A gas phase source for PFAAs based on the acid displacement mechanism using perfluoropropionate (PFPrA), perfluorobutanoate (PFBA), perfluorohexanoate (PFHxA), and perfluorooctanoate (PFOA) has been constructed. The displacement efficiency of gas phase perfluorocarboxylic acids (PFCAs) is inversely related to chain length. Decreasing displacement efficiencies for PFPrA, PFBA, PFHxA, and PFOA were 90% +/- 20%, 40% +/- 10%, 40% +/- 10%, 9% +/- 4%, respectively. Generating detectable amounts of gas phase perfluorosulfonic acids (PFSAs) was not possible. It is likely that lower vapour pressure and much higher acidity play a role in this lack of emission. PFCA emission rates were not elevated by increasing relative humidity (25%-75%), nor flow rate of carrier gas from 33-111 sccm. Overall, reproducible gaseous production of PFCAs was within the error of the production of hydrochloric acid (HCl) as a displacing acid (+/- 20%) and was accomplished using a dry nitrogen flow of 33 +/- 2 sccm. A reproducible mass emission rate of 0.97 +/- 0.10 ng min(-1) (n = 8) was observed for PFBA. This is equivalent to an atmospheric mixing ratio of 12 ppmv, which is easily diluted to environmentally relevant mixing ratios of PFBA. Conversely, generating gas phase perfluorononanoic acid (PFNA) by sublimating the solid acid under the same conditions produced a mass emission rate of 2800 ng min(-1), which is equivalent to a mixing ratio of 18 ppthv and over a million times higher than suspected atmospheric levels. Thus, for analytical certification of atmospheric sampling methods, generating gas phase standards for PFCAs is best accomplished using acid displacement under dry conditions. This yields quickly stabilized, reproducible emissions and mixing ratios that are easily diluted to environmentally relevant levels. Gas phase PFBA from this source has also been shown to be quantitatively collected using an annular denuder coated with sodium carbonate (Na2CO3) according to Environmental Protection Agency (EPA) method Compendium I.O-4.2. Overall, producing gas phase PFAAs at constant atmospherically-relevant levels will enable the development of standard approaches in certifying gas and particle collection efficiencies for instruments interrogating the gas-particle partitioning and long-range transport of PFCAs in the atmosphere.	1	1	1					B	-		
D641	環境中運命	Hua, ZL; Lu, Y; Chu, KJ; Liu, YY; Ma, YX; Gu, L; Wu, JY; Leelawattananun, W; Ky, S	Shift in the distribution and fate of perfluoroalkyl acids by sluice gates in the multi-environment media of rivers	2022	J. Environ. Manage. 2022 Mar:305:114436. doi: 10.1016/j.jenvman.2022.114436.	The impact of sluice operations on the distribution and fate of perfluoroalkyl acids (PFAAs) remains poorly understood. In this study, the distribution of PFAAs was investigated in water, suspended particles, sediment, and pore water from the upstream and downstream sections of six sluice gates along the Wangyu River, China. The target PFAAs were widely distributed in the dissolved phase (Sigma PFAAs: 447.61 +/- 180.26 ng/L), particle phase (Sigma PFAAs: 2040.95 +/- 1870.88 ng/g dw), sedimentary phase (Sigma PFAAs: 39.42 +/- 35.38 ng/g dw), and pore water phase (Sigma PFAAs: 8172.54 +/- 4278.60 ng/L). Our data suggest predominant detections of short-chain PFAAs such as perfluorobutanoic acid (PFBA) and perfluorohexanoic acid (PFHxA) in the four environmental media. Sedi-ment pore water appeared as an essential repository and potential source for PFAA re-release to the river environment. The levels of PFAAs in the dissolved and suspended particle phase upstream of the sluices were significantly lower than those downstream, while the situation in the sediment and pore water phase was the opposite. Sluice operation caused PFAA redistribution among the multi-environment media but did not change the PFAA composition, which had the significant effect on the partition behavior of perfluoroalkyl carboxylic acids (PFCAs) between particles and water, as well as changed the migration pattern of PFOA, PFNA and PFOS from equilibrium to the migration state. Quantitative prediction models were developed for simulating fate of PFAAs in gate-controlled river, and the major factors affecting the distribution and fate of PFAAs were identified. Our findings provide insights into the redistribution mechanisms of PFAAs and an understanding of their environmental fate.	1	1	1					B	-		
D642	蓄積性	Zhang, WL; Zhang, DQ; Zagorevski, DV; Liang, YN	Exposure of Juncus effusus to seven perfluoroalkyl acids: Uptake, accumulation and phytotoxicity	2019	Chemosphere 2019 Oct:233:300-308. doi: 10.1016/j.chemosphere.2019.05.258	The extensive use of poly- and perfluoroalkyl substances (PFAS) has led to perfluoroalkyl acids (PFAAs) contamination in various environmental matrices. To remove PFAAs from contaminated water, this study investigated plant uptake of PFAAs by a native wetland plant species in the US, Juncus effusus. The results showed that J. effusus translocated selected PFAAs, including perfluoropentanoic acid (PFPA), perfluorobutanesulfonic acid (PFBS), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perfluorohexanesulfonic acid (PFHxS), perfluorooctanoic acid (PFOA), and perfluorooctanesulfonic acid (PFOS). During the 21-day experimental period, the uptake of PFAAs increased with increasing PFAA5 exposure concentration and time. PFOS was largely accumulated in the roots with limited upward translocation. PFAA5 with shorter carbon chain length were taken up by J. effusus roots and tended to accumulate in plant shoots. The highest removal efficiency (11.4%) of spiked PFAA5 by J. effusus was achieved when it was exposed to PFAAs at around 4.6 mg/L for 21 days. The exposure to PFAAs stimulated the antioxidative defense system in J. effusus shoots but inhibited the superoxide dismutase (SOD) and catalase (CAT) activities and damaged the antioxidative defense system in J. effusus roots. These results warrant further studies to evaluate J. effusus's long-term performance in a PFAAs contaminated environment. Published by Elsevier Ltd.		1		1				B	-		
D643	環境中運命	Wu, JY; Fang, G; Wang, XH; Jiao, LP; Wang, SQ; Li, YY; Wang, Y	Occurrence, partitioning and transport of perfluoroalkyl acids in gas and particles from the southeast coastal and mountainous areas of China	2023	Environ. Sci. Pollut. Res. 2023 Mar:30(12):32790-32798. doi: 10.1007/s11356-022-24468-6.	Perfluoroalkyl acids (PFAA) in gas and particles were analyzed in southeast coastal and mountainous cities, including Fuzhou, Xiamen, Zhangzhou and Nanping, to study the pollution characteristics, particle size distribution, phase partitioning and atmospheric transport. PFAA ranged from 7.8 to 290 pg m(-3) in gaseous phase, 27 - 1200 pg m(-3) in particulate phase, and perfluorobutanoic acid (PFBA), perfluorooctanoic acid (PFOA) were main compounds. PFAA had the highest concentration in Nanping with perfluorohexanoic acid (PFHxA) dominant, which could be related to the emission of PFAS from local industrial plants. Perfluorocarboxylic acids (PFCAs) and perfluoroalkyl sulfonic acids (PFSAs) exhibited different particle size distribution characteristics, with PFSAs preferring to distribute on coarse particles, which could be affected by the salt, minerals and organic matter in different particle sizes. The gas - particle partitioning coefficient (K-PA) had a line relationship with the fluorinated carbon chain length of PFAA, suggesting that long-chain PFAA tended to exist in particulate phase. The Winter Monsoon could transport to the study area and drive atmospheric PFAS to southern cities.	1	1						B	-		
D644	環境中運命	Gao, LJ; Liu, JL; Bao, K; Chen, NN; Meng, B	Multicompartment occurrence and partitioning of alternative and legacy per- and polyfluoroalkyl substances in an impacted river in China	2020	Sci. Total Environ. 2020 Aug:729:138753. doi: 10.1016/j.scitotenv.2020.138753.	Per- and polyfluoroalkyl substances (PFASs) are emerging global environmental contaminants. Exploring the occurrence and environmental behavior of PFASs in the aquatic environment is a key step in solving global fluorine chemical pollution problems. In this study, surface water, pore water, and sediment were collected from the main tributary and the middle and lower reaches of the Daling River, adjacent to the Fuxin fluorochemical manufacturing facilities in Liaoning Province in China, to elucidate the occurrence and partition behavior of PFASs. The total concentrations of PFASs ranged from 48.4 to 4578 ng/L in the overlying water, from 173 to 9952 ng/L in the pore water, and from 2.16 to 40.3 ng/g dw in the sediment fraction. Generally, perfluorobutanoic acid (PFBA) and perfluorobutane sulfonate (PFBS) were the predominant congeners in the samples, with the mean relative content fractions being almost consistently >40% in the dissolved phase and >25% in the sediment. Hexafluoropropylene oxide dimer acid (HFPO-DA) and chlorinated polyfluorinated ether sulfonic acid (6:2 Cl-PFESA) were detected, albeit at low levels. In addition, the detection frequency and the contribution of legacy long-chain PFASs in sediment were higher than those in the overlying water and pore water. Except for perfluorohexane sulfonate (PFHxS), the concentrations of the alternative PFASs in the pore water were higher than in the overlying water. The organic carbon fraction was a more important controlling factor for PFAS sediment levels than cations content. As with legacy long-chain PFASs, HFPO-DA and 6:2 Cl-PFESA tended to partition into the solid phase, whereas short-chain PFASs were readily distributed in the aqueous phase. Such research results will be helpful in modeling the transport and fate of PFASs released by point sources into coastal waters through rivers and in developing effective risk assessment and management strategies for the control of PFAS pollution.	1			1	1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D645	環境中運命	Zhang, L; Sun, HW; Wang, Q; Chen, H; Yao, YM; Zhao, Z; Alder, AC	Uptake mechanisms of perfluoroalkyl acids with different carbon chain lengths (C2-C8) by wheat (Triticum acstivnm L.)	2019	Sci. Total Environ. 2019 Mar:654:19-27. doi: 10.1016/j.scitotenv.2018.10.443	Organic compounds could be taken up by plants via different pathways, depending on chemical properties and biological species, which is important for the risk assessment and risk control. To investigate the transport pathways of perfluoroalkyl acids (PFAAs) by wheat (Triticum acstivnm L.), the uptake of five perfluoroalkyl carboxylic acids (PFCAs): TFA (C2), PFPrA (C3), PFBA (C4), PFHxA (C6), PFOA (C8), and a perfluoroalkyl sulfonic acid: PFOS (C8)) were studied using hydroponic experiments. Various inhibitors including a metabolic inhibitor (Na3VO4), two anion channel blockers (9-AC, DIDS), and two aquaporin inhibitors (AgNO3, glycerol) were examined. The wheat root and shoot showed different concentration trends with the carbon chain length of PFAAs. The uptake of TFA was inhibited by Na3VO4 and 9-AC whereas PFPrA was inhibited by Na3VO4, AgNO3 and 9-AC. For the other four PFAAs, only Na3VO4 was effective.These results together with the result of concentration-dependent uptake, which followed the Michaelis-Menten model, indicate that the uptake of PFAAs by wheat is mainly an energy-dependent active process mediated by carriers. For the ultra-short chain PFCAs (C2 and C3), aquaporins and anion channels may also be involved. A competition between TFA and PFPrA was determined during the plant uptake but no competition was observed between these two shorter chain analogues with other analogues, neither between PFBA and PFHxA, PFBA and PFBS, PFOA and PFOS.	1	1		1				B	-		
D646	環境中運命	Gomez-Canela, C; Barth, JAC; Lacorte, S	Occurrence and fate of perfluorinated compounds in sewage sludge from Spain and Germany	2012	Environ. Sci. Pollut. Res. 2012 Nov:19(9):4109-4119. doi: 10.1007/s11356-012-1078-7.	Perfluorinated compounds (PFCs) are persistent and bioaccumulative organic compounds used as additives in many industrial products. After use, these compounds enter wastewater treatment plants (WWTP) and long-chain PFCs are primarily accumulated in sludge. The aim of this study was to determine the occurrence and behavior of five PFCs in sludge from 15 WWTP from Spain and Germany that receive both urban and industrial wastes. The PFCs studied were perfluorooctanesulfonate (PFOS), perfluorohexanesulfonate (PFHxS), perfluorobutanesulfonate (PFBS), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA). One gram of freeze-dried, sieved, and homogenized sludge was extracted using an ultrasonic bath with methanol and glacial acetic acid. After that, the extract was recovered and evaporated to dryness with a TurboVap and then 1 mL of acetonitrile was added and the extract was cleaned up with black carbon. Liquid chromatography coupled to mass spectrometry operated in selected reaction monitoring was used to determine target compounds. Quality parameters are provided for the set of compounds studied. PFCs were detected in all samples. In Spanish sludge, aPFC ranged from 0.28 to 5.20 ng/g dry weight (dw) with prevalence of PFOS, while in German sludge, aPFC ranged from 20.7 to 38.6 ng/g dw and PFBS was the dominant compound. As a next step, the evolution of PFC concentrations within the sludge treatment steps (primary sludge, anaerobic digested sludge, and centrifuged sludge) was evaluated and differences among levels and patterns were observed and were attributed to the influent water quality and treatment used. Finally, we estimated the amount of PFCs discharged via sludge in order to determine the potential impact to the environment according to different sludge usage practices in the two regions investigated. This manuscript provided an intra-European overview of PFC distribution in sludge. Levels and compound distribution depend on the WWTP sampled. This study demonstrates that PFCs are persistent to sludge treatment and the loads in sludge may pose a future environmental risk, if not controlled.			1	1				B	-		
D647	環境中運命	Liu, SS; Zhao, SY; Liang, ZH; Wang, F; Sun, FY; Chen, D	Perfluoroalkyl substances (PFASs) in leachate, fly ash, and bottom ash from waste incineration plants: Implications for the environmental release of PFAS	2021	Sci. Total Environ. 2021 Nov:795:148468. doi: 10.1016/j.scitotenv.2021.148468.	Perfluoroalkyl substances (PFASs) are a family of chemicals widely distributed in daily use consumer products. Most of these products become municipal solid wastes (MSWs) after they have been used. In the present study, we examined different types of PFASs in leachate, fly ash and bottom ash produced from three MSW incin-eration plants in southern China. High PFAS levels were found in leachate (mean concentration 215 ng/mL, range 21.4-682 ng/mL) from the incineration plants, which indicated large amounts of PFASs in the wastes leached out. The average quantities of PFASs annually discharged from the leachates of the three plants were estimated to be approximately 384 kg (Plant A), 47.3 kg (Plant B), and 2.82 kg (Plant C). Relatively lower levels of PFASs in fly ash (mean 16.4 ng/g, range 1.46-87.6 ng/g) and bottom ash (mean 14.6 ng/g, range 3.11-77.4 ng/g) indicated that high-temperature incineration destroyed most of the PFASs. The wide array of PFASs concentrations in all three matrices illustrated that some PFASs-containing industrial wastes were still entered into local MSW. In gen-eral, short chain PFASs, including perfluorobutyric acid (PFBA) and perfluorobutane sulfonate (PFBS), were the primary PFASs in leachate samples. In addition, PFOS was the predominant PFASs in fly ash samples. The results showed that leachate, fly ash, and bottom ash from MSW incineration plants are important vectors of PFASs.	1			1				B	-		
D648	蓄積性	Zhang, WL; Cao, HM; Liang, YN	Degradation by hydrothermal liquefaction of fluoroalkylether compounds accumulated in cattails (Typha latifolia)	2021	J. Environ. Chem. Eng. 2021 Aug;9(4):105363. doi: 10.1016/j.jece.2021.105363.	Per- and polyfluorinated substances with an ether bond (ether-PFAS), such as undecafluoro-2-methyl-3oxahexanoic acid (GenX), dodecafluoro-3H-4,8-dioxanonanoate (ADONA) and 9-chlorohexadecafluoro-3-oxanonane-1-sulfonate (F-53B), have been widely used to replace conventional PFAS, especially perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). The wide use of ether-PFAS will lead to inevitable release of these chemicals to the environment and cause environmental and human health risks. In this study, we first investigated plant uptake of GenX, ADONA and F-53B by cattails (Typha latifolia), then tested destruction of these chemicals by hydrothermal liquefaction (HTL). The results showed that GenX, ADONA, and F-53B could be taken up and accumulated in cattail tissues. HTL could completely degrade GenX and ADONA in aqueous solutions and in wet cattail biomass at both 250 degrees C and 300 degrees C. F-53B, however, was resistant to the thermal treatment. Increasing HTL temperature improved degradation of this chemical by HTL. F-53B in plant biomass had higher removal efficiency, which indicated positive catalytic effect from cattail biomass. With the addition of Ca(OH)(2), 100% degradation of F-53B in plant tissues was observed.					1			B	-		
D649	蓄積性	Vicente, J; Sampera, C; Garcia-Tarrason, M; Perez, A; Lacorte, S	Perfluoroalkyl and polyfluoroalkyl substances in entire clutches of Audouin's gulls from the ebro delta	2015	Chemosphere. 2015 Jan:119 Suppl:S62-8. doi: 10.1016/j.chemosphere.2014.04.041.	The aim of the present study was to determine the distribution of per- and polyfluoroalkyl substances (PFASs) in three-egg clutches of Audouin's gull (Larus audouinii) breeding in Ebro Delta's colony according to the laying order (a, b and c eggs). Five PFASs were analyzed in 30 eggs (yolk and albumen separately), corresponding to 10 three-egg clutches. Carbon and nitrogen stable isotopes were measured as dietary tracers. PFASs were not detected in albumen. In egg yolks, perfluorooctane sulfonate (PFOS) was the main compound detected followed by perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHS) and perfluorooctanoic acid (PFOA). Perfluorooctane sulfonate (PFBS) was not detected. Mean Sigma PFASs for a-eggs was of 236 +/- 57 ng g(-1) yolk wet weight (ww), for b-eggs was of 140 +/- 56 ng g(-1) yolk ww and for c-eggs, 133 +/- 54 ng g(-1) yolk ww. PFOS concentration decreased according to the laying order of the eggs, showing significant differences between consecutive eggs. In addition, significant ccirrelation (r(s)(2) = 0.7-0.9) was observed for PFOS concentration within the eggs from the same clutch. No relationship was found between PFOS levels and stable isotopes signatures. Capsule: In Audouin gull's eggs, PFOS was the main PFASs detected and its concentration decreased according to the laying sequence.			1	1				B	-		
D650	蓄積性	Chen, CH; Yang, SH; Liu, Y; Jamieson, P; Shan, LB; Chu, KH	Accumulation and phytotoxicity of perfluorooctanoic acid and 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)propanoate in Arabidopsis thaliana and Nicotiana benthamiana	2020	Environ. Pollut. 2020 Apr:259:113817. doi: 10.1016/j.envpol.2019.113817.	2,3,3,3-Tetrafluoro-2-(heptafluoropropoxy)propanoate (known as GenX) has been used as an alternative to perfluorooctanoic acid (PFOA) which was phased out of formulations for industrial and consumer product applications in 2015. While the effects of GenX on lab animals have been studied, little is known about its effects on plants. This study examined and compared the accumulation and toxicity of GenX and PFOA in the model plants Arabidopsis thaliana and Nicotiana benthamiana. Both plants showed reduction in biomass and root growth following exposure to PFOA or GenX in a dosage-dependent manner. The bioaccumulation factors (BFs) of GenX and PFOA were plant species-dependent, with higher BFs in A. thaliana compared to N. bethanminana. Additionally, GenX and PFOA were more readily accumulated into shoot tissues of A. thaliana than in N. bethanminana. Exposure to GenX also caused a reduction in chlorophyll content (18%) and total phenolic compounds (26%). However, GenX exposure increased superoxide dismutase activity and H2O2 content (1.6 and 2.6 folds increase, respectively) in N. benthamiana. Overall, our result suggest that GenX is bioaccumulative, and that its accumulation likely inhibits plant growth and photosynthesis as well as inducing oxidative stress.					1			B	-		
D651	環境中運命	Zhan, JX; Zhang, A; Heroux, P; Guo, Y; Sun, ZY; Li, ZY; Zhao, JY; Liu, YA	Remediation of perfluorooctanoic acid (PFOA) polluted soil using pulsed corona discharge plasma	2020	J. Hazard. Mater. 2020 Apr:387:121688. doi: 10.1016/j.jhazmat.2019.121688.	Perfluorooctanoic acid (PFOA) from contaminated soil accumulates in higher organisms, and causes health risks to humans. In this research, 71 % of the PFOA was degraded, of which 51 % was decomposed into short chain by-products, 19 % mineralized, and 1 % volatilized with 30 kV of voltage, 50 Hz of discharge frequency, 1 % of soil moisture, 300 ppm of PFOA concentration and 6.3 of soil pH using pulsed positive discharge plasma. From a series of experiments, electrons were identified as the dominant active means of PFOA degradation. The decomposition by-products were analyzed by LC-MS. The results indicated that PFOA was decomposed into small by-products including perfluoroheptanoic acid (PFHpA), perfluorohexanoic acid (PFHxA), perfluoropentanoic acid (PFPeA), perfluorobutyric acid (PFBA), pentafluoropropionic acid (PFPrA) and trifluoroacetic acid (TFA). Moreover, in plasma treated soil, the concentration of ammonia nitrogen increased from less than 10 ppm-462 ppm, and the average dry weight of lettuce was 1.6 mg higher than that in natural soil. Additionally, Planctomycetes and Nitrospirae increased after treatment, indicating that plasma technology promotes the process of nitrogen cycle. Thus, PFOA polluted soil could be remediated using this pulse corona plasma technology, and simultaneously improve the fertility of soil without chemical injections.	1	1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D652	蓄積性	Fremlin, KM; Elliott, JE; Letcher, RJ; Harner, T; Gobas, FAPC	Developing Methods for Assessing Trophic Magnification of Perfluoroalkyl Substances within an Urban Terrestrial Avian Food Web	2023	Environ Sci Technol. 2023 Aug 29;57(34):12806-12818. doi: 10.1021/acs.est.3c02361.	Trophic magnification of perfluoroalkylsubstances in aterrestrial food web was investigated by measuring concentrationsof 18 perfluoroalkyl acids within biota, air, and soil samples andnormalizing concentrations in biota to their different tissues (e.g.,protein, polar lipid, and neutral lipid). We investigated the trophic magnification potential ofperfluoroalkylsubstances (PFAS) in a terrestrial food web by using a chemical activity-basedapproach, which involved normalizing concentrations of PFAS in biotato their relative biochemical composition in order to provide a thermodynamicallyaccurate basis for comparing concentrations of PFAS in biota. Samplesof hawk eggs, songbird tissues, and invertebrates were collected andanalyzed for concentrations of 18 perfluoroalkyl acids (PFAAs) andfor polar lipid, neutral lipid, total protein, albumin, and watercontent. Estimated mass fractions of PFCA C-8-C-11 and PFSA C-4-C-8 predominantlyoccurred in albumin within biota samples from the food web with smallerestimated fractions in polar lipids > structural proteins >neutrallipids and insignificant amounts in water. Estimated mass fractionsof longer-chained PFAS (i.e., C-12-C-16) mainly occurred in polar lipids with smaller estimated fractionsin albumin > structural proteins > neutral lipids > and water.Chemicalactivity-based TMFs indicated that PFNA, PFDA, PFUdA, PFDoA, PFTrDA,PFTeDA, PFOS, and PFDS biomagnified in the food web; PFOA, PFHxDA,and PFHxS did not appear to biomagnify; and PFBS biodiluted. Chemicalactivity-based TMFs for PFCA C-8-C-11 andPFSA C-4-C-8 were in good agreement withcorresponding TMFs derived with concentrations normalized to onlytotal protein in biota, suggesting that concentrations normalizedto total protein may be appropriate proxies of chemical activity-basedTMFs for PFAS, which predominantly partition to albumin. Similarly,TMFs derived with concentrations normalized to albumin may be suitableproxies of chemical activity-based TMFs for longer-chained PFAS, whichpredominantly partition to polar lipids.			1	1				B	-		
D653	蓄積性	Qian, SH; Lu, HY; Xiong, TT; Zhi, Y; Munoz, G; Zhang, CH; Li, ZW; Liu, CH; Li, W; Wang, XM; He, Q	Bioaccumulation of Per- and Polyfluoroalkyl Substances (PFAS) in Ferns: Effect of PFAS Molecular Structure and Plant Root Characteristics	2023	Environ. Sci. Technol. 2023 Mar:57(11):4443-4453. doi: 10.1021/acs.est.2c06883.	The present study assessed the bioaccumulation potential of per- and polyfluoroalkyl substances (PFAS) in ferns and linked root uptake behaviors to root characteristics and PFAS molecular structure. Tissue and subcellular-level behavioral differences between alternative and legacy PFAS were compared via an electron probe microanalyzer with energy dispersive spectroscopy (EPMA-EDS) and differential centrifugation. Our results show that ferns can accumulate PFAS from water, immobilize them in roots, and store them in harvestable tissue. The PFAS loading in roots was dominated by PFOS; however, a substantial amount of associated PFOS could be rinsed off by methanol. Correlation analyses indicated that root length, surface and project area, surface area per unit length of the root system, and molecular size and hydrophobicity of PFAS were the most significant factors affecting the magnitude of root uptake and upward translocation. EPMA-EDS images together with exposure experiments suggested that long-chain hydrophobic compounds tend to be adsorbed and retained on the root epidermis, while short-chain compounds are absorbed and quickly translocated upward. Our findings demonstrated the feasibility of using ferns in phytostabilization and phytoextraction initiatives of PFAS in the future.								B	-		
D654	環境中運命	Levine, AJ; Bean, EZ; Hinz, FO; Wilson, PC; Reisinger, AJ	Leaching of select per-/poly-fluoroalkyl substances, pharmaceuticals, and hormones through soils amended with composted biosolids	2023	J. Environ. Manage. 2023 Oct:343:118185. doi: 10.1016/j.jenvman.2023.118185.	The use of organic amendments to enhance soil health is increasingly being identified as a strategy to improve residential landscapes while also reducing the need for external inputs (e.g., fertilizers, irrigation). Composted biosolids are a re-purposed waste product that can be used in organic amendments to improve the overall sustainability of a municipality by enhancing residential soil carbon content while simultaneously reducing waste materials. However, the biosolids-based feedstock of these compost products has the potential to be a source of organic contaminants. We conducted a laboratory-based soil column experiment to evaluate the potential for different commercially available compost products to act as a source of emerging organic contaminants in residential landscapes. We compared two biosolids-based compost products, a manure-based compost product, and a control (no compost) treatment by irrigating soil columns for 30 days and collecting daily leachate samples to quantify leaching rates of six hormones, eight pharmaceuticals, and seven per- and polyfluoroalkyl substances (PFAS). Detection of hormones and pharmaceuticals was rare, suggesting that compost amendments are likely not a major source of these contaminants to groundwater resources. In contrast, we detected three of the seven PFAS compounds in leachate samples throughout the study. Perfluorohexanoic acid (PFHxA) was more likely to leach from biosolids-based compost treatments than other treatments ($p < 0.05$) and perfluorobutane sulfonate (PFBS) was only detected in biosolids-based treatments (although PFBS concentrations did not significantly differ among treatments). In contrast, perfluorooctanoic acid (PFOA) was commonly detected across all treatments (including controls), suggesting potential PFOA experimental contamination. Overall, these results demonstrate that commercially available composted biosolids amendments are likely not a major source of hormone and pharmaceutical contamination. The detection of PFHxA at significantly higher concentrations in biosolids treatments suggests that biosolids-based composts may act as sources of PFHxA to the environment. However, concentrations of multiple PFAS compounds found in leachate in this study were lower than concentrations found in known PFAS hotspots. Therefore, there is potential for environmental contamination from PFAS leaching from composted biosolids, but leachate concentrations are low which should be considered in riskbenefit analyses when considering whether or not to use composted biosolids as an organic amendment to enhance residential soil health.		1		1				B	-		
D655	環境中運命	Timshina, A; Aristizabal-Henao, JJ; Da Silva, BF; Bowden, JA	The last straw: Characterization of per- and polyfluoroalkyl substances in commercially-available plant-based drinking straws	2021	Chemosphere. 2021 Aug:277:130238. doi: 10.1016/j.chemosphere.2021.130238.	Paper and other plant-based drinking straws are replacing plastic straws in commercial settings in response to trending plastic straw bans and the larger global movement for reducing plastic pollution. The water-resistant properties of many plant-based straws, however, may be attributed to the use of per- and polyfluoroalkyl substances (PFAS) during manufacturing. In this study, 43 brands of straws (5 plastic, 29 paper, 9 other plant-based) were analyzed for the presence of 53 semi-volatile PFAS using ultra high-performance liquid chromatography tandem mass spectrometry. While the plastic straws had no measurable PFAS, 21 PFAS were detected in the paper and other plant-based straws, with total mean PFAS concentrations (triplicate analysis) ranging from 0.043 +/- 0.004 ng/straw to 29.1 +/- 1.66 ng/straw (median = 0.554 ng/straw). Perfluorobutanoic acid (PFBA), perfluorooctanoic acid (PFOA) and perfluorohexanoic acid (PFHxA) were the most frequently detected species. In a follow-up experiment, the brand with the highest PFAS levels and most diversity was tested for leaching in water at initial temperatures of 4 degrees C, 20 degrees C, and 90 degrees C. Approximately 2/3 of the total extractable PFAS leached compared to the initial methanol extraction. Semi-volatile PFAS concentrations measured in this study may be the result of manufacturing impurities or contamination, as PFAS approved for food-contact use are, typically, polymeric species. The presence of PFAS in plant-based drinking straws demonstrates that they are not fully biodegradable, contributing to the direct human ingestion of PFAS and to the cycle of PFAS between waste streams and the environment.	1	1						B	-		
D656	環境中運命	Atoufi, HD; Lampert, DJ	Analysis of a Passive Sampling Device to Assess the Behavior of Per- and Polyfluoroalkyl Substances in Sediments	2023	Environ Toxicol Chem. 2023 Oct;42(10):2171-2183. doi: 10.1002/etc.5705.	Per- and polyfluoroalkyl substances (PFAS) are an emerging class of compounds that cause health and environmental problems worldwide. In aquatic environments, PFAS may bioaccumulate in sediment organisms, which can affect the health of organisms and ecosystems. As such, it is important to develop tools to understand their bioaccumulation potential. In the present study, the uptake of perfluorooctanoic acid (PFOA) and perfluorobutane sulfonic acid (PFBS) from sediments and water was assessed using a modified polar organic chemical integrative sampler (POCIS) as a passive sampler. While POCIS has previously been used to measure time-weighted concentrations of PFAS and other compounds in water, in our study, the design was adapted for analyzing contaminant uptake and porewater concentrations in sediments. The samplers were deployed into seven different tanks containing PFAS-spiked conditions and monitored over 28 days. One tank contained only water with PFOA and PFBS, three tanks contained soil with 4% organic matter, and three tanks contained soil combusted at 550 & DEG;C to minimize the influence of labile organic carbon. The uptake of PFAS from the water was consistent with previous research using a sampling rate model or simple linear uptake. For the samplers placed in the sediment, the uptake process was explained well using a mass transport based on the external resistance from the sediment layer. Uptake of PFOS in the samplers occurred faster than that of PFOA and was more rapid in the tanks containing the combusted soil. A small degree of competition was observed between the two compounds for the resin, although these effects are unlikely to be significant at environmentally relevant concentrations. The external mass transport model provides a mechanism to extend the POCIS design for measuring porewater concentrations and sampling releases from sediments. This approach may be useful for environmental regulators and stakeholders involved in PFAS remediation.				1				B	-		
D657	環境中運命	Milinovic, J; Lacorte, S; Rigol, A; Vidal, M	Sorption of perfluoroalkyl substances in sewage sludge	2016	Environ. Sci. Pollut. Res. 2016 May:23(9):8339-8348. doi: 10.1007/s11356-015-6019-9.	The sorption behaviour of three perfluoroalkyl substances (PFASs) (perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and perfluorobutanesulfonic acid (PFBS)) was studied in sewage sludge samples. Sorption isotherms were obtained by varying initial concentrations of PFOS, PFOA and PFBS. The maximum values of the sorption solid-liquid distribution coefficients (K-d,K-max) varied by almost two orders of magnitude among the target PFASs: 140-281 mL g(-1) for PFOS, 30-54 mL g(-1) for PFOA and 9-18 mL g(-1) for PFBS. Freundlich and linear fittings were appropriate for describing the sorption behaviour of PFASs in the sludge samples, and the derived K-F and K-d,K-linear parameters correlated well. The hydrophobicity of the PFASs was the key parameter that influenced their sorption in sewage sludge. Sorption parameters and log(K-OW) were correlated, and for PFOS (the most hydrophobic compound), pH and Ca + Mg status of the sludge controlled the variation in the sorption parameter values. Sorption reversibility was also tested from desorption isotherms, which were also linear. Desorption parameters were systematically higher than the corresponding sorption parameters (up to sixfold higher), thus indicating a significant degree of irreversible sorption, which decreased in the sequence PFOS > PFOA > PFBS.				1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D658	蓄積性	Liu, ZY; Xu, C; Johnson, AC; Sun, XY; Ding, XY; Ding, D; Liu, ST; Liang, XY	Source apportionment and crop bioaccumulation of perfluoroalkyl acids and novel alternatives in an industrial-intensive region with fluorochemical production, China: Health implications for human exposure	2022	J. Hazard. Mater.2022 Feb;423(Pt A):127019. doi: 10.1016/j.jhazmat.2021.127019.	Due to their great environmental hazards, the widely used legacy perfluoroalkyl acids (PFAAs) are gradually restricted, and novel alternatives are being developed and applied. For efficient control of emerging environmental risks in agricultural production, we systematically studied the source apportionment in field soils and bioaccumulation characteristics in multiple crops of 12 PFAAs and five novel alternatives in an industrialintensive region of China, followed by human exposure estimation and health risk assessment. Compared with perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), shorter-chained PFAAs and novel alternatives have become the dominant components in local soils and crops, indicating their wide application. A positive matrix factorization (PMF) model coupled with multivariate analysis identified fluoropolymer manufacturing and textile treatment as the principal sources. The bioaccumulation factors (BAFs) of individual PFAAs and alternatives in crops decreased with increasing carbon chain lengths. As a novel alternative of PFOA, hexafluoropropylene oxide dimer acid (GenX) exhibited much higher BAFs; for the alternative of PFOS, 6:2 chlorinated polyfluorinated ether sulfonic acid (6:2 Cl-PFESA) showed lower BAFs. The bioaccumulation capacities of PFAAs and alternatives were also associated with soil organic matter and crop species. Through crop consumption, short-chained PFAAs and novel alternatives might pose emerging human health threats.					1			B	-		
D659	蓄積性	van der Schyff, V; Yive, NSCK; Polder, A; Cole, NC; Bouwman, H	Perfluoroalkyl substances (PFAS) in tern eggs from St. Brandon's Atoll, Indian Ocean	2020	Mar. Pollut. Bull. 2020 May:154:111061. doi: 10.1016/j.marpolbul.2020.111061.	Per- and polyfluoroalkyl substances (PFAS) are anthropogenic fluorinated compounds of concern for human and environmental health. There is no data on PFAS concentrations in marine bird eggs from the Western Indian Ocean. We analysed eight PFAS in eggs of fairy terns (Gygis alba), sooty terns (Onychoprion fuscatus), and common noddies (Anous stolidus) from St. Brandon's Atoll. Fairy tern eggs contained the highest concentrations, followed by sooty terns and common noddies. Perfluoroundecanoic acid (PFUdA) had the highest mean concentration (2.3 ng/g wm), followed by perfluorooctane sulfonic acid (PFOS) (2.0 ng/g wm), and perfluorononanoic acid (PFNA) (0.93 ng/g wm) in fairy tern eggs. Concentrations of all PFAS were lower than values found in literature. PFOS and PFOA concentrations were three orders of magnitude lower than toxicity reference values and levels of lowest-observed-adverse-effect-level concentrations. Eggs from St. Brandon's would be useful to monitor background changes on a regional and perhaps global scale.			1					B	-		
D660	蓄積性	Bangma, J; Guillette, TC; Strynar, M; Lindstrom, A; McCord, J; Hill, D; Lau, C; Chernoff, N; Lang, JR	A rapid assessment bioaccumulation screening (RABS) study design for emerging per-and polyfluoroalkyl substances in mice exposed to industrially impacted surface water	2022	Chemosphere. 2022 Dec;308(Pt 1):136159. doi: 10.1016/j.chemosphere.2022.136159.	The shift away from PFOS and PFOA production in the past 20 years towards shorter chain and replacement PFAS has led to the environmental release of complex mixtures of emerging PFAS for which bioaccumulation potential and toxicology are largely unknown. The rate at which emerging PFAS can be prioritized for research in these complex mixtures is often limited by the lack of available chemical standards. We developed a study design that rapidly assesses which emerging PFAS in an environmentally derived mixture have the potential for mammalian bioaccumulation and thus prioritize these emerging chemicals for standard synthesis and toxicity testing. Surface water was collected at an impacted site downstream of an industrial fluorochemical manufacturing outfall and concentrated 100-fold via weak anion exchange, solid-phase extraction. The concentrated extract contained 13 previously identified emerging PFAS, including hexafluoropropylene oxide-dimer acid (HFPO-DA). BALB/c mice were orally dosed with surface water concentrate once a day for seven days. Twenty-four hours after the last dose, liver, serum, urine, and feces were collected and the emerging PFAS were semi-quantified based on peak area counts. Of the 13 emerging PFAS, Nafion byproduct-2 (Nafion BP2), Hydro-EVE, PFO(4)DA, and PFO(5)DoA had the largest increases in percent composition when comparing serum and liver to the dosing solution, suggesting that these PFAS may have the highest bioaccumulation potential. This finding supports other studies that detected bioaccumulation of the same four PFAS in human serum collected from communities with contaminated drinking water. In the future, the Rapid Assessment Bioaccumulation Screening (RABS) study design can be extended to other complex industrial chemical mixtures impacting surface water in order to better inform chemical prioritization for acquisition and in vitro/in vivo toxicity testing of the potential pollutants.					1			B	-		
D661	環境中運命	Xu, BL; Yang, GW; Lehmann, A; Riedel, S; Rillig, MC	Effects of perfluoroalkyl and polyfluoroalkyl substances (PFAS) on soil structure and function	2023	Soil Ecol. Lett. 2023 Mar:5(1):108-117. doi: 10.1007/s42832-022-0143-5.	Soils are impacted globally by several anthropogenic factors, including chemical pollutants. Among those, perfluoroalkyl and polyfluoroalkyl substances (PFAS) are of concern due to their high environmental persistence, and as they might affect soil structure and function. However, data on impacts of PFAS on soil structure and microbially-driven processes are currently lacking. This study explored the effects of perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and perfluorobutanesulfonic acid (PFBS) at environmental-relevant concentrations on soil health, using a 6-week microcosm experiment. PFAS (even at 0.5 ng g(-1) for PFBS) significantly increased litter decomposition, associated with positive effects on beta-glucosidase activities. This effect increased with PFAS concentrations. Soil pH was significantly increased, likely as a direct consequence of increased litter decomposition affected by PFAS. Soil respiration was significantly inhibited by PFAS in week 3, while this effect was more variable in week 6. Water-stable aggregates were negatively affected by PFOS, possibly related to microbial shifts. PFAS affected soil bacterial and fungal abundance, but not microbial and certain enzyme activities. Our work highlights the potential effects of PFAS on soil health, and we argue that this substance class could be a factor of environmental change of potentially broad relevance in terrestrial ecosystem functioning. (C) The Author(s) 2022.					1			B	-		
D662	環境中運命	Sanchez-Vidal, A; Llorca, M; Farre, M; Canals, M; Barcelo, D; Puig, P; Calafat, A	Delivery of unprecedented amounts of perfluoroalkyl substances towards the deep-sea	2015	Sci. Total Environ. 2015 Sep:526:41-48. doi: 10.1016/j.scitotenv.2015.04.080	The finding of perfluoroalkyl substances (PFASs) in particles sinking to the deep northwestern Mediterranean Sea confirms the role of the latter as ballast for the transfer of pollutants to the deep sea. The transfer of particulate matter down to the deep is enhanced during atmosphere-driven, high-energy physical oceanographic processes like dense shelf water cascading (DSWC), which is caused by winter surface heat losses and evaporation. Here we present data from samples collected during winter 2012, when dense shelf water formation and subsequent cascading triggered the flushing of large amounts of PFASs through a submarine canyon to depths in excess of 1000 m. The finding of quantifiable concentrations of long-chain PFOA, PFOS and PFNA substances and significantly high concentrations of the short-chain substances PFHxA and PFBA indicates that these compounds, sorbed onto particulate matter, are quickly and directly transferred to the ocean's interior, thus highlighting the role of DSWC in removing those pollutants from the coastal ocean. Eventually, uncertainties about our results arising from the limited number of samples available are counterbalanced by their intrinsic value as intense DSWC events, like the one in 2012, occur only every 5-7 years in the study area, which seriously restricts sampling opportunities. Our results add PFASs to the list of persistent organic pollutants like polychlorinated biphenyls, chlorobenzenes or polycyclic aromatic hydrocarbons known to be conveyed to the deep marine environment.	1	1	1					B	-		
D663	環境中運命	Chen, XW; Zhu, LY; Pan, XY; Fang, SH; Zhang, YF; Yang, LP	Isomeric specific partitioning behaviors of perfluoroalkyl substances in water dissolved phase, suspended particulate matters and sediments in Liao River Basin and Taihu Lake, China	2015	Water Res. 2015 Sep:80:235-244. doi: 10.1016/j.watres.2015.04.032	The occurrence and distribution of eleven perfluoroalkyl substances (PFASs) and the isomers of perfluorooctanoate (PFOA), perfluorooctanesulfonate (PFOS) and perfluorooctane sulfonamide (PFOSA) were investigated in water dissolved phase, sediment and suspended particulate matter (SPM) in two typical watersheds in China: Liao River Basin and Taihu Lake. The total concentrations of the PFASs in the dissolved phase were 44.4-781 ng/L in Liao River with high contribution of perfluorobutane sulfonate (PFBS) (75.7%) and PFOA (9.86%). The PFASs in the dissolved phase in Taihu Lake was 17.2-94.4 ng/L with PFOA (39.8%), perfluorohexanoate (PFHxA) (30.1%) and PFOS (16.8%) as the dominant PFASs. The log Koc values of the PFASs in both SPM and sediment increased with increasing the perfluorinated carbon chain length. In Liao River Basin, the long chain perfluorocarboxylates (C10-12) bound with SPM contributed >30% to the total amount in water, suggesting that SPM could not be ignored when the environmental load of long chain PFASs in water was assessed. For the isomers of PFOA, PFOS and PFOSA, the linear isomers always displayed higher partition coefficients on particulate phases than the branched ones. An established isomer-profiling technique was applied to assess the relative contributions of various industrial origins for PFOA. In Liao River, when SPM was included in the water samples, there were contributions of PFOA from electrochemical fluorination (ECF) (similar to 55%), linear telomer (similar to 41%) and isopropyl telomer (similar to 4%) sources. While, the results based on the dissolved phase alone indicated more contribution of ECF (similar to 70%) source and lower contribution from linear telomer (similar to 26%) source. The discrepancy suggests that omitting SPM from water samples might lead to misunderstanding on the industrial origins of PFOA. In Taihu Lake, the isomer profile of PFOA was influenced mainly by ECF (similar to 88%) and partially by linear-telomer (similar to 12%) sources.		1			1			B	-		
D664	蓄積性	Mudumbi, JBN; Daso, AP; Okonkwo, OJ; Ntwampe, SKO; Matsha, TE; Mekuto, L; Itoba-Tombo, EF; Adetunji, AT; Sibali, LL	Propensity of Tagetes erecta L., a Medicinal Plant Commonly Used in Diabetes Management, to Accumulate Perfluoroalkyl Substances	2019	Toxics. 2019 Mar;7(1):18. doi: 10.3390/toxics7010018.	It has been extensively demonstrated that plants accumulate organic substances emanating from various sources, including soil and water. This fact suggests the potentiality of contamination of certain vital bioresources, such as medicinal plants, by persistent contaminants, such as perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), and perfluorobutane sulfonate (PFBS). Hence, in this study, the propensity of Tagetes erecta L. (a commonly used medicinal plant) to accumulate PFOA, PFOS, and PFBS was determined using liquid chromatography/tandem mass spectrometry (LC-MS/MS-8030). From the results, PFOA, PFOS, and PFBS were detected in all the plant samples and concentration levels were found to be 94.83 ng/g, 5.03 ng/g, and 1.44 ng/g, respectively, with bioconcentration factor (BCF) ranges of 1.30 to 2.57, 13.67 to 72.33, and 0.16 to 0.31, respectively. Little evidence exists on the bioaccumulative susceptibility of medicinal plants to these persistent organic pollutants (POPs). These results suggest that these medicinal plants (in particular, Tagetes erecta L., used for the management of diabetes) are also potential conduits of PFOA, PFOS, and PFBS into humans.					1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D665	蓄積性	Munoz, G; Mercier, L; Duy, SV; Liu, JX; Sauve, S; Houde, M	Bioaccumulation and trophic magnification of emerging and legacy per-and polyfluoroalkyl substances (PFAS) in a St. Lawrence River food web	2022	Environ. Pollut. 2022 Sep:309:119739. doi: 10.1016/j.envpol.2022.119739.	Research on per- and polyfluoroalkyl substances (PFAS) in freshwater ecosystems has focused primarily on legacy compounds and little is still known on the presence of emerging PFAS. Here, we investigated the occurrence of 60 anionic, zwitterionic, and cationic PFAS in a food web of the St. Lawrence River (Quebec, Canada) near a major metropolitan area. Water, sediments, aquatic vegetation, invertebrates, and 14 fish species were targeted for analysis. Levels of perfluorobutanoic acid (PFBA) in river water exceeded those of perfluorooctanoic acid (PFOA) or perfluorooctane sulfonate (PFOS), and a zwitterionic betaine was observed for the first time in the St. Lawrence River. The highest mean PFAS concentrations were observed for the benthopelagic top predator Smallmouth bass (Micropterus dolomieu, Sigma(60)PFAS similar to 92 +/- 34 ng/g wet weight whole-body) and the lowest for aquatic plants (0.52-2.3 ng/g). Up to 33 PFAS were detected in biotic samples, with frequent occurrences of emerging PFAS such as perfluorobutane sulfonamide (FBSA) and perfluoroethyl cyclohexane sulfonate (PFECHS), while targeted ether-PFAS all remained undetected. PFOS and long-chain perfluorocarboxylates (C10-C13 PFCAs) dominated the contamination profiles in biota except for insects where PFBA was predominant. Gammarids, molluscs, and insects also had frequent detections of PFOA and fluorotelomer sulfonates, an important distinction with fish and presumably due to different metabolism. Based on bioaccumulation factors >5000 and trophic magnification factors >1, long-chain (C10-C13) PFCAs, PFOS, perfluorodecane sulfonate, and perfluorooctane sulfonamide qualified as very bioaccumulative and biomagnifying. Newly monitored PFAS such as FBSA and PFECHS were biomagnified but moderately bioaccumulative, while PFOA was biodiluted.	1							B	-		
D666	環境中運命	Zheng, HY; Wang, F; Zhao, Z; Ma, YX; Yang, HZ; Lu, ZB; Cai, MG; Cai, MH	Distribution profiles of per- and poly fluoroalkyl substances (PFASs) and their re-regulation by ocean currents in the East and South China Sea	2017	Mar. Pollut. Bull. 2017 Dec:125(1-2):481-486. doi: 10.1016/j.marpolbul.2017.08.009.	We investigated the distribution of 17 individual per- and polyfluoroalkyl substances (PFASs) in 42 surface water samples collected from the East and South China Seas (7.0-36.0 degrees N, 110.0 degrees N -123.0 degrees E). Concentrations of 7 individual PFASs, including perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), perfluoropentanoic acid (PFPA), perfluorohexanoate (PFHxA), perfluoroheptanoate (PFHpA), perfluorooctanoic acid (PFOA), and perfluorooctane sulfonamide (FOSA), were quantified in the East China Sea, but only concentrations of PFOA and FOSA were quantified in the South China Sea. The total concentrations of the 17 PFASs ranged from 181 to 2658 pg/L in the East China Sea and from 62 to 494 pg/L in the South China Sea. We also show that river fluxes and ocean currents had a strong influence on the distribution of PFASs in the East China Sea. Using ArcGIS 10.1, we show how ocean currents control the spatial distribution of PFOA in the central South China Sea.		1		1				B	-		
D667	環境中運命	Carey, GR; Hakimabadi, SG; Singh, M; McGregor, R; Woodfield, C; Van Geel, PJ; Pham, AL	Longevity of colloidal activated carbon for in situ PFAS remediation at AFFF-contaminated airport sites	2022	Remediation. 2022 Dec:33(1):3-23. doi: 10.1002/rem.21741.	A review of state per- and polyfluoroalkyl substances (PFAS) guidelines indicates that four long-chain PFAS (perfluorooctanesulfonic acid [PFOS] and perfluorooctanoic acid [PFOA] followed by perfluorohexanesulfonic acid [PFHxS] and perfluorononanoic acid [PFNA]) are the most frequently regulated PFAS compounds. Analysis of 17 field-scale studies of colloidal activated carbon (CAC) injection at PFAS sites indicates that in situ CAC injection has been generally successful for both short- and long-chain PFAS in the short-term (0.3-6 years), even in the presence of low levels of organic co-contaminants. Freundlich isotherms were determined under competitive sorption conditions using a groundwater sample from an aqueous film-forming foam (AFFF)-impacted site. The median concentrations for these PFAS of interest at 96 AFFF-impacted sites were used to estimate influent concentrations for a CAC longevity model sensitivity analysis. CAC longevity estimates were shown to be insensitive to a wide range of potential cleanup criteria based on modeled conditions. PFOS had the greatest longevity even though PFOS is present at higher concentrations than the other species because the CAC sorption affinity for PFOS is considerably higher than PFOA and PFHxS. Longevity estimates were directly proportional to the CAC fraction in soil and the Freundlich K-f, and were inversely proportional to the influent concentration and average groundwater velocity.			1					B	-		
D668	環境中運命	Kunacheva, C; Tanaka, S; Fujii, S; Boontanon, SK; Musirat, C; Wongwattana, T; Shivakoti, BR	Mass flows of perfluorinated compounds (PFCs) in central wastewater treatment plants of industrial zones in Thailand	2011	Chemosphere. 2011 Apr:83(6):737-744. doi: 10.1016/j.chemosphere.2011.02.059.	Perfluorinated compounds (PFCs) are fully fluorinated organic compounds, which have been used in many industrial processes and have been detected in wastewater and sludge from municipal wastewater treatment plants (WWTPs) around the world. This study focused on the occurrences of PFCs and PFCs mass flows in the industrial wastewater treatment plants, which reported to be the important sources of PFCs. Surveys were conducted in central wastewater treatment plant in two industrial zones in Thailand. Samples were collected from influent, aeration tank, secondary clarifier effluent, effluent and sludge. The major purpose of this field study was to identify PFCs occurrences and mass flow during industrial WWTP. Solid-phase extraction (SPE) coupled with HPLC-ESI-MS/MS were used for the analysis. Total 10 PFCs including perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluoropropanoic acid (PFPA), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perfluorohexane sulfonate (PFHxS), perfluorononanoic acid (PFNA), perfluordecanoic acid (PFDA), perfluoroundecanoic acid (PFUnA), and perfluorododecanoic acid (PFDoA) were measured to identify their occurrences. PFCs were detected in both liquid and solid phase in most samples. The exceptionally high level of PFCs was detected in the treatment plant of IZ1 and IZ2 ranging between 662-847 ng L-1 and 674-1383 ng L-1, respectively, which greater than PFCs found in most domestic wastewater. Due to PFCs non-biodegradable property, both WWTPs were found ineffective in removing PFCs using activated sludge processes. Bio-accumulation in sludge could be the major removal mechanism of PFCs in the process. The increasing amount of PFCs after activated sludge processes were identified which could be due to the degradation of PFCs precursors. PFCs concentration found in the effluent were very high comparing to those in river water of the area. Industrial activity could be the one of major sources of PFCs contamination in the water environment.		1	1					B	-		
D669	環境中運命	Liu, YW; Hou, XW; Chen, WF; Kong, WA; Wang, DY; Liu, JY; Jiang, GB	Occurrences of perfluoroalkyl and polyfluoroalkyl substances in tree bark: Interspecies variability related to chain length	2019	Sci. Total Environ. 2019 Nov:689:1388-1395. doi: 10.1016/j.scitotenv.2019.06.454	Occurrences of perfluoroalkyl and polyfluoroalkyl substances (PFASs) in tree bark from four species were investigated. Species-dependent congener distribution patterns were firstly reported for perfluorocarboxylic acids (PFCAs) and perfluoroalkyl sulfonic acids (PFSAs). The majority of PFSAs and PFCAs in Chinese red pine bark were C5-C7 PFSAs and perfluorohexanoic acid (PFHxA, containing six carbon atoms, C6), whereas perfluorobutanesulfonic acid (PFBS, C4) and longer chain congeners (PFCAs: C >= 7; PFSAs: C 8) took a larger proportion in the fissured bark from Canadian poplar, Chinese scholartree and weeping willow. The species dependent congener profiles depended on the structures and chemical compositions of tree bark, as well as the translocation of PFASs within plants. Different tree bark characteristics caused different retention abilities for particle-bound and gaseous PFASs. Particle-bound PFASs retained in the rougher structures of fissured bark led to preferential retention of long chain congeners (the major fraction in the particle phase), while lipid-rich Chinese red pine bark retained more gaseous PFASs (mainly short chain congeners). Besides, the abundance of short chain PFASs in red pine bark was consistent with the chain length-dependent translocation behaviors of PFASs in various plants, suggesting that translocalion of PFASs within plants to tree bark may be invovled.		1		1				B	-		
D670	環境中運命	Nguyen, TV; Reinhard, M; Chen, HT; Gin, KYH	Fate and transport of perfluoro- and polyfluoroalkyl substances including perfluorooctane sulfonamides in a managed urban water body	2016	Environ. Sci. Pollut. Res. 2016 Jun:23(11):10382-10392. doi: 10.1007/s11356-016-6788-9.	Transport and fate of perfluoro- and polyfluoroalkyl substances (PFASs) in an urban water body that receives mainly urban runoff was investigated. Water, suspended solids, and sediment samples were collected during the monsoon (wet) and inter-monsoon (dry) season at different sites and depths. Samples were analyzed for C7 to C12 perfluoroalkyl carboxylate homologues (PFCAs) (PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA), perfluorohexane, perfluorooctane, and 6:2-fluorotelomer sulfonate (PFHxS, PFOS, and 6:2FtS, respectively), perfluorooctane sulfonamide (FOSA), N-ethyl FOSA (sulfluramid), N-ethyl sulfonamidoethanol (N-EtFOSE), and N-methyl and N-ethyl sulfonamidoacetic acid (N-EtFOSAA and N-MeFOSAA, respectively). Concentrations in wet samples were only slightly higher. The sum total PFAS (I PFAS) pound concentrations dissolved in the aqueous phase and sorbed to suspended solids (SS) ranged from 107 to 253 ng/L and 11 to 158 ng/L, respectively. PFOA, PFOS, PFNA, PFHxS, and PFDA contributed most (approximately 90 %) to the dissolved I PFASs pound. N-EtFOSA dominated the particulate PFAS burden in wet samples. K (D) values of PFOA and PFOS calculated from paired SS and water concentrations varied widely (1.4 to 13.7 and 1.9 to 98.9 for PFOA and PFOS, respectively). Field derived K (D) was significantly higher than laboratory K (D) suggesting hydrophobic PFASs sorbed to SS resist desorption. The I PFAS pound concentrations in the top sedimentary layer ranged from 8 to 42 mu g/kg and indicated preferential accumulation of the strongly sorbing long-chain PFASs. The occurrence of the metabolites N-MeFOSAA, N-EtFOSAA and FOSA in the water column and sediments may have resulted from biological or photochemical transformations of perfluorooctane sulfonamide precursors while the absence of FOSA, N-EtFOSA and 6:2FtS in sediments was consistent with biotransformation.			1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D671	蓄積性	Huang, J; Liu, Y; Wang, QY; Yi, JF; Lai, H; Sun, LW; Mennigen, JA; Tu, WQ	Concentration-dependent toxicokinetics of novel PFOS alternatives and their chronic combined toxicity in adult zebrafish	2022	Sci. Total Environ. 2022 Sep:839:156388. doi: 10.1016/j.scitotenv.2022.156388.	The increasing use of perfluorooctanesulfonate (PFOS) alternatives has led to their release into the aquatic environ-ment. This study sought to determine the effects of exposure concentration on the toxicokinetics of PFOS and its alter-natives, including perfluorobutanesulfonic acid (PFBS), perfluorohexanesulfonic acid (PFHxS), chlorinated polyfluorinated ether sulfonate (F-53B) and sodium p-perfluorous nonenoxybenzenesulfonate (OBS) in adult zebrafish by exposure to mixtures of the five per-and polyfluoroalkyl substances (PFAS) at 1, 10, and 100 ng/mL for 28-day, followed by a 14-day depuration. PFAS predominantly accumulated in the blood and liver, and the bioconcentration factor (BCF) decreased in the order of F-53B > PFOS > OBS >> PFHxS > PFBS in whole-fish homogenates. The uptake rate constants and BCF of the short-chain PFAS (<= C6) positively correlated with increasing exposure concentra-tion, while the long-chain PFAS (>= C8) exhibited a pattern of first increasing and then decreasing. A consistent in-crease in the elimination rate constants of short-and long-chain PFAS was observed with increasing exposure concentration. All PFAS form tight conformations with ZSA and ZL-FABP via hydrogen bonding as revealed by mo-lecular docking analysis. Furthermore, chronic combined exposure to PFAS induced the occurrence of vacuolation and oxidative stress in the zebrafish liver. Our findings uniquely inform the concentration-dependent bioconcentration potential and health risks to aquatic organisms of these PFOS alternatives in the environment.				1				B	-		
D672	環境中運命	Xu, C; Liu, ZY; Song, X; Ding, XY; Ding, D	Legacy and emerging per- and polyfluoroalkyl substances (PFASs) in multi-media around a landfill in China: Implications for the usage of PFASs alternatives	2021	Sci. Total Environ. 2021 Jan:751:141767. doi: 10.1016/j.scitotenv.2020.141767.	To date, per- and polyfluoroalkyl substances (PFASs) in environmental media surrounding landfills have not attracted much attention. In this study, six legacy PFASs, six short-chain analogues and five emerging alternatives were investigated in groundwater, surface water and sediment samples taken in the vicinity of a valley-type landfill, which had been in operation for over 20 years. Total PFAS concentrations of 110-236 ng/L, 17.3-163 ng/L and 7.91-164 ng/g dw were detected in the surface water, groundwater and sediment samples, respectively. Overall, perfluorooctanoic acid (PFOA) was the dominant PFAS in surface water, but elevated concentrations of perfluorobutanoic acid (PFBA) and perfluoropentanoic acid (PFPeA) were detected in the surface water samples taken adjacent to the landfill, suggesting that the landfill contributed to these compounds. PFBA was the dominant PFAS in the groundwater and sediments. The concentrations of long-chain perfluoroalkyl carboxylic acids (PFCAs) (C8-C12) in the sediment samples correlated significantly with the TOC, Al2O3 and Fe2O3 contents. The partitioning behaviors of PFCAs in the water-sediment system varied depending on the CF2 moiety units. For the long-chain PFCAs, positive correlations between the average LogKd and the number of CF2 moieties were found to be statistically significant, whereas negative correlations were observed for the short-chain PFCAs (C4-C7). The ratios of short-chain analogues and emerging alternatives versus their respective legacy PFOA and perfluorooctane sulfonate (PFOS) in surface water suggested an increasing trend of short-chain analogues, such as PFBA. The potential health risks of PFOS and PFOA, determined by calculating the estimated daily intake (EDI), were found to be negligible via the drinking groundwater exposure pathway, but more comprehensive studies on the human health risks of PFASs from landfills are essential.	1							B	-		
D673	蓄積性	Huang, K; Li, YL; Bu, D; Fu, J; Wang, ML; Zhou, W; Gu, LY; Fu, YL; Cong, ZY; Hu, BY; Fu, JJ; Zhang, AQ; Jiang, GB	Trophic Magnification of Short-Chain Per- and Polyfluoroalkyl Substances in a Terrestrial Food Chain from the Tibetan Plateau	2022	Environ. Sci. Technol. Lett. 2022 Jan:9(2):147-152. doi: 10.1021/acs.estlett.1c01009.	While there is a lack of information about the trophic transfer of short-chain per- and polyfluoroalkyl substances (PFASs) in the terrestrial ecosystem, this study focused on the occurrence and trophic transfer of both legacy and short-chain PFASs in a terrestrial food chain composed of the plants, plateau pikas, and eagles of the Tibetan Plateau. Total PFAS concentrations were in the range of 0.130-1.507, 0.406-1.085, 0.601-8.293, and 5.021-76.482 ng/g dw in soils, plants, pika muscles, and eagle muscles, respectively, among which perfluorooctanesulfonic acid (PFOS) and perfluorobutanoic acid (PFBA) were predominant in all sample types. Levels of PFASs in eagle feathers were significantly correlated with those in eagle muscles (r = 0.73), implying feathers could be used as an indicator of exposure of raptors to PFASs. Trophic magnification factors of PFOS (5.75), perfluorohexanesulfonic acid (2.43), C10-C12 perfluorocarboxylic acids (1.84-4.65), PFBA (5.11), and perfluorobutanesulfonic acid (5.96) along the plant-pika-eagle food chain were all significantly greater than 1. The short-chain PFASs may be biomagnified in air-breathing animals because of the nonvolatility of their charged forms and recalcitrance (not biotransformed). The results suggest that the ecological risks of these short-chain substitutions warrant further investigation.	1			1				B	-		
D674	蓄積性	Judy, JD; Gravesen, C; Wilson, PC; Lee, L; Sarchapone, J; Hinz, F; Broadbent, E	Trophic transfer of PFAS from tomato (Solanum lycopersicum) to tobacco hornworm (Manduca sexta) caterpillars	2022	Environ. Pollut. 2022 Oct:310:119814. doi: 10.1016/j.envpol.2022.119814.	PFASs are highly persistent in the environment and the potential exists for terrestrial biota to accumulate PFAS, which may result in exposure of higher tmphic level organisms to these compounds through consumption. However, trophic transfer of proteinophilic compounds such as PFAS has not been extensively studied and the degree to which plant-accumulated PFAS will be transferred to herbivorous consumers is unclear. Here, we exposed Solanum lycopersicum (tomato) plants to a suite of 7 different PFAS, including 4 carboxylic acids (PFOA, PFHxA, PFHpA and PFDA) and 3 sulfonates (PFBS, PFHxS and PFOS). Exposed leaf tissues were subsequently fed to Manduca sexta (tobacco hornworm) caterpillars. Biomagnification factors (BMFs) were all below 1 and patterns of uptake and elimination were similar between the different PFAS. However, PFOS bioaccumulated in the hornworms to a much higher concentration, with approximately 5-fold higher BMFs and assimilation efficiencies (AEs) than other PFAS tested. AE and BMF, as well as PFAS uptake by the plants, were positively correlated with PFAS carbon chain length for both sulfonates and carboxylic acids, providing evidence that longer chain PFAS may be more efficiently accumulated (or less efficiently eliminated) than shorter-chain PFAS in some contexts.		1		1				B	-		
D675	環境中運命	Borthakur, A; Cranmer, BK; Dooley, GP; Blotevogel, J; Mahendra, S; Mohanty, SK	Release of soil colloids during flow interruption increases the pore-water PFAS concentration in saturated soil	2021	Environ. Pollut. 2021 Oct:286:117297. doi: 10.1016/j.envpol.2021.117297.	Groundwater flow through aquifer soils or packed bed systems can fluctuate for various reasons, which could affect the concentration of natural colloids and per- and polyfluoroalkyl substances (PFAS) in the pore water. In such cases, PFAS concentration could either decrease due to matrix diffusion of PFAS or increase by the detachment of colloids carrying PFAS. Yet, the effect of flow fluctuation on PFAS transport or release in porous media has not been examined. To examine the relative importance of either process, we interrupted the flow during an injection of groundwater spiked with perfluorobutanoic acid (PFBA), perfluorooctanoic acid (PFOA), and bromide as conservative tracer through clay-rich soil, so that diffusive transport would be prominent during flow interruption. After flow interruption, the PFAS concentration did not decrease indicating an insignificant contribution of matrix diffusion. The concentration increased, potentially due to enhanced release of colloidassociated PFAS. Analysis of samples before and after flow interruption by particle size analysis and SEM confirmed an increase in soil colloid concentration after the flow interruption. XRD analysis of soil and the colloids proved that PFAS were associated with specific sites of the colloids. Due to a higher affinity of PFOA to soil colloids, the total PFOA concentration in the effluent samples increased more than PFBA after the flow interruption process. The results indicate that colloids may have a disproportionally higher role in the transport of PFAS in conditions that release colloids from porous media. Thus, fluctuations in groundwater flow can increase this colloid facilitated mobility of PFAS.	1							B	-		
D676	環境中運命	Zhao, XL; Xia, XH; Zhang, SW; Wu, Q; Wang, XJ	Spatial and vertical variations of perfluoroalkyl substances in sediments of the Haihe River, China	2014	J. Environ. Sci. 2014 Aug:26(8):1557-1566. doi: 10.1016/j.jes.2014.05.023.	The levels of six perfluoroalkyl substances (PFASs) in surface sediment and their vertical variations in dated sediment cores from the Haihe River were investigated; studied substances included perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorooctane sulfonate (PFOS), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnA), and perfluorododecanoic acid (PFDoA). Results showed that the total PFAS concentration in surface sediment ranged between 0.52 and 16.33 ng/g dry weight (dw) with an average of 3.47 ng/g dw, with PFOS and PFOA as the dominant PFASs. In general, the PFAS concentrations in the mainstream increased from the upper to the lower reaches, except that a drop occurred downstream of the Erdao dam. Although the PFASs in the sediment cores did not show a clear decreasing or increasing trend with depth, the three cores had a similar vertical variation. The PFAS levels were relatively low in the surface sediment, and reached the first high point at 8-20 cm as a result of the wide use of PFASs from 1990 to 2000. After that the PFAS levels decreased, and then increased to a second high point at about 40-48 cm, which might be caused by the leaching of PFASs in sediment. Because PFASs have hydrophilic groups and relatively high solubility, the PFASs will transfer from the upper to lower layers of sediment when water infiltration occurs, leading to the fluctuation of PFAS levels in sediment cores. This study suggests that both the temporal variation of sources and transfer processes of PFASs in sediments are important factors influencing the vertical variation of PFASs in sediment cores.			1					B	-		
D677	環境中運命	Abada, B; Alivio, TEG; Shao, YR; O'Loughlin, TE; Klemashevich, C; Banerjee, S; Jayaraman, A; Chu, KH	Photodegradation of fluorotelomer carboxylic 5:3 acid and perfluorooctanoic acid using zinc oxide	2018	Environ. Pollut. 2018 Dec;243(Pt A):637-644. doi: 10.1016/j.envpol.2018.09.023.	Occurrence of per- and poly-fluoroalkyl substances (PFASs) in the environment and biota has raised a great concern to public health because these compounds are persistent, bioaccumulative, and toxic. Biodegradation of polyfluoroalkyl substances, particularly long-chain fluorotelomer-based products, can lead to production of various short-chain PFASs, with 5:3 fluorotelomer carboxylic acid (referred as 5:3 FTCA hereafter) as a dominant polyfluoroalkyl metabolite. Perfluoroalkyl acids, particularly perfluorooctanoic acid (PFOA), are toxic and current removal methods are not cost-effective. This study reports the photodegradation of 5:3 FTCA and PFOA using ZnO as a photocatalyst under neutral pH and room temperature conditions. Under long UV wavelength (365 nm), both tetrapod and commercial ZnO can photodegrade 5:3 FTCA. Five removal products-perfluorohexanoic acid, perfluoropentanoic acid, perfluorobutyric acid, 5:2 fluorotelomer carboxylic acid (5:2 FTCA), and inorganic fluoride-were identified, with PFBA and F- as dominant end products. SEM and XPS high-resolution scans on the surface of the utilized ZnO showed less units of CF2 than that in 5:3 FICA, supporting occurrence of photo degradation of 5:3 FTCA by ZnO. Defluorination of PFOA was not observed with ZnO only, but at pH 5 and in the co-presence of Fe-citrate. PFOA defluorination increased from 0.93% after 3 days of UV light exposure to 3.9% after additional 135 h under direct sunlight exposure. To the authors' best knowledge, this is the first report studying ZnO-catalyzed photodegradation of 5:3 FICA, and examining the Fe co-addition for PFOA defluorination.	1	1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D678	環境中運命	De Silva, AO; Muir, DCG; Mabury, SA	DISTRIBUTION OF PERFLUOROCARBOXYLATE ISOMERS IN SELECT SAMPLES FROM THE NORTH AMERICAN ENVIRONMENT	2009	Environ. Toxicol. Chem. 2009 Sep:28(9):1801-1814. doi: 10.1897/08-500.1.	Perfluorinated acids are anthropogenic pollutants with primarily two industrial synthetic routes: electrochemical fluorination (ECF) and telomerization. A mixture of structural isomers is produced by ECF, while telomerization conserves the geometry of its starting materials, which are typically linear. To contribute to a discussion on sources of perfluorinated acid pollution, isomer profiles of perfluorinated carboxylates (PFCAs) were determined in a diverse set of environmental and biotic samples from remote to urban locations. Analysis was conducted on the derivatized extracts using gas chromatography/mass spectrometry. The perfluorooctanoate (PFOA) isomer profile in most samples contained linear and branched isomers congruent with an ECF input, but linear PFOA (n-PFOA) predominated (>90%) greater than in the ECF technical product (78%). The perfluorononanoate (PFNA) isomer pattern varied from only n-PFNA, n-and iso-PFNA (isopropyl isomer), or n-PFNA and multiple branched isomers. At midlatitudes, PFNA isomer profiles containing multiple branched isomers are attributed to ECF sources such as impurities in ECF PFOA. In surface water from Lake Ontario (Canada) and an Arctic lake, only n-and iso-PFNA were observed. Human and dolphin blood contained multiple branched PFNA, consistent with an ECF signature albeit n-isomer enriched. Both n-and isopropyl isomers of longer-chain PFCAs were observed with a distinct pattern for dolphin and Arctic samples compared to those from the Lake Ontario ecosystem. These results support the hypothesis that long-range atmospheric transport of linear volatile precursors, subsequent degradation, and deposition contribute to the presence of n-PFCAs in the Arctic freshwater environment. The presence of longer-chain isopropyl isomers may be preliminary evidence of isopropyl fluorinated organic precursors.			1					B	-		
D679	環境中運命	Nesse, AS; Jasinska, A; Ali, AM; Sandblom, O; Sogn, TA; Benskin, JP	Uptake of Ultrashort Chain, Emerging, and Legacy Per- and Polyfluoroalkyl Substances (PFAS) in Edible Mushrooms (Agaricus spp.) Grown in a Polluted Substrate	2023	J. Agric. Food Chem. 2023 Mar:71(11):4458-4465. doi: 10.1021/acs.jafc.2c03790.	Uptake of 19 per-and polyfluoroalkyl substances (PFAS), including C3-C14 perfluoroalkyl carboxylic acids (PFCAs), C4, C6, and C8 perfluoroalkyl sulfonates (PFSAs), and four emerging PFAS, was investigated in two mushroom species (Agaricus bisporus and Agaricus subrufescens) cultivated in a biogas digestate-based substrate. Accumulation of PFAS in mushrooms was low and strongly chain-length dependent. Among the different PFCAs, bioaccumulation factors (log BAFs) decreased from a maximum of -0.3 for perfluoropropanoic acid (PFPrA; C3) to a minimum of -3.1 for perfluoroheptanoate (PFHpA; C7), with only minor changes from PFHpA to perfluorotridecanoate (PFTriDA; C13). For PFSAs, log BAFs decreased from perfluorobutane sulfonate (PFBS; -2.2) to perfluorooctane sulfonate (PFOS; -3.1) while mushroom uptake was not observed for the alternatives 3H-perfluoro-3-[(3-methoxy-propoxy)propanoic acid] (ADONA) and two chlorinated polyfluoro ether sulfonates. To the best of our knowledge, this is the first investigation of the uptake of emerging and ultra-short chain PFAS in mushrooms, and generally the results indicate very low accumulation of PFAS.				1				B	-		
D680	蓄積性	Nakata, H; Kannan, K; Nasu, T; Cho, HS; Sinclair, E; Takemura, A	Perfluorinated contaminants in sediments and aquatic organisms collected from shallow water and tidal flat areas of the Ariake Sea, Japan: Environmental fate of perfluorooctane sulfonate in aquatic ecosystems	2006	Environ. Sci. Technol. 2006 Aug:40(16):4916-4921. doi: 10.1021/es0603195.	Perfluorinated compounds (PFCs), such as perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorohexane sulfonate (PFHS), and perfluorooctane sulfonamide (PFOSA) are widely distributed in aquatic ecosystems. Despite studies reporting the occurrence of PFCs in aquatic organisms, the fate of PFCs in tidal flat and marine coastal ecosystems is not known. In this study, we determined concentrations of PFOS, PFOA, PFNA, PFHS, and PFOSA in sediments; benthic organisms, including lugworm, mussel, crab, clam, oyster, and mudskipper fish from tidal flat; and shallow water species, such as filefish, bream, flounder, shark, finless porpoise, gull, and mallard collected from the Ariake Sea, Japan. PFOS and PFOA were detected in most of the samples analyzed, followed by PFNA, PFOSA, and PFHS. In shallow water species, PFOS was the dominant contaminant, and elevated concentrations were found in higher trophic level species, such as marine mammals and omnivorous birds. These results suggest biomagnification of PFOS through the coastal food chain. In contrast, PFOA was the most abundant compound in tidal flat organisms and sediments. PFOA concentrations in sediments, lugworms, and omnivorous mudskippers in tidal flat were approximately 1 order of magnitude greater than the levels of PFOS. This indicates differences in exposure pattern and bioavailability of PFOS and PFOA between shallow water and tidal flat organisms. The accumulation profiles of PFCs were compared with those of organochlorines (polychlorinated biphenyls, PCB), organotin (tributyltin, TBT), and polycyclic aromatic hydrocarbons (PAHs) in tidal flat and shallow water samples collected from the Ariake Sea. Concentrations of PFCs in sediments and in tidal flat organisms were significantly lower than that found for PCBs, TBT, and PAHs. Nevertheless, PFOS concentrations in shallow water species were comparable to and/or significantly greater than those of other classes of contaminants. This implies that the aqueous phase is a major sink for PFCs, which is different from what was observed for nonpolar organic pollutants.			1				B	-		
D681	蓄積性	Xia, XH; Dai, ZN; Rabearisoa, AH; Zhao, PJ; Jiang, XM	Comparing humic substance and protein compound effects on the bioaccumulation of perfluoroalkyl substances by Daphnia magna in water	2015	Chemosphere 2015 Jan:119:978-986. doi: 10.1016/j.chemosphere.2014.09.034	The influence of humic substances and protein compounds on the bioaccumulation of six types of perfluoroalkyl substances (PFASs) in Daphnia magna was compared. The humic substances included humic acid (HA) and fulvic acid (FA), the protein compounds included chicken egg albumin (albumin) and peptone, and the PFASs included perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid, perfluoroundecanoic acid, and perfluorododecanoic acid. Four concentrations (0,1,10, and 20 mg L-1) of the four dissolved organic matter (DOM) types were investigated. At the 1 mg L-1 level, HA and albumin enhanced all tested PFAS bioaccumulation, whereas, FA and peptone only enhanced the bioaccumulation of shorter-chain PFASs (PFOS, PFOA, and PFNA). However, all four DOM types decreased all tested PFAS bioaccumulation at the 20 mg L-1 level, and the decreasing ratios of bioaccumulation factors caused by FA, HA, albumin, and peptone were 1-49%, 23-77%, 17-58%, and 8-56%, respectively compared with those without DOM. This is because DOM not only reduced the bioavailable concentrations and uptake rates of PFASs but also lowered the elimination rates of PFASs in D. magna, and these opposite effects would change with different DOM types and concentrations. Although the partition coefficients (L kg(-1)) of PFASs between HA and water (10(4.21)-10(4.98)) were much lower than those between albumin and water (10(4.92)-10(5.86)), their effects on PFAS bioaccumulation were comparable. This study suggests that although PFASs are a type of proteinophilic compounds, humic substances also have important effects on their bioavailability and bioaccumulation in aquatic organisms.			1				B	-		
D682	蓄積性	Pan, CG; Xiao, SK; Yu, KF; Wu, Q; Wang, YH	Legacy and alternative per- and polyfluoroalkyl substances in a subtropical marine food web from the Beibu Gulf, South China: Fate, trophic transfer and health risk assessment	2021	J. Hazard. Mater. 2021 Feb:403:123618. doi: 10.1016/j.jhazmat.2020.123618.	The usage of alternative perand polyfluoroalkyl substances (PFASs) has been increasing due to the restriction and elimination of legacy PFASs. However, there is limited knowledge on bioaccumulation and trophic magnification of alternative PFASs, especially in subtropical ecosystems. In the present study, we performed a comprehensive survey to investigate the occurrence, bioaccumulation and trophic magnification of legacy and alternative PFASs in subtropical marine food webs in the Beibu Gulf, South China. Results showed that perfluorobutanoic acid (PFBA) and perfluorooctanoic acid (PFOA) were the predominant PFASs in water phase, while perfluorooctane sufonate (PFOS) contributed most to the sum of target PFASs in sediments and marine organisms. Of the investigated PFASs, PFOS and 6:2 chlorinated polyfluoroalkyl ether sulfonic acids (F-53B) exhibited the highest bioaccumulation factor with values > 5000, qualifying as very bioaccumulative chemicals. There was a significant positive correlation between log BSAF and the carbon chain length of perfluoroalkyl carboxylic acids (PFCAs). Trophic magnification (TMF) was observed for PFOS and F-53B, while the remaining PFASs were biodiluted through the present food web. The hazard ratios for PFOS and PFOA in all organisms were far less than unity, suggesting overall low PFAS risks for humans through consumption of marine organisms.	1						B	-		
D683	環境中運命	Zhao, HT; Yang, LP; Yang, XJ; Zhao, SY	Behaviors of 6:2 fluorotelomer sulfonamide alkylbetaine (6:2 FTAB) in wheat seedlings: Bioaccumulation, biotransformation and ecotoxicity	2022	Ecotox. Environ. Safe. 2022 Jun:238:113585. doi: 10.1016/j.ecoenv.2022.113585.	As a new alternative to perfluorooctane sulfonate (PFOS), 6:2 fluorotelomer sulfonamide alkylbetaine (6:2 FTAB) has been currently used in industrial and consumer applications, which has been frequently detected in environment media. However, the behaviors of 6:2 FTAB in plants are still unclear. This study investigated the bioaccumulation, biotransformation and ecotoxicity of 6:2 FTAB in wheat (Triticum aestivum L.) by hydroponic exposure. 6:2 FTAB was easily taken up by roots with the root concentration factor (RCF) as high as 94.8, but difficult to be acropetally translocated in the shoots with the translocation factor (TF) as low as 0.058. Two intermediates and six terminal perfluorocarboxylic acid (PFCA) metabolites were detected in roots and shoots. The detected metabolites included 6:2 fluorotelomer sulfonic acid (6:2 FTSA), 6:2 fluorotelomer carboxylic acid (6:2 FTCA), perfluoroheptanoic acid (PFHpA), perfluorohexanoic acid (PFHxA), perfluoropentanoic acid (PFPeA), perfluorobutyric acid (PFBA), pentafluoropropionic acid (PFPrA) and trifluoroacetic acid (TFA), and 6:2 FTSA was the main metabolite. 6:2 FTAB significantly reduced the biomass of plant and prevented chlorophyll (Chl) accumulation, while caused no significant change in malondialdehyde (MDA) content. Significant reduction in glutathione (GSH) contents, excess production of reactive oxygen species (ROS), and obvious inhibition of superoxide dismutase (SOD), catalase (CAT), peroxidase (POD) and glutathione-s-transferase (GST) activities were observed, suggesting damage of antioxidant defense systems and failure to detoxication of 6:2 FTAB in wheat. These findings provide important knowledge for the fate of 6:2 FTAB in plants.	1	1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D684	環境中運命	Ding, XY; Song, X; Xu, MM; Yao, J; Xu, C; Tang, ZW; Zhang, ZX	Co-occurrence and correlations of PFASs and chlorinated volatile organic compounds (cVOCs) in subsurface in a fluorochemical industrial park: Laboratory and field investigations	2022	Sci. Total Environ. 2022 Mar:814:152814. doi: 10.1016/j.scitotenv.2021.152814.	Fluorochemical industrial park (FIP) represents an important source of per- and polyfluoroalkyl substances (PFASs) and chlorinated volatile organic compounds (cVOCs). Exploring the co-occurrence and correlations of PFASs and cVOCs isa key step towards the understanding their distributions in the field. In this study, perfluorooctanoic acid (PFOA) was the dominant compound in groundwater and aquifer solids, and elevated concentrations of short-chain perfluoroalkyl carboxylic acids (PFCAs) and hexafluoropropylene oxide oligomers were also detected in the field, suggesting their wide applications as substitutes for PFOA. Correlation analyses between PFASs and cVOCs suggested that cVOCs had a significant influence on the distribution and composition of PFASs in the field. In addition, the presence of cVOCs in the form of dense non-aqueous-phase organic liquids (DNAPL) affected the distribution and migration of PFASs at various depths, as evidenced by the relatively high PFASs concentrations (204 mu g/L) and PFOA abundance (85.4%) in the deep aquifer, likely due to DNAPL-water interfaces sorption or partition into bulk DNAPL. The log Kd values, determined in the laboratory, were found to increase in the presence of DNAPL, especially for PFOA, with more than one time higher than those of perfluorobutanoic acid (PFBA) and hexafluoropropylene oxide dimer acid (HFPO-DA). This conclusion further demonstrated that PFOA had a higher potential to participate into DNAPL, which can migrate with DNAPL to the deep aquifer, supporting the higher abundance of PFOA in the deep aquifer mentioned above. However, the log Kd-field values of PFBA and HFPO-DA in the field were higher than that of PFOA, and no significant correlations ($p > 0.05$) were found between log Kd-field values and the chain-length of PFCAs at various depths, suggesting that the phenomena observed in the field are a result of composite influencing factors.	1				1			B	-		
D685	蓄積性	Gui, D; Zhang, M; Zhang, T; Zhang, B; Lin, WZ; Sun, X; Yu, XJ; Liu, W; Wu, YP	Bioaccumulation behavior and spatiotemporal trends of per- and polyfluoroalkyl substances in Indo-Pacific humpback dolphins from the Pearl River Estuary, China	2019	Sci. Total Environ. 2019 Mar:658:1029-1038. doi: 10.1016/j.scitotenv.2018.12.278	Sixteen per- and polyfluoroalkyl substances (PFASs) were measured in liver (n = 52) and kidney (n = 18) tissues of inclo-Pacific humpback dolphins (Sousa chinensis) stranded in the Pearl River Estuary (PRE) of China between 2004 and 2016. The average concentrations of perfluorooctane sulfonate (PFOS), perfluorooocianoic acid (PFOA) and most of other PFASs in the liver samples were respectively greater than any records previously reported in cetaceans globally. PFOS levels in 46% of dolphin liver samples exceeded the hepatic toxicity threshold in cetaceans. For the first time, we found a U-shaped trend for the distribution pattern of perfluorinated carboxylic acids (PFCAs) between liver and kidney with 'increasing carbon chain lengths (C5-C16), whereas a descending trend (C4-C10) was found for perfluoroalkane sulfonic acids (PFASs), which may be explained by binding efficiencies of PFAS analogues to proteins. Dolphins with the highest levels of Sigma PFASs (age-corrected) were clustered near the river outlets in Lingdingyang area, which agrees with the spatial distribution of PFASs in the environment. Significant temporal trends were observed for many PFASs. Concentrations of PFOA, perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA) and peilluoroheptanoic acid (PFHpA) all peaked in year 2011, followed by a decreasing trend, while a consistently descending trend was shown for perfluorounclecanoic acid (PEUdA) and perfluoroclecane sulfonate (PEDS). Our findings contribute to the knowledge of tissue distribution and spatiotemporal trends of PFASs in the PRE dolphins, which are valuable for us to understand the PFASs exposure risk and their industrial emission in Southern China.			1					B	-		
D686	環境中運命	Dalahmeh, S; Tirgani, S; Komakech, AJ; Niwagaba, CB; Ahrens, L	Per- and polyfluoroalkyl substances (PFASs) in water, soil and plants in wetlands and agricultural areas in Kampala, Uganda	2018	Sci. Total Environ. 2018 Aug:631-632:660-667. doi: 10.1016/j.scitotenv.2018.03.024	Occurrence and concentrations of 26 per- and polyfluoroalkyl substances (PFASs) were evaluated in wastewater, surface water, soil and crop plants (yam (Dioscorea spp.), maize (tea mays) and sugarcane (Saccharum officinarum)) in Nakivubo wetland and Lake Victoria at Kampala, Uganda. Sigma PFAS concentrations in effluent from Bugolobi wastewater treatment plant (WWTP) were higher (5.6-9.1 ngL(-1)) than in the corresponding influent (3.4-5.1 ngL(-1)), indicating poor removal of PFASs within the WWTP. Sigma PFAS concentrations decreased by a factor of approximately live between Nakivubo channel (8.5-12 ng L-1) and Lake Victoria (1.0-2.5 ng L-1), due to dilution, sorption to sediment and uptake by plants in the wetland. Sigma PFAS concentrations were within the range 1700-7900 pg g(-1)dry weight (dw) in soil and 160 pg g(-1)dw (maize cobs) to 380 pg g(-1) dw (sugarcane stems) in plants. The dominant PFASs were perfluorohexanesulfonate (PFHxS) in wastewater, perfluorooctanoate (PFOA) in surface water. perfluorooctanesulfonate (PFOS) in soil and perfluoroheptanoate (PFHpA) and PFOA in different plant tissues, reflecting PFAS-specific partitioning behaviour in different matrices. Soil-water partitioning coefficient (log K-d) in wetland soil under yam was lowest for short-chain PFHxA (1.9-2.3 L kg(-1)) and increased with increasing chain length to 2.8-3.1 Lkg(-1) for perfluoroundecanoate (PFUnDA) and 2.8-3.1 Lkg(-1) for perfluorooctanesulfonate (PFOS). The log K-oc, values ranged between 22 and 3.6 Lkg(-1) , with the highest log K-oc estimated for long-chain perfluorocarbon PFASs (i.e. PFUnDA 3.2-3.5 L kg(-1) and PFOS 3.2-3.6 Lkg(-1)). The concentration ratio (CR) between plants and soil was <1 for all PFASs and plant species, with the highest CR estimated for PFHpA (0.65-0.67) in sugarcane stem and PFBS (0.53-0.59) in yam root. Overall, this investigation demonstrated PFASs entry into the terrestrial food chain and drinking water resources in Kampala, Uganda. Source identification, assessment of impacts on human health and the environment, and better wastewater treatment technologies are needed.		1		1				B	-		
D687	環境中運命	Roostaei, J; Colley, S; Mulhern, R; May, AA; Gibson, JM	Predicting the risk of GenX contamination in private well water using a machine-learned Bayesian network model	2021	J. Hazard. Mater. 2021 Jun:411:125075. doi: 10.1016/j.jhazmat.2021.125075.	Per- and polyfluoroalkyl substances (PFAS) are emerging contaminants that pose significant challenges in mechanistic fate and transport modeling due to their diverse and complex chemical characteristics. Machine learning provides a novel approach for predicting the spatial distribution of PFAS in the environment. We used spatial location information to link PFAS measurements from 1207 private drinking water wells around a fluorochemical manufacturing facility to a mechanistic model of PFAS air deposition and to publicly available data on soil, land use, topography, weather, and proximity to multiple PFAS sources. We used the resulting linked data set to train a Bayesian network model to predict the risk that GenX, a member of the PFAS class, would exceed a state provisional health goal (140 ng/L) in private well water. The model had high accuracy (ROC curve index for five-fold cross-validation of 0.85, 90% CI 0.84?0.87). Among factors significantly associated with GenX risk in private wells, the most important was the historic rate of atmospheric deposition of GenX from the fluorochemical manufacturing facility. The model output was used to generate spatial risk predictions for the study area to aid in risk assessment, environmental investigations, and targeted public health interventions.					1			B	-		
D688	環境中運命	An, XP; Lei, HJ; Lu, YL; Xie, XW; Wang, P; Liao, JM; Liang, Z; Sun, B; Wu, ZY	Per- and polyfluoroalkyl substances (PFASs) in water and sediment from a temperate watershed in China: Occurrence, sources, and ecological risks	2023	Sci. Total Environ. 2023 Sep:890:164207. doi: 10.1016/j.scitotenv.2023.164207.	Per- and polyfluoroalkyl substances (PFASs) are a class of synthetic organic fluorides that have been widely used in various industrial and consumer applications. However, their potential ecological risks have raised concerns. In this study, PFASs were investigated in different environmental media in the Jiulong River and Xiamen Bay regions of China, revealing widespread contamination of PFASs in the watershed. PFBA, PFPeA, PFOA, and PFOS were detected in all 56 sites, with short-chain PFASs dominating (72 % of the total). Novel PFAS alternatives, including F¥¥53B, HFPO-DA, and NaDONA, were detected in >90 % of the water samples. Seasonal and spatial variations in PFAS concentrations were observed in the Jiulong River estuary, while Xiamen Bay was not significantly affected by seasonal changes. In sediment, PFSAs were dominant with long-chains while PFCAs with short-chains, and the occurrence was influenced by water depth and salinity. PFSAs were more inclined to be adsorbed in sediments than PFCAs, and log Kd of PFCAs increased with the numbers of -CF2-. Paper packaging, machinery manufacturing, WWTP discharge, airport and dock	1				1			B	-		
D689	環境中運命	Cousins, IT; Johansson, JH; Salter, ME; Sha, B; Scheringer, M	Outside the Safe Operating Space of a New Planetary Boundary for Per- and Polyfluoroalkyl Substances (PFAS)	2022	Environ. Sci. Technol. 2022 Aug:56(16):11172-11179. doi: 10.1021/acs.est.2c02765.	It is hypothesized that environmental contamination by per-and polyfluoroalkyl substances (PFAS) defines a separate planetary boundary and that this boundary has been exceeded. This hypothesis is tested by comparing the levels of four selected perfluoroalkyl acids (PFAAs) (i.e., perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexanesulfonic acid (PFHxS), and perfluorononanoic acid (PFNA)) in various global environmental media (i.e., rainwater, soils, and surface waters) with recently proposed guideline levels. On the basis of the four PFAAs considered, it is concluded that (1) levels of PFOA and PFOS in rainwater often greatly exceed US Environmental Protection Agency (EPA) Lifetime Drinking Water Health Advisory levels and the sum of the aforementioned four PFAAs (sigma 4 PFAS) in rainwater is often above Danish drinking water limit values also based on sigma 4 PFAS; (2) levels of PFOS in rainwater are often above Environmental Quality Standard for Inland European Union Surface Water; and (3) atmospheric deposition also leads to global soils being ubiquitously contaminated and to be often above proposed Dutch guideline values. It is, therefore, concluded that the global spread of these four PFAAs in the atmosphere has led to the planetary boundary for chemical pollution being exceeded. Levels of PFAAs in atmospheric deposition are especially poorly reversible because of the high persistence of PFAAs and their ability to continuously cycle in the hydrosphere, including on sea spray aerosols emitted from the oceans. Because of the poor reversibility of environmental exposure to PFAS and their associated effects, it is vitally important that PFAS uses and emissions are rapidly restricted.			1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D690	蓄積性	Wen, W; Xia, XH; Chen, X; Wang, HT; Zhu, BT; Li, HS; Li, Y	Bioconcentration of perfluoroalkyl substances by Chironomus plumosus larvae in water with different types of dissolved organic matters	2016	Environ. Pollut. 2016 Jun:213:299-307. doi: 10.1016/j.envpol.2016.02.018	The effects of four types of dissolved organic matters (DOM) on the bioconcentration of perfluoroalkyl substances (PFASs) in Chironomus plumosus larvae have been studied. The PFASs included perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnA), and perfluorododecanoic acid (PFDoA). The DOM included humic acid (HA), fulvic acid (FA), tannic acid (TA), and a protein, peptone (PEP), and their concentrations ranged from 0 to 50 mg L-1. The results showed that, upon bioconcentration equilibrium, the body burdens of longer perfluoroalkyl chain PFASs (PFOS, PFDA, PFUnA and PFDoA) decreased with PEP and HA concentrations while increased with FA and TA concentrations. When FA and TA concentrations increased from 0 to 50 mg L-1, body burdens of these PFASs increased by 7.5%-148.8% and 5.7%-37.1%, respectively. However, the DOM had no significant impact on the body burdens of shorter perfluoroalkyl chain PFASs (PFOA and PFNA). All of the four types of DOM lowered not only the uptake rate constants (k(u)) of PFASs due to the decrease of freely dissolved PFAS concentrations, but also the elimination rate constants (k(e)) due to the inhibition effect of DOM on the PFAS elimination from the larvae. The reduction in the two constants varied with both DOM and PFAS types. In the presence of PEP and HA with larger molecular weights, the k(u) values decreased more than k(e), leading to the decreased body burdens of longer perfluoroalkyl chain PFASs. As for FA and TA with smaller molecular weights, the k(e) values decreased more than k(u), resulting in increased body burdens of longer perfluoroalkyl chain PFASs. This study suggests that the effects of DOM on PFAS bioconcentration depend not only on the concentration but also on the molecule weight of DOM, which should be considered in the bioavailability assessment of PFASs.								B	-		
D691	環境中運命	Kim, H; Ekpe, OD; Lee, JH; Kim, DH; Oh, JE	Field-scale evaluation of the uptake of Perfluoroalkyl substances from soil by rice in paddy fields in South Korea	2019	Sci. Total Environ. 2019 Jun:671:714-721. doi: 10.1016/j.scitotenv.2019.03.240	The concentrations of 17 perfluoroalkyl substances (PFASs) were investigated in paddy soil, void water, and brown rice collected from 30 paddy fields to examine the uptake of PFASs from soil by rice. The total concentrations of PFASs ranged from 7.76 to 3020 ng/L (average = 166 ng/L) in void water, 0.120 to 13.9 ng/g dry-weight (dw) (1.92 ng/g dw) in paddy soils, and from not-detected to 1.85 ng/g (0.403 ng/g) in brown rice samples. The highest PFAS concentrations were observed in brown rice cultivated in a paddy field where high levels of PFASs were observed in void water and paddy soil. Among target PFAS compounds, perfluorocarboxylic acids were dominant and detected in all matrices, and perfluorooctanoic acid (PFOA) was the most predominant compound in brown rice and void water. Significant positive correlations were examined for some detected PFASs between each matrix. PFOA in brown rice was positively correlated with PFOA in void water as well as perfluorodecanoic acid (PFDA) in paddy soil ($p < 0.01$). PFOA in void water also had correlated with PFDA in paddy soil. However, there was no correlation of other compounds between each matrix, except for correlations of perfluorononanoic acid (PFNA) and PFDA in paddy soil with those in void water, respectively ($p < 0.05$). Moreover, PFOA concentration in brown rice (0.093 ng/g) was much higher than one in white rice detected with a non-detectable level.			1					B	-		
D692	蓄積性	Hoke, RA; Ferrell, BD; Sloman, TL; Buck, RC; Buxton, LW	Aquatic hazard, bioaccumulation and screening risk assessment for ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate	2016	Chemosphere 2016 Apr:149:336-342. doi: 10.1016/j.chemosphere.2016.01.009	The fluoropolymer manufacturing industry is moving to alternative polymerization processing aid technologies with more favorable toxicological and environmental profiles as part of a commitment to curtail the use of long-chain perfluoroalkyl acids (PFAAs). To facilitate the environmental product stewardship assessment and premanufacture notification (PMN) process for a candidate replacement chemical, we conducted acute and chronic aquatic toxicity tests to evaluate the toxicity of ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate (C6HF11O3 center dot H3N) or the acid form of the substance to the cladoceran, Daphnia magna, the green alga, Pseudokirchneriella subcapitata, and a number of freshwater fish species including the rainbow trout, Oncorhynchus mykiss, In addition, testing with the common carp, Cyprinus carpio, was conducted to determine the bioconcentration potential of the acid form of the compound. Based on the relevant criteria in current regulatory frameworks, the results of the aquatic toxicity and bioconcentration studies indicate the substance is of low concern for aquatic hazard and bioconcentration in aquatic organisms. Evaluation of environmental monitoring data in conjunction with the predicted no effect concentration (PNEC) based on the available data suggest low risk to aquatic organisms.								C	-		
D693	環境中運命	Harfmann, JL; Tito, K; Kieber, RJ; Avery, GB; Mead, RN; Shimizu, MS; Skrabal, SA	Sorption of Hexafluoropropylene Oxide Dimer Acid to Sediments: Biogeochemical Implications and Analytical Considerations	2021	ACS Earth Space Chem. 2021 Mar:5(3):580-587. doi: 10.1021/acsearthspacechem.0c00323.	The sedimentary fate of hexafluoropropylene oxide dimer acid (HFPO-DA) was investigated over a 12 week time series in HFPO-DA-amended (600 ng of spike addition freshwater and estuarine tidal sediments collected in southeastern North Carolina. A 40-59% decrease in the concentration of HFPO-DA was observed within 14 days for freshwater and estuarine sediments. This decrease could not be explained by biological degradation because there were no statistically significant differences in HFPO-DA loss between bioactive and autoclaved sediments and no degradation products were detected via highresolution mass spectrometry. An additional 2-3% of HFPO-DA was recovered when sediments were subjected to a more aggressive extraction (12 h soak with 80:20 1 M NaOH in methanol/water), suggesting that HFPO-DA sorbs strongly to sediments and remains undetected by less aggressive PFAS sediment extraction methods. Results of this study highlight that (1) PFAS sediment extraction methodologies need to be re-evaluated, particularly as alternative compounds continue to be synthesized and discovered, and (2) studies employing less aggressive extraction methodologies significantly underestimate PFAS contamination in aquatic sediments. Given that HFPO-DA is resistant to biological degradation and has a high sorption affinity, aquatic sediments may be a more significant long-term sink for HFPO-DA and other short-chain alternative PFAS than previously thought.					1			B	-		
D694	環境中運命	Seo, SH; Son, MH; Shin, ES; Choi, SD; Chang, YS	Matrix-specific distribution and compositional profiles of perfluoroalkyl substances (PFASs) in multimedia environments	2019	J. Hazard. Mater. 2019 Feb:364:19-27. doi: 10.1016/j.jhazmat.2018.10.012	This study investigated perfluoroalkyl substances (PFASs) in multimedia environments to confirm the effects of emission sources of PFASs and to elucidate their spatial distribution. The highest PFAS levels were detected from the samples of air (272.30 pg/m(3)) and surface water (36.54 ng/L) in an industrial complex area, meanwhile high PFAS levels were found from the samples of soil (8.80 ng/g) and sediment (84.98 ng/g) in urban areas and near wastewater treatment plants (WWTPs). Perfluorobutane sulfonate (PFBS) was primarily detected in water, influent and effluent, whereas long chain perfluorocarboxylic acids (PFCAs) and perfluorooctane sulfonate (PFOS) were dominant in dust, soil, sediment and sludge. While PFBS and neutral PFASs were dominant in air, PFCAs were primarily detected in plant and fish. The specific distribution patterns of PFASs in each matrix showed the influences of surrounding environments and different physicochemical characteristics of each congener. These findings suggest that the industrial complex and WWTP might be major emission sources to air and aquatic environments, respectively. This is the first study in which 6 neutral and 13 ionic PFASs were investigated simultaneously for nine different matrices in multimedia environments, and also it would be a good model study for future assessment of PFASs.				1				B	-		
D695	環境中運命	Huff, DK; Morris, LA; Sutter, L; Costanza, J; Pennell, KD	Accumulation of six PFAS compounds by woody and herbaceous plants: potential for phytoextraction	2020	Int. J. Phytoremediat. 2020 Dec:22(14):1538-1550. doi: 10.1080/15226514.2020.1786004.	Per and polyfluoroalkyl substances (PFAS) consist of a large group of compounds used to make products more resistant to stains, grease, and water and for fire suppression. They have been widely detected in the environment and exposure has been linked to adverse human health effects. Phytoremediation could be used to remediate PFAS-impacted sites, but there is little information on herbaceous and woody plant species uptake of PFAS compounds from soil. A greenhouse study evaluated the potential for eight herbaceous and seven woody plant species to absorb PFAS compounds. Six PFAS compounds: PFPeA, PFHxA, PFOA, PFBS, PFHxS, and PFOS were added weekly to irrigation water, and the plants grown for up to 14 weeks after an initial establishment period. Significant accumulation of all PFAS compounds occurred in at least one plant species. Mass recovery in above-ground tissue by the best performing plant ranged from a low of 3.8% for PFOS byFestuca rubrato a high of 42% for PFPeA bySchedonorus arundinaceus. Hyperaccumulation, defined as tissue/soil concentrations >10/1, was observed for all six PFAS compounds in at least one plant species. These results demonstrate the potential use of phytoremediation as a tool for remediating PFAS-contaminated sites.		1		1				B	-		
D696	蓄積性	Lasters, R; Groffen, T; Bervoets, L; Eens, M	Perfluoroalkyl acid (PFAA) profile and concentrations in two co-occurring tit species: distinct differences indicate non-generalizable results across passerines	2021	Sci. Total Environ. 2021 Mar:761:143301. doi: 10.1016/j.scitotenv.2020.143301.	Eggs of terrestrial bird species have often been used to biomonitor both legacy and emerging anthropogenic contaminants, such as perfluoroalkyl acids (PFAAs). However, few, if any, studies have examined whether results obtained in a given model species can be generalized across bird species. Therefore, we compared potential differences in egg PFAA profile and concentrations between two widely studied passerine species, great tit (Parus major) and blue tit ((Cyanistes caenileus), which arc similar in many aspects of their ecology and life history. Whole clutches of both species were collected from the same breeding season and at the same place (Antwerp, Belgium), enabling us to study laying order effects. Additionally, we evaluated how egg PFAA concentrations for both species changed along a distance gradient from a PFAA point source. Although the sum PFAA concentrations did not significantly differ between great tits and blue tits, large differences in PFAA profile and laying order effects were observed. Great tits showed a more diverse PFAA detection profile, including periluorooctane sulfonic acid (PFOS) and various long-chain perfluorocarboxylic acids (PFCAs) but no short-chain compounds. Contrarily, short-chain PFCAs (periluorobutanoic acid (PFBA) and perfluorohexanoic acid (PFHxA)) were only detected in blue tit eggs. The variation of perfluorooc ianuic acicl (PFOA) concentrations within clutches was large in both species, although laying order effects on PFOA concentrations were only found in blue tits. Although egg PFOA concentrations of both species decreased similarly from the fluorochemical point source onwards, more variation in egg PFOA concentrations could be explained by distance from the fluorochemical plant in great tits (60%) than in blue tits (15%). Results showed that both species markedly differed in terms of egg PFAA profile and concentrations, must likely reflecting differences in diet, foraging habits and egg protein composition. Finally, biumonituring results of PFAAs in eggs arc likely not generalizable across bird species.	1	1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D697	蓄積性	Li, XM; Yeung, LWY; Taniyasu, S; Lam, PKS; Yamashita, N; Xu, MQ; Dai, JY	Accumulation of perfluorinated compounds in captive Bengal tigers (Panthera tigris tigris) and African lions (Panthera leo Linnaeus) in China	2008	Chemosphere. 2008 Nov:73(10):1649-1653. doi: 10.1016/j.chemosphere.2008.07.079.	The accumulation of perfluorinated compounds (PFCs) in the sera of captive wildlife species Bengal tigers (Panthera tigris tigris) and African lions (Panthera leo Linnaeus) from Harbin Wildlife Park, Heilongjiang Province, in China were analyzed by high-performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS). Perfluorooctanesulfonate (PFOS) was the predominant contaminant with a mean serum concentration of 1.18ng mL(-1) in tigers and 2.69 ng mL(-1) in lions. Perfluorononanoic acid (PFNA) was the second most prevalent contaminant in both species. The composition profiles of the tested PFCs differed between tigers and lions, and the percentages of perfluorooctanoic acid (PFCA) were greater in lions than in tigers, indicating different exposures and/or metabolic capabilities between the two species. Assessments of the risk of PFC contamination to the two species were obtained by comparing measured concentrations to points of departure or toxicity reference values (TRVs). Results suggest no risk of PFOS exposure or toxicity for the two species.			1					B	-		
D698	蓄積性	Xu, C; Song, X; Liu, ZY; Ding, XY; Chen, H; Ding, D	Occurrence, source apportionment, plant bioaccumulation and human exposure of legacy and emerging per- and polyfluoroalkyl substances in soil and plant leaves near a landfill in China	2021	Sci. Total Environ. 2021 Jul:776:145731. doi: 10.1016/j.scitotenv.2021.145731.	In this study, 17 legacy and emerging PFASs were investigated in soil and plant leaves near a valley-type landfill, which has been in operation for over 20 years. Sigma FASs concentrations ranged from 5.31 to 108 ng/g dw and 11.9 to 115 ng/g dw in the soil and leaf samples, respectively, and perfluorobutanoic acid (PFBA) was dominant in both soil and leaves. The concentrations of hexafluoropropylene oxide dimer acid (HFPO-DA), 6:2 chlorinated polyfluorinated ether sulfonic acid (F-53B) and 6:2 fluorotelomer sulfonic acid (6:2 FTS) were significantly higher than those of legacy PFOA and PFOS, indicating emerging alternatives were widely applied in the region. The integrated approach of PCA analysis, field investigation of relevant industrial activities in the study area, along with the Unmix model analysis quantitatively revealed that factories producing consumer products and the landfill were the major sources of PFASs in soil, accounting for 57% of total Sigma FASs detected. Bioaccumulation factors (BAFs) of PFASs in leaves varied from 0.37 to 8.59, and higher BAFs were found in camphor leaves. The log(10)BAFs in all plant leaves showed a linear decrease with increasing carbon chain lengths for individual PFCAs (C4-C8). The BAF values of HFPO-DA, F-53B and 6:2 FTS were 0.01-3.39, 0.04-6.15 and 0.01-6.33, respectively. The human health risk assessment of EDIs showed a decreasing trend with the increasing carbon chain lengths of PFCAs (C4-C9), and the PFASs EDI indicated further study on the human health risk via vegetable consumption be warranted.	1				1			B	-		
D699	蓄積性	De Silva, AO; Tseng, PJ; Mabury, SA	TOXICOKINETICS OF PERFLUOROCARBOXYLATE ISOMERS IN RAINBOW TROUT	2009	Environ. Toxicol. Chem. 2009 Feb:28(2):330-337. doi: 10.1897/08-088.1.	Perfluorooctanoate (PFOA) and other perfluorocarboxylates (PFCAs) are widely dispersed in the environment. Current and/or historical production of PFOA and fluorochemical precursors was conducted by telomerization and electrochemical fluorination (ECF). Telomer products typically contain linear chains of perfluorocarbons, and ECF products are a mixture of linear and branched isomers. The objective of the present study was to examine the role of toxicokinetics on PFCA isomer profiles in fish since monitoring studies have revealed a predominance of n-isomers of PFCAs in biota. Using dietary exposure, rainbow trout were administered technical ECF PFOA isomers (6.9 mu g/kg/d), linear perfluorononanoate (1.4 mu g/kg/d n-PFNA), and isopropyl PFNA (1.1 mu g/kg/d iso-PFNA) for 36 d and then switched to a 40-d clean diet. Throughout exposure and depuration phases, blood and tissue sampling ensued. The accumulation ratio (AR) revealed similar accumulation propensity of n-PFOA and two minor branched PFOA isomers; however, the majority of branched isomers had lower AR values than n-PFOA. Enrichment of n-PFOA and n-PFNA relative to most branched isomers was consistent in all tissues. First-order elimination (k(d)) and half-life (t(1/2)) values were calculated. The largest t(1/2) corresponded to n-PFNA followed by iso-PFNA. In ECF PFOA isomers, both n-PFOA and one minor branched isomer had the largest t(1/2), suggesting that this minor isomer could be diagnostic of ECF exposure using environmental PFOA isomer patterns. Results of lower-dose ECF PFOA exposure showed similar results to the high-dose study; it is possible that both scenarios resulted in saturation of processes involved in PFCA transport. As such, the toxicokinetics of PFCA isomers at environmentally realistic levels may deviate from the results of the present study.			1					B	-		
D700	環境中運命	Chen, H; Zhao, LJ; Wang, N; Yao, YM; Sun, HW	Aerobic biotransformation of 6:2 fluorotelomer sulfonic acid in soil	2019	Chin. Sci. Bull.-Chin. 2019;64(33):3441-3448. doi: 10.1360/TB-2019-0126.	Per- and polyfluoroalkyl substances (PFASs) have been widely used in numerous industrial and household products due to its hydrophobic and lipophobic nature. As the main active ingredient, PFASs have been widely used in aqueous film forming foam (AFFF) used to fight liquid-fueled fires. As the electrochemical fluorination (ECF)-based PFASs were gradually phased out by major PFAS manufacturers worldwide, fluorotelomer-based PFASs, such as 6:2 fluorotelomer sulfonic acid (6:2 FTSA, [F(CF2)(6)CH2CH2SO3H]) and its precursors, have been widely detected in soil and groundwater effected by firefighting training activities. A few precursors (e.g., 6:2 fluorotelomer alcohol, 6:2 FTOH, [F(CF2)(6)CH2CH2OH]) have been well studied, but there are still leaving major gaps in understanding of 6:2 FTSA fate and aerobic biotransformation in soil. Soil collected from forest area was dosed with 6:2 FTSA to investigate its biotransformation rate and to identify major transformation products in a flow-through soil incubation system over 90 d. The overall mass balance at day 90 in sterile and live treatments averaged 97.4% and 76.8%, respectively, suggesting that there may be soil-bound residues and conjugates between fluorinated transformation products and dissolved soil components only in live test system not in the sterile soil. The 6:2 FTSA biotransformation was relatively low with a half-life more than 56 d, and 33% of initial 6:2 FTSA remained at day 90. According to the transformation products and the results in 6:2 FTSA biodegradation, the pathways of 6:2 FTSA aerobic biodegradation in the soil were proposed. The volatile 5:2 secondary alcohol (5:2 sFTOH, [F(CF2)(5)CH(OH)CH3]) and 5:2 fluorotelomer ketone (5:2 FT ketone, [F(CF2)(5)COCH3]) were the most abundant intermediate transformation products at the beginning, and reached highest at day 7 and 14, respectively. Perfluoropentanoic acid (PFPeA, [F(CF2)(4)COOH]) and perfluorohexanoic acid (PFHxA, [F(CF2)(5)COOH]) were produced as end products by 6:2 FTSA through desulfonation, oxidation and other reactions. In another minor pathway, 5:3 polyfluorinated acid (5:3 acid, [F(CF2)(5)CH2CH2COOH]) and perfluorobutanoic acid (PFBA, [F(CF2)(3)COOH]) were also formed. The concentrations of these end products, including PFBA, PFPeA, PFHxA, and 5:3 acid, increased in all experiment period. At day 90, the generations of PFPeA, PFHxA, 5:3 acid, and PFBA at a yield of 20.4 mol%, 6.5 mol%, 9.5 mol%, and 1.0 mol% were observed. Perfluoroheptanoic acid (PFHpA, [F(CF2)(6)COOH]) was not detected in the soil, suggesting that there was no alpha-oxidation in the process of 6:2 FTSA biotransformation in live soil. NaOH-acetonitrile extraction plus ENVI-Carb (TM) clean up could breakdown the binding between 5:3 acid and organic matter of the soil, and an enhancement factor up to 18 could be achieved for 5:3 acid by this cleanup method. The sorption of 6:2 FTSA to soil could low the biotransformation. The enzymatic desulfonation step may limit 6:2 FTSA biotransformation in aerobic soil. This study indicates that 6:2 FTSA may be persistent in aerobic soil, and a potential source of short chain perfluorocarboxylic acids (PFCAs) in soil. More studies need to be done to	1	1						B	-		
D701	環境中運命	Liu, W; Jin, YH; Quan, X; Sasaki, K; Saito, N; Nakayama, SF; Sato, I; Tsuda, S	Perfluorosulfonates and perfluorocarboxylates in snow and rain in Dalian, China	2009	Environ. Int. 2009 May:35(4):737-742. doi: 10.1016/j.envint.2009.01.016.	Samples of precipitation events (snow and rain) in Dalian, a typical coastal town in China, were analyzed for perfluorosulfonates (PFSAs) and perfluorocarboxylates (PFCAs) to investigate atmospheric contamination by these compounds. In the snow event on December 16, 2006, samples were collected from 21 different sites and in another 6 precipitation events, samples were collected from a single location. Four PFSAs (C4, C6, C8, C10) and seven PFCAs (C6-12) were analyzed. Among the homologues, perfluorooctane sulfonate (PFOS) concentrations were the highest with a geometric mean (CM) of 145 ng/L (n = 21) during the snow event on December 16, 2006. followed by perfluorooctanoate (PFOA) with a GM of 24.7 ng/L (n = 21). Concentrations of perfluorobutane sulfonate (PFBS). perfluorohexane sulfonate (PFHxS) and perfluoroheptanoate (PFHpA) were more than two orders of magnitude lower than that of PFOS. Other PFSAs and PFCAs were found to be below the limit of detection in all the samples. In other 6 precipitation events, PFSAs and PFCAs were detected approximately in the same order of magnitude in both snow and rain. The results indicate that wet deposition may be a potential transport mechanism of perfluorinated chemicals in the environment.					1			B	-		
D702	環境中運命	Gao, Y; Liang, Y; Gao, K; Wang, YJ; Wang, C; Fu, JJ; Wang, YW; Jiang, GB; Jiang, YS	Levels, spatial distribution and isomer profiles of perfluoroalkyl acids in soil, groundwater and tap water around a manufactory in China	2019	Chemosphere 2019 Jul:227:305-314. doi: 10.1016/j.chemosphere.2019.04.027	In this study, 32 surface soil samples, 24 groundwater samples, and 6 tap water samples were collected around a perfluorosulfonates (PFSAs) manufactory in China to analyze the distributions of perfluoroalkyl acids (PFAAs) including linear and branched isomers. The total concentrations of PFAAs (Sigma PFAAs) ranged from 1.30 to 913 ng/g on a dry weight basis (dw), 31.4-15656 ng/L, and 11.8-59.7 ng/L in soil, ground-water and tap water samples respectively. Perfluorooctanesulfonate (PFOS) and perfluorobutanoic acid (PFBA) were the predominant PFAAs in the soil whereas PFBA was the predominant congener in groundwater. PFAA concentrations in the soil and groundwater decreased with increasing distance from the manufactory. Shorter-chain PFAAs showed higher proportions in groundwater than in soil samples and that shorter-chain PFAAs exhibited faster decreasing rates in soil samples, which may be due to the differences in the polarity and hydrophobicity of these molecules. For isomer profiles, n-PFHxS, n-PFOS, and n-PFOA were the main isomer in soil samples and groundwater samples. Direct exposure to PFOS and PFOA via the soil and tap water posed relatively low risk to the residents' health.	1							B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D703	蓄積性	Ahrens, L; Siebert, U; Ebinghaus, R	Total body burden and tissue distribution of polyfluorinated compounds in harbor seals (Phoca vitulina) from the German Bight	2009	Mar. Pollut. Bull. 2009 Apr:58(4):520-525. doi: 10.1016/j.marpolbul.2008.11.030.	Total body burden and tissue distribution of polyfluorinated compounds (PFCs) were investigated in harbor seals (Phoca vitulina) from the German Bight in 2007. A total number of 18 individual PFCs from the following groups could be quantified in the different tissues: perfluorinated carboxylic acids (PFCAs) and perfluorinated sulfonates (PFSAs) and their precursors perfluorinated sulfinates (PFSiAs), perfluorinated sulfonamides, and sulfonamido ethanols. Perfluorooctanesulfonate (PFOS) was the predominant compound in all measured seal tissues (up to 1665 ng g(-1) wet weight in liver tissue). The dominant PFCAs were perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA), but their concentrations were much lower compared to PFOS. The mean whole body burden in harbor seals of all detected PFCs was estimated to be 2665 +/- 1207 mu g absolute. The major amount of the total PFCs burden in the bodies was in blood (38%) and liver (36%), followed by muscle (13%), lung (8%), kidney (2%), blubber (2%), heart (1%), brain (1%), thymus (<0.01%) and thyroid (<0.01%). These data suggest large differences in body burden and accumulation pattern of PFCs in marine mammals.			1					B	-		
D704	蓄積性	Larson, ES; Conder, JM; Arblaster, JA	Modeling avian exposures to perfluoroalkyl substances in aquatic habitats impacted by historical aqueous film forming foam releases	2018	Chemosphere 2018 Jun:201:335-341. doi: 10.1016/j.chemosphere.2018.03.004	Releases of Perfluoroalkyl and Polyfluoroalkyl Substances (PFASs) associated with Aqueous Film Forming Foams (AFFFs) have the potential to impact on-site and downgradient aquatic habitats. Dietary exposures of aquatic-dependent birds were modeled for seven PFASs (PFHxA, PFOA, PFNA, PFDA, PFHxS, PFOS, and PFDS) using five different scenarios based on measurements of PFASs obtained from five investigations of sites historically-impacted by AFFF. Exposure modeling was conducted for four avian receptors representing various avian feeding guilds: lesser scaup (Aythya affinis), spotted sandpiper (Actitis macularia), great blue heron (Ardea herodias), and osprey (Pandion haliaetus). For the receptor predicted to receive the highest PFAS exposure (spotted sandpiper), model-predicted exposure to PFOS exceeded a laboratory-based, No Observed Adverse Effect Level exposure benchmark in three of the five model scenarios, confirming that risks to aquatic-dependent avian wildlife should be considered for investigations of historic AFFF releases. Perfluoroalkyl sulfonic acids (PFHxS, PFOS, and PFDS) represented 94% (on average) of total PFAS exposures due to their prevalence in historical AFFF formulations, and increased bioaccumulation in aquatic prey items and partitioning to aquatic sediment relative to perfluoroalkyl carboxylic acids. Sediment-associated PFASs (rather than water-associated PFASs) were the source of the highest predicted PFAS exposures, and are likely to be very important for understanding and managing AFFF site-specific ecological risks. Additional considerations for research needs and site specific ecological risk assessments are discussed with the goal of optimizing ecological risk-based decision making at AFFF sites and prioritizing research needs.		1	1					B	-		
D705	環境中運命	Wickersham, LC; Mattila, JM; Krug, JD; Jackson, SR; Wallace, MAG; Shields, EP; Halliday, H; Li, EY; Liberatore, HK; Farrior, S; Preston, W; Ryan, JV; Lee, CW; Linak, WP	Characterization of PFAS air emissions from thermal application of fluoropolymer dispersions on fabrics	2023	J. Air Waste Manage. Assoc. 2023 Jul:73(7):533-552. doi: 10.1080/10962247.2023.2192009.	During thermal processes utilized in affixing fluoropolymer coatings dispersion to fibers and fabrics, coating components are vaporized. It is suspected that per- and polyfluoroalkyl substances (PFAS) from the dispersions may undergo chemical transformations at the temperatures used, leading to additional emitted PFAS thermal byproducts. It is important to characterize these emissions to support evaluation of the resulting environmental and health impacts. In this study, a bench-scale system was built to simulate this industrial process via thermal application of dispersions to fiberglass utilizing relevant temperatures and residence times in sequential drying, baking, and sintering steps. Experiments were performed with two commercially available dispersions and a simple model mixture containing a single PFAS (6:2 fluorotelomer alcohol [6:2 FTOH]). Vapor-phase emissions were sampled and characterized by several off-line and real-time mass spectrometry techniques for targeted and nontargeted PFAS. Results indicate that multiple PFAS thermal transformation products and multiple nonhalogenated organic species were emitted from the exit of the high temperature third (sintering) furnace when 6:2 FTOH was the only PFAS present in the aqueous mixture. This finding supports the hypothesis that temperatures typical of these industrial furnaces may also induce chemical transformations within the fluorinated air emissions. Experiments using the two commercial fluoropolymer dispersions indicate air emissions of part-per-million by volume (ppmv) concentrations of heptafluoropropyl-1,2,2,2-tetrafluoroethyl ether (Fluoroether E1), as well as other PFAS at operationally relevant temperatures. We suspect that E1 is a direct thermal decomposition product (via decarboxylation) of 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)propanoic acid (commonly referred to as HFPO-DA) present in the dispersions. Other thermal decomposition products, including the monomer, tetrafluoroethene, may originate from the PFAS used to stabilize the dispersion or from the polymer particles in suspension. This study represents the first researcher-built coating application simulator to report nontargeted PFAS emission characterization, real-time analyses, and the quantification of 30 volatile target PFAS.Implications: Thermal processes used to affix fluoropolymers to fabrics are believed to be a source of PFAS air emissions. These coating operations are used by many large and small manufacturers and typically do not currently require any air emissions control. This research designed and constructed a bench-scale system that simulates these processes and used several off-line and advanced real-time mass spectroscopy techniques to characterize PFAS air emissions from two commercial fluoropolymer dispersions. Further, as the compositions of commercial dispersions are largely unknown, a model three-component solution containing a single PFAS was used to characterize emissions of multiple PFAS thermal transformation products at operationally relevant conditions. This research shows that fluoropolymer fabric coating facilities can be sources of complex mixtures of PFAS air emissions that					1			B	-		
D706	環境中運命	Lesmeister, L; Lange, FT; Breuer, J; Biegel-Engler, A; Giese, E; Scheurer, M	Extending the knowledge about PFAS bioaccumulation factors for agricultural plants - A review	2021	Sci. Total Environ. 2021 Apr:766:142640. doi: 10.1016/j.scitotenv.2020.142640.	A main source of perfluoroalkyl and polyfluoroalkyl substances (PFASs) residues in agricultural plants is their uptake from contaminated soil. Bioaccumulation factors (BAFs) can be an important tool to derive recommendations for cultivation or handling of crops prior consumption. This review compiles >4500 soil-to-plant BAFs for 45 PFASs from 24 studies involving 27 genera of agricultural crops. Grasses (Poaceae) provided most BAFs with the highest number of values for perfluorooctanoic add and perfluorooctane sulfonic acid Influencing factors on PFAS transfer like compound-specific properties (hydrophobicity, chain length, functional group, etc.), plant species, compartments, and other boundary conditions are critically discussed. Throughout the literature, BAFs were higher for vegetative plant compartments than for reproductive and storage organs. Decreasing BAFs per additional perfluorinated carbon were clearly apparent for aboveground parts (up to 1.16 in grains) but not always for roots (partly down to zero). Combining all BAFs per single perfluoroalkyl carboxylic add (C4-C14) and sulfonic acid (C4-C10), median log BAFs decreased by -025(+/- 0.029) and -024 (+/- 0.013) per fluorinated carbon, respectively. For the first time, the plant uptake of ultra-short-chain (<= C3) perfluoroalkyl acids (PFAAs) was reviewed and showed a ubiquitous occurrence of trifluoroacetic acid in plants independent from the presence of other PFAAs. Based on identified knowledge gaps, it is suggested to focus on the uptake of precursors to PFAAs, PFAAs <= C3, and additional emerging PFASs such as GenX or fluorinated ethers in future research. Studies regarding the uptake of PFASs by sugar cane, which accounts for about one fifth of the global crop production, are completely lacking and are also recommended. Furthermore, aqueous soil leachates should be tested as an alternative to the solvent extraction of soils as a base for BAF calculations.					1			B	-	総説	
D707	蓄積性	Nakayama, K; Iwata, H; Tao, L; Kannan, K; Imoto, M; Kim, EY; Tashiro, K; Tanabe, S	POTENTIAL EFFECTS OF PERFLUORINATED COMPOUNDS IN COMMON CORMORANTS FROM LAKE BIWA, JAPAN: AN IMPLICATION FROM THE HEPATIC GENE EXPRESSION PROFILES BY MICROARRAY	2008	Environ. Toxicol. Chem. 2008 Nov:27(11):2378-2386. doi: 10.1897/07-614.1.	Contamination levels of perfluorinated compounds (PFCs), including perfluorooctanesulfonate (PFOS), perfluorononanoic acid (PFNA), perfluorooctane sulfonamide (PFOSA), perfluorohexanesulfonate (PFHS), and perfluorooctanoic acid (PFOA), were determined in the livers of wild common cormorants (Phalacrocorax carbo) from Lake Biwa, Japan. Potential effects of PFCs alone and combined effects by complex mixture of PFCs and dioxins and related compounds (DRCs) were also assessed by gene expression profiling using a cormorant oligo array. Perfluorooctanesulfonate, PFNA, and PFOSA were detected in almost all liver samples analyzed, while concentrations of PFHS and PFOA were below the limit of quantification. The microarray data analyses revealed that hepatic PFC levels were correlated with the expression of 74 genes. Real-time reverse-transcript polymerase chain reaction data demonstrated that PFOS concentration was positively correlated with mRNA levels of glutathione peroxidase 1 and glutathione S-transferase alpha 3 and negatively correlated with levels of heat shock 70-kDa protein 8 and tumor rejection antigen 1 mRNAs. These results suggest the induction of antioxidant enzymes in response to oxidative stress caused by PFCs and the suppression of molecular chaperones, leading to reduction in protein stability. Moreover, multiple regression analyses identified seven significant models in which certain genes showed expression levels altered by accumulation of PFCs and DRCs. The regression models explained associations with cytochrome P450 1A mRNA and protein expression levels, and its catalytic activity, ethoxyresorufin-O-deethylase of both PFNA and the 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalent levels. Thus, the regression models suggested the potential of PFCs to enhance toxicities of DRCs. Since mixture toxicity is an urgent issue, further study is required to understand the effects of mixtures of PFCs and DRCs in wild cormorants.			1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D708	蓄積性	Diao, JY; Chen, ZW; Wang, TY; Su, CH; Sun, QP; Guo, YJ; Zheng, Z; Wang, L; Li, P; Liu, WH; Hong, S; Khim, JS	Perfluoroalkyl substances in marine food webs from South China Sea: Trophic transfer and human exposure implication	2022	J. Hazard. Mater. 2022 Jun:431:128602. doi: 10.1016/j.jhazmat.2022.128602.	Perfluoroalkyl substances (PFASs) are known to be persistent and toxic, and can be accumulated and trophic magnified in the environments. PFASs are widely distributed, and their coastal input poses a threat to the health of aquatic organisms and local residents. In present study, 17 PFASs including one emerging polyether substitute in water, sediment, and organisms were investigated from the South China Sea. Perfluorobutanoic acid (PFBA) was predominant in water, of which concentration ranged from ND to 10.26 ng/L, with a mean of 5.21 ng/L. Similar to sediment and organisms, PFBA was the substance with the highest concentration detected among PFASs. This result seemingly indicated that use of short-chain PFASs as substitutes for long-chain PFASs in recent years. Trophic magnification factors (TMFs) of PFASs were estimated in the marine food web. TMFs > 1 was observed only in perfluorooctane sulfonic acid (PFOS), indicating a biomagnification potential of PFOS in the given ecosystem. The estimated daily intake (EDI) of PFOS and PFOA were most prevalent in mollusk, whereas the EDI of PFBA was greater in fish and shrimp. The hazard ratio (HR) reported for seven dominant PFASs were lower than 1, which suggests that PFASs via seafood consumption would not cause significant health risk to local residents.	1							B	-		
D709	蓄積性	Gao, K; Miao, X; Fu, J; Chen, Y; Li, HJ; Pan, WX; Fu, JJ; Zhang, QH; Zhang, AQ; Jiang, GB	Occurrence and trophic transfer of per- and polyfluoroalkyl substances in an Antarctic ecosystem	2020	Environ. Pollut. 2020 Feb:257:113383. doi: 10.1016/j.envpol.2019.113383.	Information on the occurrence and trophodynamics of per- and polyfluoroalkyl substances (PFASs) in the Antarctic region is limited. We investigated the occurrence of PFASs in an ecosystem in the Fildes Peninsula at King George Island and Ardley Island, Antarctica. The profiles, spatial distribution, and trophic transfer behavior of PFASs were further studied. Sigma PFASs ranged from 0.50 +/- 38.0 ng/g dw (dry weight) in algae to 4.97 +/- 1.17 ng/g dw in Neogastropoda (Ngas), which was lower than those in the low- and mid-latitude regions and even Arctic regions. Perfluorobutyric acid (PFBA) was predominant with detection frequencies above 50% in all types of samples, and the relative contribution of PFBA ranged from 22% to 57% in the biota samples. The biomagnification factors of PFBA, perfluoroheptanoate (PFHpA), perfluorohexane sulfonate (PFHxS), and perfluorooctane sulfonate (PFOS) between Archaeogastropoda (Agas) and Ngas were 0.67 +/- 0.54, 0.77 +/- 0.38, 1.04 +/- 1.56, 3.30 +/- 4.07, and 1.61 +/- 0.89, respectively. The trophic magnification factors of PFHxS and PFOS were 2.09 and 2.92, respectively, which indicated that they could be biomagnified through the food chain. Considering the increasing production and uncertain toxicological risks of emerging PFASs and the sensitive ecosystems in Antarctic regions, more attention should be paid, especially for the short-chain ones in the Antarctic region.	1							B	-		
D710	蓄積性	Meng, J; Liu, SF; Zhou, YQ; Wang, TY	Are perfluoroalkyl substances in water and fish from drinking water source the major pathways towards human health risk?	2019	Ecotox. Environ. Safe. 2019 Oct:181:194-201. doi: 10.1016/j.ecoenv.2019.06.010	Due to potential adverse effects and bioaccumulation in biota and humans, perfluoroalkyl substances (PFASs) have raised wide attention in recent years. Ingestion is a vital pathway for PFASs to transmit to humans especially through water and fish. In present study, PFASs in water and fish from the drinking water source of Beijing in China were investigated. Three layers of water were collected in order to find the connection between concentrations of PFASs and depth of water, which showed no prominent correlation. PFASs in water from Miyun Reservoir with concentrations of 5.30-8.50 ng/L, were relatively lower compared with other reports on raw drinking water. Perfluorobutanoic acid (PFBA) and perfluorooctanoic acid (PFOA) were the dominant PFASs. In addition, six species of fish (including Cyprinus carpio, Carassius auratus, Erythroculter dabryi, Pseudohemiculter dispar, Hypophthalmichthys molitrix and Siniperca chuatsi) were analyzed, with concentrations of PFASs ranging from 1.70 to 14.32 ng/g wet weight (w.w.). Due to relatively stronger bioaccumulation potential, long chain perfluorinated carboxylates (PFCAs) and perfluorinated sulfonates (PFSAs) were detected with higher concentrations, especially perfluoroundecanoic acid (PFUdA) and perfluorodecanoic acid (PFDA). The estimated daily intake (EDI) of PFASs through drinking water and fish consumption were 0.20-0.34 and 3.44-12.61 ng/kg bw/day based on Exposure Factors Handbook of Chinese Population, respectively. In addition, the EDI of high priority concern PFASs via pork, chicken and dust were also calculated, with value of 0.015-0.043, 0.003-0.013 and 0.074-0.390 ng/kg bw/day, respectively. The total EDI of PFOS and PFOA via diverse pathways were less than suggested tolerable daily intake (PFOS, 150 ng/kg bw/day; PFOA, 1500 ng/kg bw/day), indicating that the detected levels would not cause severe health effects on Beijing residents.	1							B	-		
D711	環境中運命	Pan, G; Zhou, Q; Luan, X; Fu, QS	Distribution of perfluorinated compounds in Lake Taihu (China): Impact to human health and water standards	2014	Sci. Total Environ. 2014 Jul:487:778-784. doi: 10.1016/j.scitotenv.2013.11.100	The distribution in water and sediment, the sources/sinks and the risk of perfluorinated compounds (PFCs) in Lake Taihu, China were investigated. The total PFCs concentration was 164 to 299 ng L-1 in water and 5.8 to 35 ng g(-1) (dw) in sediment. The highest concentrations of perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) in water were 29.2 ng L-1 and 136 ng L-1. PFOS was largely associated with sediment, whereas short chain PFCs predominated in water. The partition coefficient (K-d) was positively correlated with the organic carbon fraction (f(oc)) for PFOS but not for the other PFCs. The organic carbon normalized partition coefficient (K-oc) increased by 0.51 log units for each additional CF2 moiety from perfluoro-butanesulfonate (PFBS) to PFOS. For the same chain length but different functional groups, the log K-oc, of PFOS was 1.35 units higher than PFOA. PFOS exhibited the highest affinity for sediment through the partition mechanism, and f(oc) affected the sediment as a sink of PFOS. Although there was no immediate health impact by the intake of the water alone, the consumption of aquatic products may cause potential health risks for animals/humans on the time scale of months to years. The relationship between the concentration, water-sediment distribution, bioaccumulation and toxicity should be considered in determining the water standards of PFCs.				1				B	-		
D712	蓄積性	Wang, JS; Zhang, YT; Zhang, F; Yeung, LWY; Taniyasu, S; Yamazaki, E; Wang, RP; Lam, PKS; Yamashita, N; Dai, JY	Age- and gender-related accumulation of perfluoroalkyl substances in captive Chinese alligators (Alligator sinensis)	2013	Environ. Pollut. 2013 Aug:179:61-67. doi: 10.1016/j.envpol.2013.04.020	Fourteen perfluoroalkyl substances (PFASs) were measured in serum of the highly endangered captive Chinese alligators, whole body homogenates of six kinds of fish (alligator prey species), and pond water (alligator habitat) in the Anhui Research Center for Chinese Alligator Reproduction. Six PFASs, including PFOS and five perfluorinated carboxylates, were detected in all alligator samples. The most dominant PFAS was PFUnDA, with a mean value of 31.4 ng/mL. Significant positive correlations were observed among the six PFASs, suggesting that they shared similar sources of contamination. Significantly higher PFOS and PFUnDA levels were observed in males, but the other four PFCAs did not differ between genders. An age related PFAS bioaccumulation analysis showed a significant negative correlation of the concentrations for five PFCAs to age, which means that higher concentrations were found in younger animals. Bioaccumulation factors (BAF) in fish for PFASs ranged from 21 to 28,000, with lower BAF for PFOA than that for longer carbon chain PFCAs, including PFUnDA, PFDA, and PFNA.			1					B	-		
D713	環境中運命	Fang, SH; Li, C; Zhu, LY; Yin, HL; Yang, YC; Ye, ZX; Cousins, IT	Spatiotemporal distribution and isomer profiles of perfluoroalkyl acids in airborne particulate matter in Chengdu City, China	2019	Sci. Total Environ. 2019 Nov:689:1235-1243. doi: 10.1016/j.scitotenv.2019.06.498	Airborne particulate matter (APM) was collected in four seasons at five different areas of the city of Chengdu, China to study the spatial and seasonal contamination pattern of perfluoroalkyl acids (PFAAs). The results showed that Sigma PFAA concentrations in Downtown Chengdu (mean value: 297 +/- 238 pg/m(3)) were higher than concentrations in suburban areas. The highest concentrations of PFAAs occurred during spring (97.5-709 pg/L; arithmetic mean concentration: 297 +/- 191 pg/L) while the lowest concentration occurred during autumn (9.27-105 pg/L; arithmetic mean concentration 41.1 +/- 24.8 pg/L). Perfluorooctanoic acid (PFOA) was the main PFAA quantified during winter, summer and autumn, and perfluorononanoic acid (PFNA) was the predominant PFAA in spring. Relative humidity (RH) and average daily precipitation (PRE) showed significant negative correlations with PFAA concentrations in winter and summer, suggesting that they played an important role in controlling PFAA concentrations in APM. The linear structural isomer of PFOA (n-PFOA) was the most abundant isomer in APM in Chengdu, with the average proportion of 85.6% +/- 6.13%, higher than the proportion in ECF PFOA commercial products (74.3-77.6%). However, the consistent fingerprint of branched PFOA in the APM implies that ECF PFOA makes a significant contribution to the PFOA in APM. PEELS in the APM collected throughout the year had a mean proportion of 54.0 +/- 8.81% of n-PFOS. This proportion of n-PFOS is lower than commercial ECF products (62.9-78.2%), suggesting an additional proportion of branched PFOS isomers in APM in Chengdu.			1					B	-		
D714	蓄積性	Wang, FH; Zhao, CY; Gao, Y; Fu, JJ; Gao, K; Lv, K; Wang, K; Yue, HZ; Lan, XF; Liang, Y; Wang, YW; Jiang, GB	Protein-specific distribution patterns of perfluoroalkyl acids in egg yolk and albumen samples around a fluorochemical facility	2019	Sci. Total Environ. 2019 Feb;650(Pt 2):2697-2704. doi: 10.1016/j.scitotenv.2018.10.006.	In this study, eggs from free-range and barn chickens in farms around a fluorochemical facility were collected to assess the distribution profiles of perfluoroalkyl acids (PFAAs), including isomers of perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorohexane sulfonate (PFHxS), in egg yolk and albumen. The results revealed that the concentrations of PFAAs in yolks were significantly higher than those in albumen. All 17 PFAAs examined could be detected in yolks, showing decreasing concentrations with increasing distance from the fluorochemical facility. The three predominant compounds in yolks were perfluorobutanoic acid (PFBA, mean concentration 81.4 ng/g ww), PFOS (28.0 ng/g ww), and PFOA (4.83 ng/g ww), and this result is consistent with the product structure of the facility. Moreover, n-PFOA, n-PFOS, and n-PFHxS were the dominant contaminants in yolk, with mean concentrations of 4.75, 25.7, and 4.29 ng/g ww, respectively. In albumen, PFBA was still the predominant PFAA congener (mean concentration = 3.93 ng/g ww), followed by PFOA. Docking analysis indicated that the PFAAs presented higher binding abilities with the low density lipoprotein, high density lipoprotein, and vitellin proteins in yolk than that with ovalbumin albumen proteins, which might be the main factor influencing the possible difference in distributions of PFAAs in yolk and albumen.	1							B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D715	蓄積性	Xia, XH; Rabearisoa, AH; Dai, ZN; Jiang, XM; Zhao, PJ; Wang, HT	INHIBITION EFFECT OF NA(+) AND CA(2+) ON THE BIOACCUMULATION OF PERFLUOROALKYL SUBSTANCES BY DAPHNIA MAGNA IN THE PRESENCE OF PROTEIN	2015	Environ. Toxicol. Chem. 2015 Feb:34(2):429-436. doi: 10.1002/etc.2823.	The authors investigated the individual effects of Ca2+ and Na+ on the bioaccumulation of 6 types of perfluoroalkyl substances (PFASs), including perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnA), and perfluorododecanoic acid (PFDoA), by Daphnia magna in water with 10mgL(-1) bovine albumin or soy peptone. The bioaccumulation factors of PFASs by D. magna decreased linearly with the increase of Ca2+ and Na+ concentrations. The inhibition effect of Ca2+ was stronger than that of Na+, and the decreasing percentages of the body burden of PFASs in D. magna caused by the increment of 1mmolL(-1) Ca2+ and 1mmolL(-1) Na+ were 41% to approximately 48% and 2% to approximately 5%, respectively, in the presence of soy peptone. The partition coefficients (K-p) of PFASs between protein and water increased with rising Ca2+ and Na+ concentrations. The elevated K-p values led to the reduced concentrations of freely dissolved PFASs. This resulted in a decrease of PFAS bioaccumulation in D. magna, and the body burden of each PFAS was positively correlated with its freely dissolved concentration in water. The present study suggests that cations should be considered in the assessment of bioavailability and risk of PFASs in natural waters containing proteinaceous compounds.			1					B	-		
D716	環境中運命	Wang, SQ; Lin, XP; Li, Q; Liu, C; Li, YY; Wang, XH	Neutral and ionizable per-and polyfluoroalkyl substances in the urban atmosphere: Occurrence, sources and transport	2022	Sci. Total Environ. 2022 Jun:823:153794. doi: 10.1016/j.scitotenv.2022.153794.	In the atmosphere, the photodegradation of neutral per-and polyfluoroalkyl substances (n-PFASs) is a source of ionizable PFASs (i-PFASs). However, they are not frequently simultaneously analyzed to study their transport and sources. In this study, n-PFASs and i-PFASs were simultaneously analyzed in the atmosphere of China, Japan and Malaysia to investigate the occurrence, seasonal variations, sources and transport. Results showed that n-PFASs ranged from 4.8 to 1400 pgm(-3), with an average value of 170 pgm(-3), and 8:2fluorotelomer alcohol (8:2 FTOH) was the most abundant compound. i-PFASs ranged from 3.7 to 330 pg m(-3), with an average value of 49 pg m(-3), and perfluorobutanoic acid (PFBA) had the highest concentration. Generally, airborne PFASs had a decreasing gradient from cities with high population density toward less industrialized sites. i-PFASs exhibited significantly ($P < 0.05$) seasonal variations, which were higher in the summer. 8:2 FTOH and 10:2 FTOH had significant ($P < 0.05$) positive correlations with perfluorooctanoic acid and perfluorodecanoic acid, suggesting that they had same sources, such as co-emission and photodegradation of FTOHs. Urumqi and Selangor were far away from industry, and high percentages (>95%) but low concentrations of PFBA were found in these cities, indicating the long-range atmospheric transport of PFBA due to its high volatility. The Summer Monsoon may promote the transport of high concentrations of PFAS from coastal cities to inland cities.	1							B	-		
D717	蓄積性	Babut, M; Labadie, P; Simonnet-Laprade, C; Munoz, G; Roger, MC; Ferrari, BJD; Budzinski, H; Sivade, E	Per- and poly-fluoroalkyl compounds in freshwater fish from the Rhone River: Influence of fish size, diet, prey contamination and biotransformation	2017	Sci. Total Environ. 2017 Dec:605:38-47. doi: 10.1016/j.scitotenv.2017.06.111	Pools of aquatic plants and benthic invertebrates were collected along with 47 individuals from three cyprinid fish species (Barbus barbus, Gobio gobio, Rutilus rutilus) at a site in the Rhone River (France). Carbon and nitrogen isotopic ratios (delta C-13 and delta N-15) and a wide range of per-and poly-fluorinated chemicals (PFASs) were analysed in all samples. The sum of PFAS concentrations (Sigma PFAS) increased from aquatic plants to fish dorsal muscles; molecular profiles were dominated by C9-C13 perfluorocarboxylic acids (PFCAs), while perfluorooctane sulfonate (PFOS) and perfluorooctane sulfonamide (FOSA) were detected in all samples at lower concentrations. SPFAS and especially Sigma PFCAs were higher in barbels (B. barbus) than in other species, while roaches (R. rutilus) were less contaminated by PFOS than barbels and gudgeons (G. gobio). Gudgeons accumulated significantly higher FOSA concentrations. Young (small) barbels displayed significantly higher PFOS, perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) concentrations than did large specimens; conversely, perfluorotetradecanoic acid (PFTeDA) concentrations were significantly higher in large barbels. Multiple linear regressions were performed on the whole set of fish samples with size, mass and isotopic ratios as explicative variables, and several single compounds as explained variables. Regardless of the compound, the regressions did not explain much of the contamination variability. However, adding species as a qualitative variable, i.e. performing analyses of covariance (ANCOVAs) improved the fit greatly, while adding sex did not. Diet (i.e. delta C-13 and delta N-15) was the main factor explaining interspecific differences. Biotransformation was assessed by comparing concentration ratios of PFOS or FOSA to their precursors in the food-web compartments. These ratios increased from invertebrates to fish, and differed among fish species, suggesting that biotransformation occurred but was species-specific. Biomagnification factor calculations showed that C11-C13 PFCAs, PFOS and FOSA were apparently biomagnified in barbels and gudgeons.			1					B	-		
D718	環境中運命	Jin, BS; Zhu, YW; Zhao, WY; Liu, ZK; Che, S; Chen, KP; Lin, YH; Liu, JY; Men, Y	Aerobic Biotransformation and Defluorination of Fluoroalkylether Substances (ether PFAS): Substrate Specificity, Pathways, and Applications	2023	Environ. Sci. Technol. Lett. 2023 Aug. doi: 10.1021/acs.estlett.3c00411	Fluoroalkylether substances (ether PFAS) constitute alarge groupof emerging PFAS with uncertain environmental fate. Among them, GenXis the well-known alternative to perfluorooctanoic acid and one ofthe six proposed PFAS to be regulated by the U.S. Environmental ProtectionAgency. This study investigated the structure-biodegradabilityrelationship for 12 different ether PFAS with a carboxylic acid headgroupin activated sludge communities. Only polyfluorinated ethers withat least one -CH2- moiety adjacent to or a C ・C bondin the proximity of the ether bond underwent active biotransformationvia oxidative and hydrolytic O-dealkylation. The bioreactions at etherbonds led to the formation of unstable fluoroalcohol intermediatessubject to spontaneous defluorination. We further demonstrated thatthis aerobic biotransformation/defluorination could complement theadvanced reduction process in a treatment train system to achievemore cost-effective treatment for GenX and other recalcitrant perfluorinatedether PFAS. These findings provide essential insights into the environmentalfate of ether PFAS, the design of biodegradable alternative PFAS,and the development of cost-effective ether PFAS treatment strategies.			1		1			B	-		
D719	環境中運命	Li, YL; Lv, LX; Yang, L; He, LY; Chen, YL; Wu, L; Zhang, ZL	Boosting degradation and defluorination efficiencies of PFBS in a vacuum-ultraviolet/S(IV) process with iodide involvement	2023	Chemosphere. 2023 Feb:313:137531. doi: 10.1016/j.chemosphere.2022.137531.	Perfluorobutane sulfonate (PFBS) is considered to be a promising alternative of perfluorooctane sulfonates (PFOS), while it is also hazardous. The UV/S (IV) system has been confirmed to be effective for PFOS removal from water, while it is inefficient for PFBS decomposition. A hybrid vacuum-ultraviolet (VUV)/S (IV)/KI process was investigated for the degradation of PFBS in aqueous solution. With KI involvement, the degradation rate of PFBS was boosted from 1.8802 mu g h-1 up to 3.5818 mu g h-1 in the VUV/S (IV) process. Alkaline conditions significantly increased the degradation efficiency of PFBS, which can be explained that S (IV) was dominated by SO32- rather than HSO3- and H2SO3 in alkaline conditions. Cl-, HCO3-, NO3-, NO2-, and HA would inhibit the performance of the VUV/S (IV)/KI process via various reactions. In addition, the toxicity of PFBS was significantly reduced by the VUV/S (IV)/KI process. Even in actual waters, the VUV/S (IV)/KI process also presented a satisfying performance in the degradation of PFBS.				1				B	-		
D720	蓄積性	Ren, JD; Point, AD; Baygi, SF; Fernando, S; Hopke, PK; Holsen, TM; Crimmins, BS	Bioaccumulation of perfluoroalkyl substances in the lake Erie food web	2023	Environ. Pollut. 2023 Jan:317:120677. doi: 10.1016/j.envpol.2022.120677.	The bioaccumulation and biomagnification of perfluoroalkyl substances (PFAS) in the Lake Erie food web was investigated by analyzing surface water and biological samples including 10 taxa of fish species, 2 taxa of benthos and zooplankton. The carbon (delta C-13) and nitrogen (delta N-15) isotopic composition and fatty acids profiles of biological samples were used to evaluate the food web structure and assess the biomagnification of Sigma PFAS. Perfluorooctane sulfonate (PFOS) dominated the total Sigma PFAS (SPFAS) concentration (50-90% of SPFAS concentration), followed by C9-C11 perfluorinated carboxylic acids (PFCAs). The highest PFOS concentrations (79 +/- 4.8 ng/g, wet weight (wwt)) and SPFAS (88 +/- 5.2 ng/g, wwt) were detected in yellow perch (Perca flavescens). The C8-C14 PFAS biomagnification factors (BMFs) between apex piscivorous fish and prey fish were found to be generally greater than 1, indicative of PFAS biomagnification, while biodilution (BMF<1) was observed between planktivorous fish and zooplankton. Trophic magnification factors (TMFs) of C8-C14 PFCA were not correlated with perfluoroalkyl chain length. The C4-C9 PFAS were detected in the surface water of Lake Erie, and PFBA was found to have the highest concentrations (2.1-2.8 ng/L) among all PFAS detected. The log of bioaccumulation factor (BAF) was found to generally increase with increasing log K-ow for C6, 8, and 9 PFAS in all selected species from three tropic levels.	1							B	-		
D721	環境中運命	Gomez, V; Torres, M; Karaskova, P; Pribylova, P; Klanova, J; Pozo, K	Occurrence of perfluoroalkyl substances (PFASs) in marine plastic litter from coastal areas of Central Chile	2021	Mar. Pollut. Bull. 2021 Nov:172:112818. doi: 10.1016/j.marpolbul.2021.112818.	Perfluorinated alkyl substances (PFASs) were determined in marine plastic litter (MPL) on six beaches of central Chile. MPL was characterized physically and chemically, showing an abundance of macroplastic (size >2.5 cm). The polypropylene (PP) (47%) was the predominant polymer found. The Desembocadura beach, located at the mouth of the Biobio River, recorded the highest abundance of MPL (3.7 items m(-2)). PFAS detected (n = 15/21) ranged from 279 to 1211 pg g(-1) and accounted for MeFOSE (46%) > PFHxS (14%) > PFPA (11%) > PFBS (6%) > PFOA (4%) and > PFOS (4%). Long-chain PFAS were prevalent, which can be metabolically degraded into PFOS (new POPs). This study i) highlights the need to further investigate the occurrence of chemicals in the MPL to reduce their impact on the environment; and ii) points out the need to improve future coastal management strategies for the elimination of solid waste along the coast of the country.				1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D722	環境中運命	Cai, WW; Navarro, DA; Du, J; Ying, GG; Yang, B; McLaughlin, MJ; Kookana, RS	Increasing ionic strength and valency of cations enhance sorption through hydrophobic interactions of PFAS with soil surfaces	2022	Sci. Total Environ. 2022 Apr:817:152975. doi: 10.1016/j.scitotenv.2022.152975.	The effect of soluble cations on sorption in soils of a range of anionic PFAS is not well studied. We investigated the role of three common cations (Na+, Ca2+, and Mg2+) at varying solution concentrations on the sorption coefficients (K-d) of 18 anionic PFAS in two contrasting soils. The effective charge of the soil suspension (Zeta potential) became less negative as the concentration of these cations increased in the soil solutions. Perfluorinated compounds showed greater sorption than polyfluorinated compounds, with sulfonates of comparable chain lengths showing higher sorption than the carboxylates. We observed that the K-d values of several PFAS in the two soils were positively correlated with the concentration of cations in solution, especially in the presence of polyvalent cations (Ca2+ and Mg2+). The changes in sorption with cation concentration were more prominent for long-chain PFAS, with C > 10 PFAS being completely removed from solution at higher cation concentrations. The emerging PFAS (replacement compounds GenX and ADONA) showed negligible or little sorption (K-d < 0.6 L/kg). While several mechanisms contribute towards sorption of PFAS in the presence of cations, we conclude that the primary effect of cations is through screening of negative charges on head groups of PFAS and reorientation of molecules at the interface between organic matter surfaces and soil solution as well as charge neutralisation at soil solid surface. Screening of negative charges allows for greater hydrophobic interaction between hydrophobic tails of PFAS and soil surfaces resulting in greater sorption. Increasing cation concentrations in soil solutions could thus reduce mobility of PFAS through a soil profile.					1			B	-		
D723	環境中運命	Gan, CD; Peng, MY; Liu, HB; Yang, JY	Concentration and distribution of metals, total fluorine, per- and poly-fluoroalkyl substances (PFAS) in vertical soil profiles in industrialized areas	2022	Chemosphere. 2022 Sep:302:134855. doi: 10.1016/j.chemosphere.2022.134855.	The widespread usage of per- and poly-fluoroalkyl substances (PFAS) has caused great concern due to their potential toxicology to human and environmental health. However, there have been limited investigations on the vertical distribution of PFAS in fluorine (F) contaminated soils. In this study, the spatial and vertical distribution of metals, total F, and PFAS in the soil profiles were investigated at different areas in an industrial city. The higher F concentrations in the farmland soils with intensive agricultural activities suggested the impacts of soil tillage. The sigma PFAS concentrations ranged from 0.187 to 1.852 ng g-1 in all soil samples, with PFOA as the dominant pollutant, which accounted for 17.2%-51.6% of the sigma PFAS in all samples. Highest level of PFAS was found in the shallow layer of the soil profiles. The long-chain PFAS such as PFUdA and PFTeDA tended to remain in the topsoil, while the short-chains (PFBA, PFPeA, and PFHxA) have migrated to depth of 100 cm in the vertical soil profile. The application of F-enriched phosphorus fertilizers and atmospheric deposition may be important sources of F and PFAS in soils in this area. Correlation analysis indicated that most of PFAS have similar common sources, and the significantly positive correlation between Zn and PFAS suggested they may share similar sources. This study highlights the need for further work to monitor the PFAS level in soil environments in industrialized areas, in addition to focusing on soil metal and F pollution.	1	1						B	-		
D724	環境中運命	Xie, QL; Xu, BL; Rillig, MC	Litter Decomposition Is Not Affected by Perfluorobutane Sulfonate (PFBS) in Experimental Soil Microcosms	2023	Soil Syst. 2023 MAR;7(1):13. doi: 10.3390/soilsystems7010013.	Perfluorobutane sulfonate (PFBS) has been found in increasing concentrations in the environment. However, its effect on litter decomposition in soils is still unclear. Therefore, the effect of PFBS on the decomposition of various litter types was tested, as well as on selected aspects of soil quality. Soil samples were treated with different concentrations of PFBS (0, 1, and 10 mu g g(-1)) and five organic litter materials were used with various C:N ratios. A soil microcosm experiment was performed at 20 degrees C for 6 weeks. Litter decomposition, soil respiration, enzyme activities, soil pH, water-stable aggregates (WSA), and soil total C and N contents were measured. PFBS treatments were observed to have negligible effects on litter decomposition as well as on other soil properties. This means that in the concentration range examined, this substance has no observable effects on the key soil parameters examined. The present result was inconsistent with the findings of a previous study with similar experimental microcosms but different soils. This study suggests that the effects of PFBS may be less pronounced in the tested soil, but it cannot be concluded that PFBS is harmless in soil ecosystems. A wider range of soil types and PFBS levels should be tested in future studies.				1				B	-		
D725	蓄積性	Parolini, M; Cappelli, F; De Felice, B; Possenti, CD; Rubolini, D; Valsecchi, S; Polesello, S	Within- and Among-Clutch Variation of Yolk Perfluoroalkyl Acids in a Seabird from the Northern Adriatic Sea	2021	Environ. Toxicol. Chem. 2021 Mar:40(3):744-753. doi: 10.1002/etc.4833.	Perfluoroalkyl substances (PFAS) are surface-active agents used in diverse industrial and commercial applications. They contaminate both freshwater and marine ecosystems, are highly persistent, and accumulate through trophic transfer. Seabirds are exposed to environmental contaminants due to their high trophic position in food webs and relatively long lifespan. We measured levels of 10 perfluoroalkyl acids (PFAAs) in egg yolks of yellow-legged gulls (Larus michahellis) breeding in the northern Adriatic Sea (Northeast Italy). We examined variations in PFAAs within clutches (between eggs of different laying order) and among clutches. Perfluorooctane sulfonate (PFOS) was the most abundant yolk PFAA (mean = 42.0 ng/g wet wt), followed by perfluorooctanoic acid (PFOA; 3.8 ng/g wet wt) and perfluorododecanoic acid (PFDoDa; 2.8 ng/g wet wt). The n-ary sumation PFAAs averaged 57.4 ng/g wet weight, ranging between 26.5 and 115.0 ng/g wet weight. The PFAA levels varied substantially among clutches (0.29-0.79 of the total variation), whereas the effects of laying order were considerably weaker (0.01-0.13). Egg-laying order effects were detected for n-ary sumation PFAAs, PFOS, perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnA), and PFDoDa, whereby the last-laid eggs exhibited lower PFAA concentrations than early-laid eggs. Our results indicate that seagulls from the northern Adriatic basin deposit measurable amounts of PFAAs in their eggs. The large among-clutches differences in PFAAs suggest that exposure of yellow-legged gull females to these compounds is highly variable.				1				B	-		
D726	蓄積性	Groffen, T; Oden, S; Claeijs, N; Willems, T; Schoenaers, S; Vissenberg, K; Bervoets, L; Eens, M; Prinsen, E	Accumulation and effects of perfluoroalkyl substances in Arabidopsis thaliana in a temperature-dependent manner: an in vitro study	2023	Environ. Sci. Pollut. Res. 2023 Jun:30(26):68732-68742. doi: 10.1007/s11356-023-27237-1.	The replacement of long-chained per- and polyfluoroalkyl substances (PFAS) with their short-chained homologues may have an impact on the accumulation in plants. The extent to which PFAS are absorbed by plants may differ among species and may depend on environmental factors, including temperature. The effect of an increased temperature on root uptake and translocation of PFAS in plants has been poorly studied. In addition, very few studies have examined toxicity of environmentally realistic PFAS concentrations to plants. Here, we investigated the bioaccumulation and tissue-distribution of fifteen PFAS in Arabidopsis thaliana L. grown in vitro at two different temperatures. Additionally, we examined the combined effects of temperature and PFAS accumulation on plant growth. Short-chained PFAS mainly accumulated in the leaves. The perfluorocarboxylic acid (PFCA) concentrations in roots and leaves, and the relative contribution of PFCAs to the Sigma PFAS concentrations increased with carbon chain length regardless of temperature, with the exception of perfluorobutanoic acid (PFBA). An increased uptake of PFAS in leaves and roots at higher temperatures was observed for PFAS containing either eight or nine carbon atoms and could hence potentially result in higher risks for human intake. Leaf:root ratios of PFCAs followed a U-shaped pattern with carbon chain length, which is attributed to both hydrophobicity and anion exchange. Overall, no combined effects of realistic PFAS concentrations and temperature on the growth of A. thaliana were observed. PFAS exposure positively affected early root growth rates and root hair lengths, indicating a potential effect on factors involved in root hair morphogenesis. However, this effect on root growth rate became negligible later on in the exposure, and solely a temperature effect was observed after 6 days. Temperature also affected the leaf surface area. The underlying mechanisms on how PFAS stimulates root hair growth require further examination.	1							B	-		
D727	蓄積性	Miranda, DA; Benskin, JP; Awad, R; Lepoint, G; Leonel, J; Hatje, V	Bioaccumulation of Per- and polyfluoroalkyl substances (PFASs) in a tropical estuarine food web	2021	Sci. Total Environ. 2021 Feb:754:142146. doi: 10.1016/j.scitotenv.2020.142146.	The biomagnification of per- and polyfluoroalkyl substances (PFASs) was investigated in a tropical mangrove food web from an estuary in Bahia, Brazil. Samples of 44 organisms (21 taxa), along with biofilm, leaves, sediment and suspended particulate matter were analyzed. Sum (Sigma) PFAS concentrations in biota samples were dominated by perfluorooctane sulfonate (PFOS, 93% detection frequency in tissues; 0.05 to 1.97 ng g(-1) ww whole-body (wb)), followed by perfluorotridecanoate (PFTrDA, 57%; 0.01 to 0.28 ng g(-1) ww wb). PFOS precursors such as perfluorooctane sulfonamide (FOSA, 54%; 0.01 to 0.32 ng g(-1) ww wb) and N-ethyl perfluorooctane sulfonamide (EtFOSA; 30%; 0.01 to 0.21 ng g(-1) ww wb) were also detected. PFAS accumulation profiles revealed different routes of exposure among bivalve, crustacean and fish groups. Statistics for left-censored data were used in order to minimize bias on trophic magnification factors (TMFs) calculations. TMFs >1 were observed for PFOS (linear + branched isomers), EtFOSA (linear + branched isomers), and perfluorononanoate (PFNA), and in all cases, dissimilar accumulation patterns were observed among different trophic positions. The apparent biodilution of some long-chain PFCAs through the food chain (TMF < 1) may be due to exposure from multiple PFAS sources. This is the first study investigating bioaccumulation of PFASs in a tropical food web and provides new insight on the behavior of this ubiquitous class of contaminants.				1				B	-		
D728	環境中運命	Zhang, YW; Tan, DF; Geng, Y; Wang, L; Peng, Y; He, ZY; Xu, YP; Liu, XW	Perfluorinated Compounds in Greenhouse and Open Agricultural Producing Areas of Three Provinces of China: Levels, Sources and Risk Assessment	2016	Int. J. Environ. Res. Public Health. 2016 Dec;13(12):1224. doi: 10.3390/ijerph13121224.	Field investigations on perfluoroalkyl acid (PFAA) levels in various environmental matrixes were reported, but there is still a lack of PFAA level data for agricultural environments, especially agricultural producing areas, so we collected soil, irrigation water and agricultural product samples from agricultural producing areas in the provinces of Liaoning, Shandong and Sichuan in China. The background pollution from instruments was removed and C-4-C-18 PFAAs were detected by LC-MS/MS. The concentrations of PFAAs in the top and deep layers of soil were compared, and the levels of PFAAs in different agricultural environments (greenhouses and open agriculture) were analyzed. We found the order of PFAA levels by province was Shandong > Liaoning > Sichuan. A descending trend of PFAA levels from top to deep soil and open to greenhouse agriculture was shown and perfluorobutanoic acid (PFBA) was considered as a marker for source analysis. Bean vegetables contribute highly to the overall PFAA load in vegetables. A significant correlation was shown between irrigation water and agricultural products. The EDI (estimated daily intake) from vegetables should be of concern in China.	1							B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D729	蓄積性	Surma, M; Gizejewski, Z; Zielinski, H	Determination of perfluorinated sulfonate and perfluorinated acids in tissues of free-living European beaver (castor fiber L.) by d-SPE/micro-UHPLC-MS/MS	2015	Ecotox. Environ. Safe. 2015 Oct:120:436-444. doi: 10.1016/j.ecoenv.2015.06.029	Perfluorooctanesulfonate (PFOS) and perfluorooctanoic acid (PFOA) are the main representatives of an rising class of persistent organic pollutants (POPs), perfluorochemicals (PFCs). In this study, determination of selected PFCs concentration in liver, brain, tail, adipose and peritoneum tissues of free-living European beaver (Castor fiber L.) was addressed. Tissue samples, collected from beavers living in Masurian Lakeland (NE Poland), were analyzed by dispersive Solid Phase Extraction (D-SPE) with micro-UHPLC-MS/MS system. In a group of ten selected pefrluorinated compounds only two perfluorinated acids (PFOA and PFNA) and one peflourinated sulfonate (PFOS) were quantified. PFOA was detected in all analysed tissue samples in both female and male beavers in a range from 0.55 to 0.98 ng g(-1) ww whereas PFOS was identified in all analyzed female beaver tissues and only in liver, subcutaneous adipose and peritoneum tissues of male beavers at the concentration level from 0.86 to 5.08 ng g(-1) ww. PFNA was only identified in female beaver tissues (liver, subcutaneous adipose and peritoneum) in a range from 1.50 to 6.61 ng g(-1) ww. This study demonstrated the bioaccumulation of PFCs in tissue samples collected from beavers living in area known as green lungs of Poland. The results provided in this study indicate for the increasing risk of PFCs occurrence in the environment and the level of PFCs in tissue of free-living European beavers may serve as bioindicator of environmental pollution by these compounds.			1					B	-		
D730	環境中運命	Zhao, SY; Zhou, T; Zhu, LY; Wang, BH; Li, Z; Yang, LP; Liu, LF	Uptake, translocation and biotransformation of N-ethyl perfluorooctanesulfonamide (N-EtFOSA) by hydroponically grown plants	2018	Environ. Pollut. 2018 Apr:235:404-410. doi: 10.1016/j.envpol.2017.12.053	N-ethyl perfluorooctane sulfonamide (N-EtFOSA) is an important perfluorooctanesulfonate (PFOS) precursor (PreFOS) which is used in sulfluramid. The present work studied the uptake, translocation and metabolism of N-EtFOSA in wheat (Triticum aestivum L), soybean (Glycine max L Merrill) and pumpkin (Cucurbita maxima L) by hydroponic exposure. Except for parent N-EtFOSA, its metabolites of perfluorooctane sulfonamide acetate (FOSAA), perfluorooctane sulfonamide (PFOSA), PFOS, perfluorohexane sulfonate (PFHxS) and perfluorobutane sulfonate (PFBS) were detected in the roots and shoots of all the three plant species examined. This suggested that plant roots could take up N-EtFOSA from solutions efficiently, and translocate to shoots. A positive correlation was found between root concentration factors (RCFs) of N-EtFOSA and root lipid content. Much higher proportion of N-EtFOSA transformation products in plant tissues than in the solutions suggested that N-EtFOSA could be in vivo metabolized in plant roots and shoots to FOSAA, PFOSA and PFOS, and other additional shorter-chain perfluoroalkane sulfonates (PFSAs), including PFHxS and PFBS. The results suggested that plants had biotransformation pathways to N-EtFOSA that were different than those from microorganisms and animals. This study provides important information about the uptake and metabolism of PreFOSs in plants.				1				B	-		
D731	蓄積性	Garcia, LAA; Descamps, S; Herzke, D; Chastel, O; Carravieri, A; Cherel, Y; Labadie, P; Budzinski, H; Munoz, G; Bustamante, P; Polder, A; Gabrielsen, GW; Bustnes, JO; Borga, K	Bioaccumulation of Per and Polyfluoroalkyl Substances in Antarctic Breeding South Polar Skuas (Catharacta maccormicki) and Their Prey	2022	Front. Mar. Sci. 2022 Mar:9:819525. doi: 10.3389/fmars.2022.819525.	Per and polyfluoroalkyl substances (PFASs) are found in Antarctic wildlife, with high levels in the avian top predator south polar skua (Catharacta maccormicki). As increasing PFAS concentrations were found in the south polar skua during the breeding season in Antarctica, we hypothesised that available prey during the breeding period contributes significantly to the PFAS contamination in skuas. To test this, we compared PFAS in south polar skuas and their main prey from two breeding sites on opposite sides of the Antarctic continent: Antarctic petrel (Thalassoica antarctica) stomach content, eggs, chicks, and adults from Svarthamaren in Dronning Maud Land and Adelie penguin chicks (Pygoscelis adeliae) from Dumont d'Urville in Adelie Land. Of the 22 PFAS analysed, seven were present in the majority of samples, except petrel stomach content [only perfluoroundecanoate (PFUnA) present] and Adelie penguins (only four compounds present), with increasing concentrations from the prey to the skuas. The biomagnification factors (BMFs) were higher at Dumont d'Urville than Svarthamaren. When adjusted to reflect one trophic level difference, the BMFs at Svarthamaren remained the same, whereas the ones at Dumont d'Urville doubled. At both the colonies, the skua PFAS pattern was dominated by perfluorooctanesulfonic acid (PFOS), followed by PFUnA, but differed with the presence of branched PFOS and perfluorotetradecanoate (PFTeA) and lack of perfluorononanoate (PFNA) and perfluorodecanoate (PFDA) at Dumont d'Urville. At Svarthamaren, the pattern in the prey was comparable to the skuas, but with a higher relative contribution of PFTeA in prey. At Dumont d'Urville, the pattern in the prey differed from the skuas, with the domination of PFUnA and the general lack of PFOS in prey. Even though the PFAS levels are low in Antarctic year-round resident prey, the three lines of evidence (pattern, BMF difference, and BMF adjusted to one trophic level) suggest that the Antarctic petrel are the significant source of PFAS in the Svarthamaren skuas, whereas the skuas in Dumont d'Urville have other important sources to PFAS than Adelie penguin, either in the continent or external on the inter-breeding foraging grounds far from Antarctica.			1					B	-		
D732	蓄積性	Liu, CH; Gin, KYH; Chang, VWC; Goh, BPL; Reinhard, M	Novel Perspectives on the Bioaccumulation of PFCs - the Concentration Dependency	2011	Environ. Sci. Technol. 2011 Nov:45(22):9758-9764. doi: 10.1021/es202078n.	The effects of exposure concentration on the bioaccumulation of four perfluorinated chemicals (PFCs): perfluorooctanesulfonate (PFOS), perfluoroocanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA), was investigated using green mussels, Perna viridis. Mussels were exposed to concentrations of 1 mu gL(-1) and 10 mu gL(-1) of each PFC for 56 days, and the bioaccumulation factors (BAF) were found to range from 15 to 859 L/kg and from 12 to 473 L/kg at 1 mu gL(-1) and 10 mu gL(-1), respectively. For all compounds, the BAF was larger at the lower dosage. Results suggest that the bioaccumulation of PFCs is concentration dependent. This concentration dependency can be explained by a nonlinear adsorption mechanism, which was further supported by the experimental results. The sensitivity of BAF to exposure concentration was found to be positively related to perfluorinated chain length and the binding affinity of the compounds. Bioaccumulation of long chain carboxylates and sulfonates are more easily affected by concentration changes. The validity of the conventional kinetic method was examined by comparing the results with the fundamental steady-state method: in addition to the above-mentioned batch test, mussels were also subject to 24-day exposure (1 mu gL(-1) and 10 mu gL(-1)) followed by 24-day depuration. Contradictions were found in the resulting kinetic BAF and model curving fittings. A new kinetic model based on adsorption mechanism was proposed, which potentially provide more accurate description of the bioaccumulation process of PFCs.			1					B	-		
D733	蓄積性	Colomer-Vidal, P; Bertolero, A; Alcaraz, C; Garreta-Lara, E; Santos, FJ; Lacorte, S	Distribution and ten-year temporal trends (2009-2018) of perfluoroalkyl substances in gull eggs from Spanish breeding colonies	2022	Environ. Pollut. 2022 Jan:293:118555. doi: 10.1016/j.envpol.2021.118555.	Gull eggs are excellent bioindicators of environmental pollution as reflect the contamination levels of coastal areas, especially of persistent and bioacumulative compounds such as perfluoroalkyl substances (PFAS). This study aims to evaluate the geographical distribution and 10-year temporal trends (2009-2018) of 17 PFAS in eggs of two gull species (Larus michahellis and Larus audouinii) from 5 main Spanish colonies. Sigma PFAS ranged from 13.7 +/- 5.9 to 164 +/- 17 ng g(-1) wet weight and higher concentrations were observed in L. audouinii than in L. michahellis. Perfluorooctane sulfonate (PFOS) was the predominant compound in all samples, followed by perfluoroundecanoic acid (PFUnA) and perfluorotridecanoic acid (PFTriDA). Perfluorododecanoic acid (PFDoA), perfluorodecanoic acid (PFDA) and perfluorooctanoic acid (PFNA) were also found in all studied areas but at lower concentrations, while perfluorooctanoic acid (PFOA) was only detected in the Medes Islands. Principal Component Analysis revealed the co-occurrence of the 6 detected PFAS, and differentiated samples from Ebro Delta and Medes Islands, both located in the North-Eastern Mediterranean Sea, with high contribution of all PFAS, from Chafarinas and Atlantic Islands with lower concentration levels and variability. Also, different patterns were observed among colonies, suggesting the fish-based diet plays an important role in PFAS bio-accumulation. In all colonies, except for the Medes Islands, Sigma PFAS decreased through the 10-year study period, with PFOS, PFUnA, and PFTriDA showing a significant concentration reduction in a colony-specific manner. This study demonstrates the usefulness and importance of continuous systematic long-term monitoring to determine the geographical distribution and temporal variations of PFAS in marine protected areas using gull eggs as bioindicators of environmental pollution.			1					B	-		
D734	環境中運命	Feng, XM; Ye, MQ; Li, Y; Zhou, J; Sun, BB; Zhu, YM; Zhu, LY	Potential sources and sediment-pore water partitioning behaviors of emerging per/polyfluoroalkyl substances in the South Yellow Sea	2020	J. Hazard. Mater. 2020 May:389:122124. doi: 10.1016/j.jhazmat.2020.122124.	Emerging per/polyfluoroalkyl substances (PFASs) have received great concerns, but there are few data in the coastal environment, which play an essential role in their global transport. In this study, surface water and sediment samples were collected in the South Yellow Sea close to Jiangsu Province China, and 26 legacy as well as emerging PFASs were investigated. Perfluorooctanoic acid (PFOA) and perfluorobutane sulfonate (PFBS) were predominant in the coastal water of the South Yellow Sea with a relatively higher level than other coastal regions in the world. PFBS and 6:2 fuorotelomer sulfonic acid (6:2 FTSA) were two major alternatives of perfluorooctane sulfonate (PFOS) which were used in textile surface treatment and fire-fighting foams, respectively. Multiple receptor models identified that fluoropolymer manufacture, textile and food packages were three major sources of PFASs in the South Yellow Sea. The partitioning behaviors of PFASs between sediment and pore water in the marine environment were compared, and the partitioning coefficients of hexafluoropropylene oxide trimer acid (HFPO-TA) and 6:2 chlorinated polyfluorinated ether sulfonic acid (6:2 F-53B) were reported for the first time, which exhibited stronger partition in sediment than their predecessors. The results provide important hints to understand the environmental transport of PFASs in the marine environment.				1	1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D735	環境中運命	Sun, M; Arevalo, E; Strynar, M; Lindstrom, A; Richardson, M; Kearns, B; Pickett, A; Smith, C; Knappe, DRU	Legacy and Emerging Perfluoroalkyl Substances Are Important Drinking Water Contaminants in the Cape Fear River Watershed of North Carolina	2016	Environ. Sci. Technol. Lett. 2016 Dec:3(12):415-419. doi: 10.1021/acs.estlett.6b00398.	Long-chain per- and polyfluoroalkyl substances (PFASs) are being replaced by short-chain PFASs and fluorinated alternatives. For ten legacy PFASs and seven recently discovered perfluoroalkyl ether carboxylic acids (PFECAs), we report (1) their occurrence in the Cape Fear River (CFR) watershed, (2) their fate in water treatment processes, and (3) their adsorbability on powdered activated carbon (PAC). In the headwater region of the CFR basin, PFECAs were not detected in raw water of a drinking water treatment plant (DWTP), but concentrations of legacy PFASs were high. The U.S. Environmental Protection Agency's lifetime health advisory level (70 ng/L) for perfluorooctanesulfonic acid and perfluorooctanoic acid (PFOA) was exceeded on 57 of 127 sampling days. In raw water of a DWTP downstream of a PFAS manufacturer, the mean concentration of perfluoro-2-propoxypropanoic acid (PFPrOPrA), a replacement for PFOA, was 631 ng/L (n = 37). Six other PFECAs were detected, with three exhibiting chromatographic peak areas up to 15 times that of PFPrOPrA. At this DWTP, PFECA removal by coagulation, ozonation, biofiltration, and disinfection was negligible. The adsorbability of PFASs on PAC increased with increasing chain length. Replacing one CF2 group with an ether oxygen decreased the affinity of PFASs for PAC, while replacing additional CF2 groups did not lead to further affinity changes.					1			B	-		
D736	環境中運命	Courtier-Murias, D; Michel, E; Rodts, S; Lafolie, F	Novel Experimental Modeling Approach for Characterizing Perfluorinated Surfactants in Soils	2017	Environ. Sci. Technol. 2017 Mar:51(5):2602-2610. doi: 10.1021/acs.est.6b05671.	Soil contamination is still poorly understood and modeled in part because of the difficulties of looking inside the black box constituted by soils. Here, we investigated the application of a recently developed H-1 NMR. technique to F-19 NMR relaxometry experiments and utilized the results as inputs for an existing model. This novel approach yields F-19 T-2 NMR relaxation values of any fluorinated contaminant, which are among the most dangerous contaminants, allowing us to noninvasively and directly monitor their fate in soils. Using this protocol, we quantified the amount of a fluorinated xenobiotic (heptafluorobutyric acid, HFBA) in three different environments in soil aggregate packings and monitored contaminant exchange dynamics between these compartments. A model computing HFBA partition dynamics between different soil compartments showed that these three environments corresponded to HFBA in solution (i) between and (ii) inside the soil aggregates and (iii) to HFBA adsorbed to (or strongly interacting with) the soil constituents. In addition to providing a straightforward way of determining the sorption kinetics of any fluorinated contaminant, this work also highlights the strengths of a combined experimental-modeling approach to unambiguously understand experimental data and more generally to study contaminant fate in soils.								C	-		
D737	蓄積性	Jouanneau, W; Bardsen, BJ; Herzke, D; Johnsen, TV; Eulaers, I; Bustnes, JO	Spatiotemporal Analysis of Perfluoroalkyl Substances in White-Tailed Eagle (Haliaeetus albicilla) Nestlings from Northern Norway-A Ten-Year Study	2020	Environ. Sci. Technol. 2020 Apr:54(8):5011-5020. doi: 10.1021/acs.est.9b06818.	The white-tailed eagle (Haliaeetus albicilla) in Scandinavia has suffered from impaired reproduction due to high exposure to industrial pollution between the 1960s and 1980s. While population numbers are rising again, new contaminants, such as per- and polyfluoroallcyl substances (PFAS), are increasingly found in high trophic avifauna and are of concern to potentially impact once again on population health. In the present study, we examined PFAS levels in plasma of white-tailed eagle nestlings from northern Norway over the last decade (2008-2017). While PFOA and PFNA exposure did not follow a significant time trend, PFOS and PFHxS concentrations decreased over time, and >= C-11 perfluorinated carboxylic acids only seem to level off during the last four years. This may in fact be the first evidence for a change in the trend for some of these compounds. Furthermore, since several PFAS are expected to be highly present in aqueous film-forming foams used at airports, we also investigate the potential of the two main airports in the region to act as hotspots for PFAS. Our results indeed show decreasing exposure to PFOA with distance to the airports. Altogether, our results seem to show that legislation actions are effective, and continued concern for PFAS exposure of high trophic wildlife is still warranted, even in the northern environment.			1					B	-		
D738	蓄積性	Hart, K; Gill, VA; Kannan, K	Temporal Trends (1992-2007) of Perfluorinated Chemicals in Northern Sea Otters (Enhydra lutris kenyoni) from South-Central Alaska	2009	Arch. Environ. Contam. Toxicol. 2009 Apr:56(3):607-614. doi: 10.1007/s00244-008-9242-2.	Perfluorinated chemicals (PFCs) have been detected in abiotic and biotic matrices worldwide, including the Arctic Ocean. Considering these chemicals' persistent and bioaccumulative potentials, it was expected that levels of PFCs, like those of many legacy organic pollutants, would respond slowly to the restrictions in production and usage. Temporal trend studies in remote areas, such as the Arctic, can help determine the chronology of contamination and the response of the environment to regulations on PFCs. Prior to this study, temporal trends of PFCs in Alaskan coastal waters had not been examined. In the present study, concentrations of six PFCs were determined in livers of northern sea otters (Enhydra lutris kenyoni) collected from three areas in south-central Alaska (Prince William Sound, n = 36; Resurrection Bay, n = 7; Kachemak Bay, n = 34) from 1992 to 2007. Additionally, previously published profiles and concentrations of PFCs in southern sea otters from California and Asian sea otters from Kamchatka (Russia) were compared to our new data, to determine the geographical differences in PFC profiles among these three regions in the Pacific Ocean. Perfluorooctanesulfonate (PFOS), perfluorooctanesulfonamide (PFOSA), and perfluorononanoate (PFNA) were the predominant PFCs found in the livers of northern sea otters from 1992 to 2007. Other PFCs, such as perfluorooctanoate (PFOA), perfluoroundecanoate (PFUnDA), and perfluorodecanoate (PFDA), were detected less frequently, and at low concentrations. Overall, from 2001 to 2007, a decrease in concentrations of PFOS was found in northern sea otters, suggesting an immediate response to the phase-out in 2000 of perfluorooctanesulfonyl-based compounds by a major producer in the United States. In contrast, concentrations of PFNA in northern sea otters increased by 10-fold from 2004 to 2007. These results indicate that the contribution by PFNA to I PFC pound concentrations is increasing in northern sea otters. The profiles (i.e., composition of individual PFC to I PFC pound concentration) of PFCs in northern sea otters from Alaska were similar to those reported for southern sea otters from California, but were considerably different from the profiles reported for Asian sea otters from Russia, suggesting differences in point sources of exposure.			1					B	-		
D739	蓄積性	Petre, VA; Chiriac, FL; Lucaciu, IE; Paun, I; Pirvu, F; Iancu, VI; Novac, L; Gheorghe, S	Tissue Bioconcentration Pattern and Biotransformation of Per-Fluorooctanoic Acid (PFOA) in Cyprinus carpio (European Carp)-An Extensive In Vivo Study	2023	Foods. 2023 Apr;12(7):1423. doi: 10.3390/foods12071423.	The perfluoroalkyl substances (PFAS) represent a persistent class of synthetic chemicals that spread in the environment as a result of industrialization. Due to their bioaccumulative and endocrine disruption implications, these chemicals can affect food quality and human health, respectively. In the present study, the bioconcentration and biotransformation of perfluorooctanoic acid (PFOA) in common carp (Cyprinus carpio) were evaluated in a biphasic system (exposure and depuration). Carp were continuously exposed, under laboratory conditions, to 10 (Experiment 1) and 100 (Experiment 2) mu g/L PFOA for 14 weeks, followed by a wash out period of 3 weeks. Fish organs and tissues were collected at 8, 12, 14 weeks of exposure and at week 17, after the depuration period. The results obtained from the LC-MS/MS analysis showed the presence of PFOA in all studied organs. The highest values of PFOA were identified in the gallbladder (up to 2572 ng/g d.w.) in Experiment 1 and in the gallbladder (up to 18,640 ng/g d.w.) and kidneys (up to 13,581 ng/g d.w.) in Experiment 2. The average BCF varied between 13.4 and 158 L/Kg in Experiment 1 and between 5.97 and 80.3 L/Kg in Experiment 2. Four biotransformation products were identified and quantified in all organs, namely: PFBA, PFPeA, PFHxA, and PFHpA. PFBA was proven to be the dominant biotransformation product, with the highest values being determined after 8 weeks of exposure in the kidney, gallbladder, brain, liver, and gonads in both experiments. Because freshwater fish are an important food resource for the human diet, the present study showed the fishes' capacity to accumulate perfluoroalkyl substances and their metabolites. The study revealed the necessity of monitoring and risk studies of new and modern synthetic chemicals in aquatic resources.	1	1						B	-		
D740	環境中運命	Pickard, HM; Criscitiello, AS; Persaud, D; Spencer, C; Muir, DCG; Lehnherr, I; Sharp, MJ; De Silva, AO; Young, CJ	Ice Core Record of Persistent Short-Chain Fluorinated Alkyl Acids: Evidence of the Impact From Global Environmental Regulations	2020	Geophys. Res. Lett. 2020 MAY 28;47(10):e2020GL087535. doi: 10.1029/2020GL087535.	Short chain perfluoroalkylcarboxylic acids (scPFCAs, CxF2x+1COOH, x <= 3) are persistent compounds formed from atmospheric oxidation of fluorotelomer compounds and chlorofluorocarbon (CFC) replacements introduced as a result of the Montreal Protocol. Understanding sources and impacts of scPFCAs has been limited by observational data. We report multidecadal depositional fluxes for trifluoroacetic acid (TFA), perfluoropropionic acid (PFPrA), and perfluorobutanoic acid (PFBA) from two Arctic ice cores. Fluxes of all three scPFCAs increase starting around 1990. Through comparison with chemical transport models and assessment of temporal trends, we observe the importance of CFC replacements in the increased deposition of TFA. Fluorotelomer degradation may contribute to the deposition of PFBA but is insignificant for TFA and PFPrA. Deposition of TFA is expected to increase as new CFC replacement compounds are phased in. This work demonstrates the increased environmental burden of persistent and potentially toxic scPFCAs as a result of global regulation. Plain Language Summary Measurements of persistent compounds were made in two Arctic ice cores. The multidecadal records allow us to better understand the sources and deposition of these chemicals to remote areas. We observed that amounts deposited to the Arctic increased with time starting around 1990. Our results suggest that global regulation and replacement of other environmentally harmful chemicals contributed to the increase of these compounds in the Arctic, illustrating that regulations can have important unanticipated consequences.	1							B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D741	蓄積性	Ghelli, E; Tondo, MT; Zironi, E; Pagliuca, G; Sirri, F; Gazzotti, T	Preliminary monitoring of the presence of perfluoroalkyl substances in Italian eggs from different breeding systems	2019	Ital. J. Food Saf. 2019 ;8:120-123. doi: 10.4081/ijfs.2019.7702	Perfluoroalkylated substances (PFASs) are a wide cluster of fluorinated molecules largely engaged industrially and commercially for many purposes. Because of the strength of the fluorine-carbon bond, PFASs show a firm tenacity against thermal degradation, hydrolysis, photolysis and biodegradation. On the other hand, such chemical stability gives them persistent environmental pollutant feature. In 2012, EFSA published a scientific report on PFASs in food, mentioning their adverse effects on health. Based on observational studies evidences, EFSA has recommended a tolerable daily intake (TDI) for the two most known PFASs, i.e. PFOS 150 ng/kg b.w./day and PFOA 1500 ng/kg b.w./day. The aim of this study was to monitor, for the first time, the level of contamination of PFASs in chicken eggs laid in Northern Italy. The eggs were collected from different rearing systems, in order to search a correlation between this variable and the contamination of PFASs. In this study four PFASs [perfluoro-nnonanoic acid (PFNA), perfluoro-noctanoic-acid (PFOA), sodium perfluoro-1-hexanesulfonate (PFHxS) and sodium perfluoro-1-octanesulfonate (PFOS)] were analyzed by liquid chromatography-tandem mass spectrometer (LC-MS/MS). 132 eggs were analyzed, split up in 11 groups according to the geographical origin and rearing system. Results accord with literature data available for chicken eggs: almost all the samples show a PFASs contamination level under the limit of quantification (LOQ) of 0.25 ng/mL. No significant difference results from the rearing system, attesting an equal distribution and a concentration of PFASs detectable under the limit of quantification.			1					B	-		
D742	蓄積性	Kannan, K; Yun, SH; Evans, TJ	Chlorinated, brominated, and perfluorinated contaminants in livers of polar bears from Alaska	2005	Environ. Sci. Technol. 2005 Dec:39(23):9057-9063. doi: 10.1021/es051850n.	The existence of two subpopulations of polar bears in Alaska, the Beaufort Sea and the Chukchi Sea populations, has been documented. In this study, differences in concentrations and profiles of organochlorine pesticides, polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and perfluorinated acids were examined in livers of polar bears from the two subpopulations in Alaska. Concentrations of most of the organohalogens analyzed were greater in the Beaufort Sea subpopulation than in the Chukchi Sea subpopulation, except for HCHs and perfluorononanoic acid (PFNA), which were high in samples from the Chukchi Sea subpopulation. Concentrations of chlordanes, PCBs, and perfluorooctanesulfonate (PFOS) were significantly different between the two subpopulations. Chlordane was the predominant contaminant in the Beaufort Sea population, and PFOS was the major contaminant in the Chukchi Sea population. Polar bears from the Beaufort Sea showed significantly higher proportions of more highly chlorinated PCBs than those from the Chukchi Sea. Concentrations of several perfluorinated acids were significantly correlated. Overall, the concentrations and profiles of organohalogens analyzed in the two subpopulations of polar bears suggest differences in the sources of exposures between the two regions of Alaska.			1					B	-		
D743	蓄積性	Liu, ZY; Lu, YL; Song, X; Jones, K; Sweetman, AJ; Johnson, AC; Zhang, M; Lu, XT; Su, C	Multiple crop bioaccumulation and human exposure of perfluoroalkyl substances around a mega fluorochemical industrial park, China: Implication for planting optimization and food safety	2019	Environ. Int. 2019 Jun:127:671-684. doi: 10.1016/j.envint.2019.04.008	Perfluoroalkyl substances (PFASs) have become a recognized concern due to their mobility, persistence, ubiquity and health hazards in the environment. In this study, ten types of vegetables and three types of grain crops were collected in two open-air fields with different distances (0.3 km, 10 km) from a mega fluorochemical industrial park (FIP), China. Bioaccumulation characteristics of PFASs in light of crop types and organs were explored, followed by analyzing human exposure and risks to local residents with different age groups and dietary habits. Elevated levels of Sigma PFASs were found nearby the FIP ranging from 79.9 ng/g to 200 ng/g in soils and from 58.8 ng/g to 8085 ng/g in crops. Perfluorooctanoic acid (PFOA) was the predominant PFAS component in soil; while shorter-chain perfluoroalkyl carboxylic acids (PFCAs), especially perfluorobutanoic acid (PFBA), were the major PFAS contaminants in multiple crops, resulting from their bioaccumulation preference. Depending on the crop types, the bioaccumulation factors (BAFs) of Sigma PFASs for edible parts varied from 0.36 to 48.0, and the highest values were found in shoot vegetables compared with those in fruit vegetables, flower vegetables, root vegetables and grain crops. For typical grains, the BAFs of Sigma PFASs decreased in the order of soybean (Glycine max (Linn.) Merr.), wheat (Triticum aestivum L.) and corn (Zea mays L.), possibly related to their protein and lipid content. Among specific organs in the whole plants, leaves exhibited the highest BAFs of Sigma PFASs compared with corresponding roots, stems, husks or grains. With increasing carbon chain lengths of individual PFCAs (C4-C8), the logarithm of their BAFs for edible parts of various crops showed a linear decrease (0.1-1.16 log decrease per CF2 unit), and the largest decrease was observed in grains. Human exposure to PFOA via the consumption of contaminated crops represents a health risk for local residents, especially for low-age consumers or urban consumers with higher vegetable diet. Implications for planting optimization and food safety were provided aiming to reduce health hazards of PFASs.	1							B	-		
D744	環境中運命	Zhong, HF; Liu, WC; Li, NQ; Ma, DH; Zhao, CY; Li, J; Wang, YW; Jiang, GB	Assessment of perfluorohexane sulfonic acid (PFHxS)-related compounds degradation potential: Computational and experimental approaches	2022	J. Hazard. Mater. 2022 Aug:436:129240. doi: 10.1016/j.jhazmat.2022.129240.	Perfluorohexane sulfonic acid (PFHxS) and PFHxS-related compounds are listed in Annex A of the Stockholm Convention without specific exemptions. Substances that potentially degrade to PFHxS are considered as their related compounds. Unfortunately, the degradation behavior of PFHxS precursors, an important basis for the corresponding chemical regulation, remains unclear. Herein, based on the hypothesis that bond dissociation enthalpy (BDE) is the determining factor for the degradation of PFHxS precursors, the BDE of PFHxS-related precursors to produceC6F13SO2 -groups was calculated. In addition, quantitative structure-activity relationship models based on partial least squares, partial least squares discrimination analysis, and support vector machine algorithms were developed to predict the BDE of 48 PFHxS precursors and distinguish the precursors with different degradation potential. Subsequent photodegradation experiments demonstrated that the order of degradation rates was consistent with that predicted by theoretical models. Importantly, perfluorohexanoic acid (PFHxA) and perfluorobutanoic acid, and not PFHxS, were detected as the degradation products of potential PFHxS precursors. Sulfonamides, phenyl unit, and other radicals in the non-nucleus part of PFHxS precursors were identified as the critical molecular segments that affect their degradation potential. Ultimately, by comparing BDE values, it was theoretically speculated that PFHxS related compounds exhibit a greater potential to generate PFHxA than PFHxS. Results in this study indicated for the first time that not all the compounds containing C6F13SO2 groups were guaranteed to degrade into PFHxS under natural conditions.	1	1						B	-		
D745	蓄積性	Bossi, R; Dam, M; Riget, FF	Perfluorinated alkyl substances (PFAS) in terrestrial environments in Greenland and Faroe Islands	2015	Chemosphere 2015 Jun:129:164-169. doi: 10.1016/j.chemosphere.2014.11.044	Perfluorinated alkylated substances (PFASs) have been measured in liver samples from terrestrial organisms from Greenland and the Faeroe Islands. Samples from ptarmigan (West Greenland), reindeer (south-west-Greenland), muskox (East Greenland), and land-locked Arctic char from southwest Greenland and the Faroe Islands were analyzed. In addition, PFASs levels in land-locked brown trout from Faroese lakes are reported. Of the 17 PFASs analyzed in the samples the following compounds were detected: PFOS, PFNA, PFDA, PFUnA, PFDoA, PFTrA, and PFTeA. PFNA was the compound detected in most samples and in all species. However, the compound detected at highest concentration was dependent on species, with overall highest concentrations of PFTrA and PFUnA being detected in trout liver from Lake a Myranar (Faroe Islands). In muskox, the PFAS occurring at highest concentrations was PFDA, which was among the PFAS detected at lowest concentrations in freshwater fish, and was only detected in one individual ptarmigan. The concentration of PFOS, PFDoA and PFTrA in Arctic char from Greenland and Faroe Islands were similar, whereas the concentration of PFNA, PFDA and PFUnA were higher in Arctic char than those from Greenland. The opposite was observed for PFFeA. The PFASs occurring at highest concentrations in trout were PFTrA and PFUnA. Arctic char from Lake a Myranar had much lower concentrations of PFTrA and PFUnA than in trout from the lakes analyzed, but a higher concentration of PFTeA than trout from the same lake. A clear pattern with odd-carbon number homologues concentrations higher than the next lower even homologue was observed in fish samples, which is consistent with the hypothesis of transport of volatile precursors to remote regions.			1					B	-		
D746	環境中運命	Shi, QY; Xiong, YX; Kaur, P; Dennis, NM; Schlenk, D; Gan, JY	Strategy to Minimize Plant Accumulation of Contaminants of Emerging Concern: Alternation between Treated Wastewater and Freshwater Irrigation	2023	Environ. Sci. Technol. Lett. 2023 Apr:10(4):302-307. doi: 10.1021/acs.estlett.3c00058.	Treated wastewater (TWW) is increasingly used for agricultural irrigation in arid and semiarid areas, but it can introduce contaminants of emerging concern (CECs) into the food chain, posing a potential risk to human health. While many studies have shown that plants can accumulate some CECs, so far little effort has been made to explore mitigation strategies. This study tested the concept of alternating between TWW with conventional freshwater for irrigation to minimize CEC accumulation in plants. Tomato and lettuce seedlings were first cultivated in CEC-containing hydroponic solutions for 3 weeks, and then in CEC-free media for another 3 weeks. The plant tissues contained elevated concentrations of perfluorobutanesulfonate, perfluorobutanoic acid, perfluorohexanoic acid, carbamazepine, and fluoxetine ranging from 42.1 to 2724.2 ng/g (dry weight). However, after being transferred to CEC-free media, most CEC levels decreased by over 75%, attributed to plant metabolism, growth dilution and back release to culture media. This proof-of-concept study suggested that using TWW during the early part of the growing season may effectively minimize CEC accumulation. Such hybrid irrigation schemes have a great prospect for expanding the safe reuse of TWW and other lower-quality water sources in agriculture and should be further evaluated under field conditions.	1	1		1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D747	蓄積性	Lopez-Antia, A; Kavelaars, MM; Muller, W; Bervoets, L; Eens, M	Understanding PFAAs exposure in a generalist seabird species breeding in the vicinity of a fluorochemical plant: Influence of maternal transfer and diet	2021	Environ. Pollut. 2021 Feb:271:116355. doi: 10.1016/j.envpol.2020.116355.	Perfluoroalkyl acids (PFAAs) are a focus of scientific and regulatory attention nowadays. However, PFAAs dynamics in the environment and the factors that determine wildlife exposure are still not well understood. In this study we examined PFAAs exposure in chicks of a generalist seabird species, the lesser black-backed gull (Larus fuscus), breeding 49 km away of a PFAAs hotspot (a fluorochemical plant in Antwerp, Belgium). In order to study the pathways of PFAAs exposure, we measured how chicks' PFAAs burden varied with age, sex, and body condition. In addition, we related PFAA concentrations to chicks' diet using stable isotope signatures. For this purpose, we studied plasma PFAA concentrations in 1-week and 4-week-old gull chicks. Only 4 (PFOS, PFOA, PFDA and PFNA) out of the 13 target PFAA compounds were detected. Measured concentrations of PFOS and PFOA were generally high compared to other seabird species but were highly variable between individuals. Furthermore, our results suggest that maternal transfer plays a significant role in determining chicks' PFAAs burden, and that there are variable sources of exposure for PFOS and PFOA during post-hatching development. The association between PFOS and specific stable isotopes (i.e. delta N-15 and delta C-13) suggests a higher exposure to PFOS in birds with a predominantly marine diet. We also found that males' condition was positively associated with PFOS plasmatic concentration, probably due to the indirect effect of being fed a high quality (marine) diet which appears PFOS rich. Yet, exact exposure source(s) for PFOA remain(s) unclear. Given that PFOS concentrations measured in some chicks surpassed the toxicity reference value calculated for top avian predators, continued monitoring of exposure and health of this gull population, and other wildlife populations inhabiting the area, is highly recommended.								B	-		
D748	環境中運命	Nguyen, TMH; Braunig, J; Thompson, K; Thompson, J; Kabiri, S; Navarro, DA; Kookana, RS; Grimison, C; Barnes, CM; Higgins, CP; McLaughlin, MJ; Mueller, JF	Influences of Chemical Properties, Soil Properties, and Solution pH on Soil-Water Partitioning Coefficients of Per- and Polyfluoroalkyl Substances (PFASs)	2020	Environ. Sci. Technol. 2020 Dec:54(24):15883-15892. doi: 10.1021/acs.est.0c05705.	The aim of this study was to assess the soil-water partitioning behavior of a wider range of per- and polyfluoroalkyl substances (PFASs) onto soils covering diverse soil properties. The PFASs studied include perfluoroalkyl carboxylates (PFCAs), perfluoroalkane sulfonates (PFSAs), fluorotelomer sulfonates (FTSs), nonionic perfluoroalkane sulfonamides (FASAs), cyclic PFAS (PFEtCHxS), per- and polyfluoroalkyl ether acids (GenX, ADONA, 9Cl-PF3ONS), and three aqueous film-forming foam (AFFF)-related zwitterionic PFASs (AmPr-FHxSA, TAmPr-FHxSA, 6:2 FTSA-PrB). Soil-water partitioning coefficients (log K-d values) of the PFASs ranged from less than zero to approximately three, were chain-length-dependent, and were significantly linearly related to molecular weight (MW) for PFASs with MW > 350 g/mol (R-2 = 0.94, p < 0.0001). Across all soils, the K-d values of all short-chain PFASs (<= 5 -CF2- moieties) were similar and varied less (<0.5 log units) compared to long-chain PFASs (>0.5 to 1.5 log units) and zwitterions AmPr- and TAmPr-FHxSA (similar to 1.5 to 2 log units). Multiple soil properties described sorption of PFASs better than any single property. The effects of soil properties on sorption were different for anionic, nonionic, and zwitterionic PFASs. Solution pH could change both PFAS speciation and soil chemistry affecting surface complexation and electrostatic processes. The K-d values of all PFASs increased when solution pH decreased from approximately eight to three. Short-chain PFASs were less sensitive to solution pH than long-chain PFASs. The results indicate the complex interactions of PFASs with soil surfaces and the need to consider both PFAS type and soil properties to describe mobility in the environment.			1		1			B	-		
D749	蓄積性	Hart, K; Kannan, K; Isobe, T; Takahashi, S; Yamada, TK; Miyazaki, N; Tanabe, S	Time trends and transplacental transfer of perfluorinated compounds in melon-headed whales stranded along the Japanese coast in 1982, 2001/2002, and 2006	2008	Environ. Sci. Technol. 2008 Oct:42(19):7132-7137. doi: 10.1021/es801224v.	As a result of the phase-out of production of perfluorooctanesulfonyl-based compounds by a major producer, concentrations of perfluorooctanesulfonate (PFOS) in marine mammals from North American and European coastal waters have been declining since the early 2000s. Nevertheless, temporal trends in perfluorochemical (PFC) concentrations in marine mammals from Asian coastal waters have not been examined. In this study, PFCs were determined in livers of melon-headed whales (Peponocephala electra) collected along the coast of Japan, from three mass strandings that occurred during the past 25 years. Concentrations of nine PFCs were determined in livers of 48 melon-headed whales that were collected during strandings in 1982, 2001/2002, and 2006. In addition, concentrations in liver tissues obtained from two pregnant females and their fetuses were compared for determination of transplacental transfer rates of PFCs during gestation. PFOS and perfluorooctanesulfonamide (PFOSA) were the predominant PFCs found in livers of melon-headed whales collected in 1982 (n = 22). PFOS, PFOSA, perfluoroundecanoate (PFUnDA), perfluorododecanoate (PFDoDA), perfluorodecanoate (PFDA), and perfluorononanoate (PFNA) were found in whales collected in 2001/2002 In = 21) and in 2006 (n = 5). Concentrations of PFOS and PFOSA were approximately 10-fold higher in 2001/2002 than in 1982. Whereas concentrations of PFOSA then declined by 2-fold from 2001/2002 to 2006, concentrations of PFOS and perfluorocarboxylates did not decline after 2001/2002. Conversely, concentrations of PFNA and PFDA increased significantly from 2001/2002 to 2006. The proportion of perfluoroalkylsulfonates in total PFC concentrations decreased from 75% in 1982 to 51% in 2006. Conversely,the contribution of perfluorocarboxylates to total PFC concentrations increased from 25% in 1982 to 49% in 2006. PFUnDA was the major perfluorocarboxylate found in whale livers collected after 2000. Analysis of paired samples of mother-fetus demonstrated that the transplacental transfer rates of PFCs were higher than those for PCBs and PBDEs.								B	-		
D750	環境中運命	Wang, Y; Shi, XY	Photochemical Degradation of Perfluorocarboxylic Acids Induced by Ferric Ion: Effects of pH and Carbon Chain	2014	Acta Chim. Sin. 2014 Jun:72(6):682-688. doi: 10.6023/A14020101.	Perfluorooctanoic acid (PFOA), as a typical perfluorinated compounds, is one kind of emerging persistent pollutants appearing in natural water. The existence of ferric ion in aquatic system improves the degradation of PFOA under the irradiation of 254 nm UV light. pH is an important factor for not only the distribution of photo activity species of ferric ion but also the degradation of PFOA. When the initial pH of reaction solution was 2.53, 3.04 and 3.71, respectively, PFOA was decomposed effectively and no obvious difference was observed whether for the degradation ratio of PFOA or for its corresponding defluorination ratio. On the contrary, when pH was 4.92 and 7.05, respectively, the degradation and defluorination of PFOA was inhibited markedly, which further confirmed that dissoluble iron played a key role in the decomposition of PFOA. And Fe(OH)(2+) was the dominant species of the hydroxy complexes of Fe3+. At the same time, the degradation of short chain PFCAs bearing C4 similar to C7 caused by ferric ions under the irradiation of 254 nm UV light was also investigated. As for PFCAs with C6 similar to C8, the degradation ratio at 240 min was as follows: PFOA>PFHpA>PFHxA, which showed that the longer the carbon chain was, the easier the degradation of PFCAs was. While, for PFCAs with the number of carbon element less than 6, their degradation ratio at 240 min was as follows: PFHxA>PFBA>PFPeA. The relationship between the degradation of PFCAs and the length of carbon chain of PFCAs was not clear. More short chain PFCAs were identified by LC/MS as the primary intermediates of these short chain PFCAs. Based on these, it was proposed that the degradation of PFCAs bearing C4 similar to C8 was mainly caused by the formation of complexes between ferric ion and PFCAs, and then hydroxyl radical formed from photolysis of Fe(OH)(2+) and the redox cycle of Fe2+/Fe3+ further improved their degradation. As a result, PFCAs were decomposed step by step.	1	1						B	-		
D751	環境中運命	Cousins, IT; Kong, D; Vestergren, R	Reconciling measurement and modelling studies of the sources and fate of perfluorinated carboxylates	2011	Environ. Chem. 2011;8(4):339-354. doi: 10.1071/EN10144.	This study critically evaluates the recently published measurement and modelling studies of the sources and fate of perfluorinated carboxylates (PFCAs). It is concluded that modelling studies provide support to the 'direct hypothesis' for PFOA and PFNA (i.e. the global dominance of direct sources (mainly from fluoropolymer manufacturing)). Empirical evidence for the importance of direct sources of PFOA and PFNA is provided by PFNA : PFOA ratios and isomer profiles of PFOA in ocean water. However, homologue patterns of long-chain PFCAs in biota from remote regions suggest that indirect sources (mainly from precursor degradation) are proportionally more important for PFCAs with more than 10 carbons. Temporal data in biotic and abiotic media are reviewed and an increasing trend to 2000 is observed for all PFCAs, with discrepancies in time trends reported after that period. Some studies on temporal patterns report a levelling off or decline in the latter part of the 2000s for PFOA and PFNA, whereas others show a continual increase throughout the study period. Differences in temporal patterns result from the fact that some environments respond faster to emission changes than others and may thus be useful to elucidate the importance of direct and indirect sources to different regions.			1					B	-		
D752	環境中運命	Anderson, RH; Long, GC; Porter, RC; Anderson, JK	Occurrence of select perfluoroalkyl substances at US Air Force aqueous film-forming foam release sites other than fire-training areas: Field-validation of critical fate and transport properties	2016	Chemosphere 2016 May:150:678-685. doi: 10.1016/j.chemosphere.2016.01.014	The use of aqueous film-forming foam (AFFF) to extinguish hydrocarbon-based fires is recognized as a significant source of environmental poly- and perfluoroalkyl substances (PFASs). Although the occurrence of select PFASs in soil and groundwater at former fire-training areas (FTAs) at military installations operable since 1970 has been consistently confirmed, studies reporting the occurrence of PFASs at other AFFF-impacted sites (e.g. emergency response locations, AFFF lagoons, hangar-related AFFF storage tanks and pipelines, and fire station testing and maintenance areas) are largely missing from the literature. Further, studies have mostly focused on a single site (i.e., FTAs at military installations) and, thus, lack a comparison of sites with diverse AFFF release history. Therefore, the purpose of this investigation was to evaluate select PFAS occurrence at non-FTA sites on active U.S. Air Force installations with historic AFFF use of varying magnitude. Concentrations of fifteen perfluoroalkyl acids (PFAAs) and perfluorooctane sulfonamide (PFOSA), an important PFOS precursor, were measured from several hundred samples among multiple media (i.e., surface soil, subsurface soil, sediment, surface water, and groundwater) collected from forty AFFF-impacted sites across ten installations between March and September 2014, representing one of the most comprehensive datasets on environmental PFAS occurrence to date. Differences in detection frequencies and observed concentrations due to AFFF release volume are presented along with rigorous data analyses that quantitatively demonstrate phase-dependent (i.e., solid-phase vs aqueous-phase) differences in the chemical signature as a function of carbon chain-length and in situ PFOS (and to a slightly lesser extent PFHxS) formation, presumably due to precursor biotransformation. Published by Elsevier Ltd.								B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D753	環境中運命	Zhang, FS; Wang, YL; Wei, Z; Zhang, GX; Wang, JQ	Perfluorinated compounds in a river basin from QingHai-Tibet Plateau: Occurrence, sources and key factors	2021	Ecotox. Environ. Safe. 2021 Dec:228:113043. doi: 10.1016/j.ecoenv.2021.113043.	The occurrence of perfluorinated compounds (PFCs) in different environmental media in the QingHai-Tibet Plateau has been limitedly investigated. In this study, the water, sediments, soils and agricultural product samples were collected in the Huangshui River basin, and contents of the PFCs and values of water parameters were determined. This study investigated dominantly regulating factors of the distribution of PFCs in the water emphatically, explored the sources and assessed potential risks of the PFCs integrally. The results showed that perfluorohexanesulfonic acid, perfluorooctanesulfonic acid, perfluorobutanoic acid (PFBA) and perfluorooctanoic acid presented high maximum concentrations of 3207.42, 3015.96, 1941.89 and 826.4 ng L-1 in the water, respectively. There were 12 PFCs detected in crops, with the maximum concentration of 5206.86 ng g-1 for PFBA. The significantly positive correlation ($p < 0.05$) was observed between the concentrations of PFBA in crops and that in adjacent rivers, indicating that the irrigation most likely contributed to the accumulation of PFBA in the studied crops. The occurrence of the PFCs in the water during the dry season was dominantly regulated by fluorescent dissolved organic matters via the hydrophobic interaction, while it was primarily regulated by the total nitrogen and electrical conductivity via electrostatic interaction during the wet season. The PFCs in the water were mainly from the wastewater discharged from wastewater treatment plants and carpet factories, while the resuspension of the PFCs in sediments was also an important contribution especially in wet season. The PFCs in the river has posed sustained risk to the public health, especially children.	1							B	-		
D754	環境中運命	Gan, CD; Gan, ZW; Cui, SF; Fan, RJ; Fu, YZ; Peng, MY; Yang, JY	Agricultural activities impact on soil and sediment fluorine and perfluorinated compounds in an endemic fluorosis area	2021	Sci. Total Environ. 2021 Jun:771:144809. doi: 10.1016/j.scitotenv.2020.144809.	Perfluorinated compounds (PFCs) are organo-fluorine compounds which have been identified at significant levels in soils due to their widespread usage in industrial and commercial applications. However, few studies are available regarding the occurrence of PFCs in the environment of endemic fluorosis areas. To address the issue, soils collected from an endemic fluorosis area of southwestern China were analyzed for the distribution of fluorine and 21 kinds of PFCs. The average water-soluble fluorine concentration in cultivated soil (4.87 mg kg-1) was significantly higher than that in uncultivated soil (3.15 mg kg(-1)), which mainly ascribed to the utilization of fluorine-enriched fertilizers during agricultural practices. Concentrations of SPFCs in all soils ranged from 0.508 to 6.83 ng g(-1), with an average of 2.81 ng g(-1), dominated by perfluorononanoic acid (PFNA) and perfluorooctanoic acid (PFOA). Highest Sigma PFCs was found in the soil samples collected from cropland with intensive agricultural activities. Long-chain PFCs, including four perfluoroalkylcarboxylic acids (PFCAs, C >= 8) and one perfluoroalkylsulfonic acids (PFSAs) (perfluorooctane sulfonate (PFOS), C8), exhibited high levels in soils, probably due to their higher hydrophobicity and lower water-solubility than short-chain PFCs. While in sediments, short-chain PFCAs were the dominant compounds. Based on correlation analysis, the relationship between total fluorine and PFCs was insignificant, and soil organic matter was a relevant factor affecting PFCs distribution in soils. This study is expected to present a more comprehensive information about fluorine contamination under the influence of agricultural activities in an endemic fluorosis area. (C) 2021 Elsevier B.V. All rights reserved.			1					B	-		
D755	環境中運命	Wang, N; Liu, JX; Buck, RC; Korzeniowski, SH; Wolstenholme, BW; Folsom, PW; Sulecki, LM	6:2 Fluorotelomer sulfonate aerobic biotransformation in activated sludge of waste water treatment plants	2011	Chemosphere. 2011 Feb:82(6):853-858. doi: 10.1016/j.chemosphere.2010.11.003.	The aerobic biotransformation of 6:2 FTS salt [F(CF2)(6)CH2CH2SO3- K+] was determined in closed bottles for 90 d in diluted activated sludge from three waste water treatment plants (WWTPs) to compare its biotransformation potential with that of 6:2 FTOH [F(CF2)(6)CH2CH2OH]. The 6:2 FTS biotransformation was relatively slow, with 63.7% remaining at day 90 and all observed transformation products together accounting for 6.3% of the initial 6:2 FTS applied. The overall mass balance (6:2 FTS plus observed transformation products) at day 90 in live and sterile treatments averaged 70% and 94%, respectively. At day 90, the stable transformation products observed were 5:3 acid [F(CF2)(5)CH2CH2COOH, 0.12%], PFBA [F(CF2)(3)COOH, 0.14%], PFPeA [F(CF2)(4)COOH, 1.5%], and PFHxA [F(CF2)(5)COOH 1.1%]. In addition, 5:2 ketone [F(CF2)(5)C(O)CH3] and 5:2 sFTOH [F(CF2)(5)CH(OH)CH3] together accounted for 3.4% at day 90. The yield of all the stable transformation products noted above (2.9%) was 19 times lower than that of 6:2 FTOH in aerobic soil. Thus 6:2 FTS is not likely to be a major source of PFCAs and polyfluorinated acids in WWTPs. 6:2 FTOH, 6:2 FTA [F(CF2)(6)CH2COOH], and PFHpA [F(CF2)(6)COOH] were not observed during the 90-d incubation. 6:2 FTS primary biotransformation bypassed 6:2 FTOH to form 6:2 FTUA [F(CF2)(5)CF = CHCOOH], which was subsequently degraded via pathways similar to 6:2 FTOH biotransformation. A substantial fraction of initially dosed 6:2 FTS (24%) may be irreversibly bound to diluted activated sludge catalyzed by microbial enzymes. The relatively slow 6:2 FTS degradation in activated sludge may be due to microbial aerobic de-sulfonation of 6:2 FTS, required for 6:2 FTS further biotransformation, being a rate-limiting step in microorganisms of activated sludge in WWTPs. (C) 2010 Elsevier Ltd. All rights reserved.	1	1						B	-		
D756	環境中運命	Taniyasu, S; Yamashita, N; Moon, HB; Kwok, KY; Lam, PKS; Horii, Y; Petrick, G; Kannan, K	Does wet precipitation represent local and regional atmospheric transportation by perfluorinated alkyl substances?	2013	Environ. Int. 2013 May:55:25-32. doi: 10.1016/j.envint.2013.02.005	Perfluorinated alkyl substances (PFASs) have been found widely in the environment including remote marine locations. The mode of transport of PFASs to remote marine locations is a subject of considerable scientific interest. Assessment of distribution of PFASs in wet precipitation samples (i.e., rainfall and snow) collected over an area covering continental, coastal, and open ocean will enable an understanding of not only the global transport but also the regional transport of PFASs. Nevertheless, it is imperative to examine the representativeness and suitability of wet precipitation matrixes to allow for drawing conclusions on the transport PFASs. In this study, we collected wet precipitation samples including rainfall, surface snow, and snow core from several locations in Japan to elucidate the suitability of these matrixes for describing local and regional transport of PFASs. Rain water collected at various time intervals within a single rainfall event showed high fluxes of PFASs in the first 1-mm deposition. The scavenging rate of PFASs by wet deposition varied depending on the fluorocarbon chain length of PFAS. The depositional fluxes of PFASs measured for continental (Tsukuba, Japan) and open ocean (Pacific Ocean, 1000 km off Japanese coast) locations were similar, on the order of a few nanograms per square meter. The PFAS profiles in freshly deposited and aged (deposited:on the ground for a few days) snow samples taken from the same location varied considerably. The freshly deposited snow represents current atmospheric profiles of PFASs, whereas the aged snow sample reflects sequestration of local sources of PFASs from the atmosphere. Post-depositional modifications in PFAS profiles were evident, suggesting reactions of PFASs on snow/ice surface. Transformation of precursor chemicals such as fluorotelomer alcohols into perfluoroalkylcarboxylates is evident on snow surface. Snow cores have been used to evaluate time trends of PFAS contamination in remote environments. Snow collected at various depths from a core of up to 7.7 m deep, at Mt. Tateyama (2450 m), Japan, showed the highest concentrations of PFASs in the surface layer and the concentrations decreased with increasing depth for most PFASs, except for perfluorobutanesulfonate (PFBS). Downward movement of highly water soluble PFASs such as PFBS, following melting and freezing cycles of snow, was evident from the analysis of snow core. (C) 2013 Elsevier Ltd. All rights reserved.				1				B	-		
D757	環境中運命	Zhao, SY; Zhu, LY	Uptake and metabolism of 10:2 fluorotelomer alcohol in soil-earthworm (Eisenia fetida) and soil-wheat (Triticum aestivum L.) systems	2017	Environ. Pollut. 2017 Jan;220(Pt A):124-131. doi: 10.1016/j.envpol.2016.09.030.	The behavior of 10:2 fluorotelomer alcohol (10:2 FTOH) in the systems of soil-earthworm (Eisenia fetida), soil-wheat (Triticum aestivum L.) and soil-earthworm-wheat, including degradation in soil, uptake and metabolism in wheat and earthworms were investigated. Several perfluorocarboxylic acids (PFCAs) as degradation products of 10:2 FTOH were identified in the soil, plant and earthworms. 10:2 FTOH could be biodegraded to perfluorooctanoate (PFOA), perfluorononanate (PFNA) and perfluorodecanoate (PFDA) in soil in the absence or presence of wheat/earthworms, and PFDA was the predominant metabolite. Accumulation of initial 10:2 FTOH and its metabolites were observed in the wheat and earthworms, suggesting that 10:2 FTOH could be bioaccumulated in wheat and earthworms and biotransformed to the highly stable PFCAs. Perfluoropentanoic acid (PFPeA), perfluorohexanoic (PFHxA) and PFDA were detected in wheat root, while PFDA and perfluoroundecanoic acid (PFUnDA) were detected in shoot. PFNA and PFDA were determined in earthworms and the concentration of PFDA was much higher. The presence of earthworms and/or plant stimulated the microbial degradation of 10:2 FTOH in soil. The results supplied important evidence that degradation of 10:2 FTOH was an important potential source of PFCAs in the environment and in biota. (C) 2016 Elsevier Ltd. All rights reserved.		1	1					B	-		
D758	環境中運命	Yao, HY; Zhao, D; Wang, WX; Liu, ZQ; Zhou, HY	Occurrence and risk assessment of perfluoroalkyl substances in the river basin around fluorine industry parks, China	2023	Env. Pollut. Bioavail. 2023 DEC 31;35(1):2218569. doi: 10.1080/26395940.2023.2218569.	Fluorine industry parks (FIPs) play a fundamental role in the advancement of China's fluorine industry. In this study, Target analysis was combined with traceability analysis to determine the type of PFASs present in the surface water and sediment around FIPs in China. Meanwhile, the risk they posed to the surrounding river was examined through risk characterisation ratio. Among the areas surveyed, 10 and 15 PFASs were detected in the surface water and sediment, with concentrations of up to 32,674.0 ng/L and 17.84 ng/g, respectively. There were a larger proportion of short-chain PFASs (C4-C7), and perfluoropentanoic acid was particularly prevalent. Source analysis indicates that the PFASs in the surface water may have originated from precursor degradation and atmospheric deposition. The fluorine rubber industry was the main source for the sediment PFASs, particularly for short-chain compounds. A risk characterisation ratio analysis identified perfluorododecanoic acid, perfluorobutane sulfonate, perfluoroheptanoic acid, perfluoropentanoic acid, and perfluorohexanoic acid as compounds with relatively high risks.		1		1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D759	環境中運命	MacInnis, JJ; French, K; Muir, DCG; Spencer, C; Criscitiello, A; De Silva, AO; Young, CJ	Emerging investigator series: a 14-year depositional ice record of perfluoroalkyl substances in the High Arctic	2017	Environ. Sci.-Process Impacts 2017 Jan:19(1):22-30. doi: 10.1039/c6em00593d.	To improve understanding of long-range transport of perfluoroalkyl substances to the High Arctic, samples were collected from a snow pit on the Devon Ice Cap in spring 2008. Snow was analyzed for perfluoroalkyl acids (PFAAs), including perfluoroalkyl carboxylic acids (PFCAs) and perfluoroalkyl sulfonic acids (PFSAs), as well as perfluorooctane sulfonamide (FOSA). PFAAs were detected in all samples dated from 1993 to 2007. PFAA fluxes ranged from < 1 to hundreds of ng per m(2) per year. Flux ratios of even-odd PFCA homologues were mostly between 0.5 and 2, corresponding to molar ratios expected from atmospheric oxidation of fluorotelomer compounds. Concentrations of perfluorobutanoic acid (PFBA) were much higher than other PFCAs, suggesting PFBA loading on the Devon Ice Cap is influenced by additional sources, such as the oxidation of heat transfer fluids. All PFCA fluxes increased with time, while PFSA fluxes generally decreased with time. No correlations were observed between PFAAs and the marine aerosol tracer, sodium. Perfluoro-4-ethylcyclohexanesulfonate (PFECHS) was detected for the first time in an atmospherically - derived sample, and its presence may be attributed to aircraft hydraulic system leakage. Observations of PFAAs from these samples provide further evidence that atmospheric oxidation of volatile precursors is an important source of PFAAs to the Arctic environment.	1							B	-		
D760	環境中運命	Yan, N; Ji, YF; Zhang, BH; Zheng, XL; Brusseau, ML	Transport of GenX in Saturated and Unsaturated Porous Media	2020	Environ. Sci. Technol. 2020 Oct:54(19):11876-11885. doi: 10.1021/acs.est.9b07790.	The objective of this research was to investigate the retention and transport behavior of GenX in five natural porous media with similar median grain diameters but different geochemical properties. Surface tensions were measured to characterize surface activity. Miscible-displacement experiments were conducted under saturated conditions to characterize the magnitude of solid-phase adsorption, while unsaturated-flow experiments were conducted to examine the impact of air-water interfacial adsorption on retention and transport. The results from surface-tension measurements showed that the impact of solution composition is greater for the ammonium form of GenX than for the acid form, due to the presence of the NH4 counterion. The breakthrough curves for the experiments conducted under saturated conditions were asymmetrical, and a solute-transport model employing a two-domain representation of nonlinear, rate-limited sorption provided reasonable simulations of the measured data. The magnitudes of solid-phase adsorption were relatively small, with the highest adsorption associated with the medium containing the greatest amount of metal oxides. The breakthrough curves for the experiments conducted under unsaturated conditions exhibited greater retardation due to the impact of adsorption at the air-water interface. The contributions of air-water interfacial adsorption to GenX retention ranged from similar to 24% to similar to 100%. The overall magnitudes of retardation were relatively low, with retardation factors < similar to 3, indicating that GenX has significant migration potential in soil and the vadose zone. To our knowledge, the results presented herein represent the first reported data for solid-water and air-water interfacial adsorption of GenX by soil. These data should prove useful for assessing the transport and fate behavior of GenX in soil and groundwater.					1			B	-		
D761	蓄積性	Carravieri, A; Burthe, SJ; de la Vega, C; Yonehara, Y; Daunt, F; Newell, MA; Jeffreys, RM; Lawlor, AJ; Hunt, A; Shore, RF; Pereira, MG; Green, JA	Interactions between Environmental Contaminants and Gastrointestinal Parasites: Novel Insights from an Integrative Approach in a Marine Predator	2020	Environ. Sci. Technol. 2020 Jul:54(14):8938-8948. doi: 10.1021/acs.est.0c03021.	Environmental contaminants and parasites are ubiquitous stressors that can affect animal physiology and derive from similar dietary sources (co-exposure). To unravel their interactions in wildlife, it is thus essential to quantify their concurring drivers. Here, the relationship between blood contaminant residues (11 trace elements and 17 perfluoroalkyl substances) and nonlethally quantified gastrointestinal parasite loads was tested while accounting for intrinsic (sex, age, and mass) and extrinsic factors (trophic ecology inferred from stable isotope analyses and biologging) in European shags Phalacrocorax aristotelis. Shags had high mercury (range 0.65-3.21 mu g g(-1) wet weight, ww) and extremely high perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) residues (3.46-53 and 4.48-44 ng g(-1) ww, respectively). Males had higher concentrations of arsenic, mercury, PFOA, and PFNA than females, while the opposite was true for selenium, perfluorododecanoic acid (PFDoA), and perfluooctane sulfonic acid (PFOS). Individual parasite loads (Contracaecum rudolphii) were higher in males than in females. Females targeted pelagic-feeding prey, while males relied on both pelagic- and benthic-feeding organisms. Parasite loads were not related to trophic ecology in either sex, suggesting no substantial dietary co-exposure with contaminants. In females, parasite loads increased strongly with decreasing selenium:mercury molar ratios. Females may be more susceptible to the interactive effects of contaminants and parasites on physiology, with potential fitness consequences.			1					B	-		
D762	環境中運命	Chen, J; Zhang, PY; Liu, J	Photodegradation of perfluorooctanoic acid by 185 nm vacuum ultraviolet light	2007	J. Environ. Sci. 2007 ;19:387-390. doi: 10.1016/S1001-0742(07)60064-3	The photodegradation of persistent and bioaccumulative perfluorooctanoic acid (PFOA) in water by 185 run vacuum ultraviolet (VUV) light was examined to develop an effective technology to deal with PFOA pollution. PFOA degraded very slowly under irradiation of 254 nm UV light. However, 61.7% of initial PFOA was degraded by 185 nm VUV light within 2 h, and defluorination ratio reached 17.1%. Pseudo first-order-kinetics well simulated its degradation and defluorination. Besides, fluoride ion formed in water, 4 shorter-chain perfluorinated carboxylic acids (PFCAs), that is, perfluoroheptanoic acid, perfluorohexanoic acid, perfluoropentanoic acid, and perfluorobutanoic acid. These were identified as intermediates by LC-MS measurement. These PFCAs consecutively formed and further degraded with irradiation time. According to the mass balance calculation, no other byproducts were formed. It was proposed that PFCAs initially are decarboxylated by 185 rim light, and the radical thus formed reacts with water to form shorter-chain PFCA with one less CF2 unit.	1	1						B	-		
D763	蓄積性	Yeung, LWY; Yamashita, N; Taniyasu, S; Lam, PKS; Sinha, RK; Borole, DV; Kannan, K	A survey of perfluorinated compounds in surface water and biota including dolphins from the Ganges River and in other waterbodies in India	2009	Chemosphere. 2009 Jun:76(1):55-62. doi: 10.1016/j.chemosphere.2009.02.055.	Despite the reports of the occurrence of perfluorochemicals (PFCs) in industrialized nations, information on PFCs in less industrialized countries is meager. In the present study, concentrations and Profiles of PFCs were investigated in surface waters (rivers, lakes, coastal seas and untreated sewage: n = 42) including the Ganges River water, and biota such as shrimp (n = 2), fish (n = 28), and Ganges River dolphin (Platanista gangetica; n = 15). PFOS was the dominant PFC found in most of the samples analyzed including water samples except untreated sewage (water: <0.04-3.91 ng L-1; biota: 0.248-27.9 ng g(-1) ww). Long-chain (C11-C18) perfluorocarboxylates (PFCAs) were not detected in the water samples (<0.2 ng L-1), although PFDA (0.061-0.923 ng g(-1) ww) and PFUnDA (0.072-0.998 ng g(-1) ww) were found in biological samples The arithmetic mean PFOS concentration found in the liver of Ganges River dolphin was 27.9 ng g(-1) ww. Bioconcentration and biomagnifications factors of PFCs were estimated in the Ganges River basin food web. The highest concentration of PFOA, 23.1 ng L-1, was found in untreated sewage samples. Overall, concentrations of PFCs of water and biological samples from India are lower than the concentrations reported for other countries so far. PFC profiles in Indian waters are dominated by PFOS, followed by PFOA, which is different from the pattern reported for other countries such as Korea, Japan and USA, where PFOA was the predominant Compound in waters. The flux estimates for PFOS, PFOA and PFNA from the Ganges River in India to the Bay of Bengal were in the range of several hundreds of kilograms per year. (C) 2009 Elsevier Ltd. All rights reserved.			1					B	-		
D764	蓄積性	Penland, TN; Cope, WG; Kwak, TJ; Strynar, MJ; Grieshaber, CA; Heise, RJ; Sessions, FW	Trophodynamics of Per- and Polyfluoroalkyl Substances in the Food Web of a Large Atlantic Slope River	2020	Environ. Sci. Technol. 2020 Jun:54(11):6800-6811. doi: 10.1021/acs.est.9b05007.	Per- and polyfluoroalkyl substances (PFASs) have attracted scientific and regulatory attention due to their persistence, bioaccumulative potential, toxicity, and global distribution. We determined the accumulation and trophic transfer of 14 PFASs (5 short-chain and 9 long-chain) within the food web of the Yadkin-Pee Dee River of North Carolina and South Carolina, US. Food web components and pathways were determined by stable isotope analyses of producers, consumers, and organic matter. Analyses of water, sediment, organic matter, and aquatic biota revealed that PFASs were prevalent in all food web compartments. Biofilm, an aggregation of bacteria, fungi, algae, and protozoans and a basal resource for the aquatic food web, showed high PFAS accumulation (in 10 of 14 compounds), particularly for perfluorooctanoic acid, with the greatest mean concentration of 463.73 ng/g. The food web compartment with the most detections and greatest concentrations of PFASs was aquatic insects; all 14 PFASs were detected in individual aquatic insect sampl [1.0 (range of 0.57 to 2.33); it is possible that an unmeasured PFBS precursor may be accumulating in biota and metabolizing to PFBS, leading to a higher than expected TMFs for this compound. Our findings demonstrate the prevalence of PFASs in a freshwater food web with potential implications for ecological and human health.					1			B	-		
D765	環境中運命	Veillette, J; Muir, DCG; Antoniades, D; Small, JM; Spencer, C; Loewen, TN; Babaluk, JA; Reist, JD; Vincent, WF	Perfluorinated Chemicals in Meromictic Lakes on the Northern Coast of Ellesmere Island, High Arctic Canada	2012	Arctic. 2012 Sep:65(3):245-256. doi: 10.14430/arctic4213	Perfluorinated chemicals (PFCs) have been recorded in many types of marine and freshwater ecosystems. The aim of the present study was to examine meromictic lakes and their catchments on the far northern coast of Ellesmere Island, Nunavut, Canada, and to evaluate the results in the context of climate change. Our analyses revealed the presence of several PFCs in catchment snowpack, inflowing streams, lake water, and the aquatic food web of Lake A (83 degrees 00'N, 75 degrees 30'W), showing that dispersal of these contaminants reaches the northern limit of the terrestrial High Arctic. However, the concentrations were low (total PFCs: 27-754 pg L-1 for water, 134-848 pg L-1 for melted snow, 5-2149 pg g(-1) wet weight for fish; PFOS: 66 pg g(-1) dry weight in surficial sediments) and at or below values reported to date in the literature for other remote lakes. PFHpA, PFOA, and PFNA were the main compounds detected in water and melted snow, while PFNA, PFDA, and PFUnA were the predominant compounds in the aquatic biota, indicating their bioaccumulative potential. Salinity-temperature-depth profiles suggested that most of the present contaminant load enters the lake via streams and flows directly under the lake ice to the ocean. The onset of summer open water in this perennially ice-covered lake in response to climate warming, and the increased duration of open water in recent years; have implications for the distribution, transport, and retention of PFCs in Arctic lakes.			1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D766	蓄積性	Reiner, JL; O'Connell, SG; Moors, AJ; Kucklick, JR; Becker, PR; Keller, JM	Spatial and Temporal Trends of Perfluorinated Compounds in Beluga Whales (Delphinapterus leucas) from Alaska	2011	Environ. Sci. Technol. 2011 Oct:45(19):8129-8136. doi: 10.1021/es103560q.	Wildlife from remote locations have been shown to bioaccumulate perfluorinated compounds (PFCs) in their tissues. Twelve PFCs, consisting of perfluorinated carboxylic (PFCA) and sulfonic (PFSA) acids as well as the perfluorooctane sulfonate (PFOS) precursor perfluorooctane sulfonamide (PFOSA), were measured in livers of 68 beluga whales (Delphinapterus leucas) collected from two subpopulations, Cook Inlet and eastern Chukchi Sea, in Alaska between 1989 and 2006. PFOS and PFOSA were the dominant compounds measured in both beluga stock populations, with overall median concentrations of 10.8 ng/g and 22.8 ng/g, respectively. Long- chain perfluorocarboxylates, PFCAs (9 to 14 carbons), were detected in more than 80% of the samples. Perfluoroundecanoic acid (PFUnA) and perfluorotridecanoic acid (PFTriA) made up a large percentage of the PFCAs measured with median concentrations of 8.49 ng/g and 4.38 ng/g, respectively. To compare differences in location, year, sex, and length, backward stepwise multiple regression models of the individual and total PFC concentrations were used. Spatially, the Cook Inlet belugas had higher concentrations of most PFCAs and PFOS ($p < 0.05$); however, these belugas had a lower median concentration of PFOSA when compared to belugas from the eastern Chukchi Sea ($p < 0.05$). Temporal trends indicated most PFCAs, PFHxS, PFOS, and PFOSA concentrations increased from 1989 to 2006 ($p < 0.05$). Males had significantly higher concentrations of PFTriA, Sigma PFCA, and PFOS ($p < 0.05$). Perfluorononanic acid (PFNA) and PFOS showed a significant decrease in concentration with increasing animal length ($p < 0.05$). These observations suggest the accumulation of PFCs in belugas is influenced by year, location, sex, and length.			1					B	-		
D767	環境中運命	Shi, YL; Pan, YY; Wang, JM; Cai, YQ	Distribution of perfluorinated compounds in water, sediment, biota and floating plants in Baiyangdian Lake, China	2012	J. Environ. Monit. 2012 Feb:14(2):636-642. doi: 10.1039/c1em10772k.	The distribution of perfluorinated compounds (PFCs) in Baiyangdian Lake, China, was determined in this study. Perfluorooctanoic acid (PFOA) was the dominant PFC in lake water (1.70-73.5 ng L-1, median 9.72 ng L-1), while perfluorooctane sulfonate (PFOS) was the dominant PFC in sediments (0.06-0.64 ng g(-1) dry wt, median 0.19 ng g(-1) dry wt) and in aquatic animals (0.57-13.7 ng g(-1) wet wt, median 2.56 ng g(-1) wet wt). Significant differences in PFC levels were observed among various aquatic animals. We also determined, for the first time, the PFC levels in floating plants, including Ceratophyllum demersum L., Hydrocharis dubia (Bl.) Backer and Salvinia natans (L.), and we found that PFOA and PFNA were the dominant PFCs in these plants. Furthermore, floating plants were observed to have different composition profiles compared to aquatic animals. Geographical differences in PFC levels were also observed, with higher PFC levels in samples from the north part of Baiyangdian Lake than those in the south. The differences in human and industrial activities in different parts of the lake and the discharged wastewater from the Fuhe River may be the major contributors for these geographical differences.			1					B	-		
D768	蓄積性	Zhang, Z; Peng, H; Wan, Y; Hu, JY	Isomer-Specific Trophic Transfer of Perfluorocarboxylic Acids in the Marine Food Web of Liaodong Bay, North China	2015	Environ. Sci. Technol. 2015 Feb:49(3):1453-1461. doi: 10.1021/es504445x.	Trophic transfers of perfluorocarboxylic acids (PFCAs) have been well studied in aquatic food webs; however, most studies examined PFCAs as single compounds without differentiating isomers. In this study, an in-port derivatization GC-MS method was used to determine PFCA (perfluorooctanoic acid, PFOA; perfluorononanoic acid, PFNA; perfluorodecanoate acid, PFDA; perfluoroundecanoate acid, PFUnDA; perfluorododecanoate acid, PFDoDA; perfluorotridecanoate acid, PFTriDA, and perfluorotetradecanoate acid, PFTeDA) structural isomers in 11 marine species including benthic invertebrates, fishes, and gulls collected in November 2006 from Liaodong Bay in China. The total concentrations of linear PFCAs were 0.35-1.10, 0.93-2.61, and 2.13-2.69 ng/g ww, and the corresponding percentages of branched PFCAs to linear PFCAs were 6.6-15.5%, 4.2-9.9%, and 4.5-6.0% in invertebrates, fishes, and birds, respectively. Except for linear PFOA, significant positive relationships were found between the concentrations of all the target linear PFCAs and trophic levels, and the trophic magnification factors (TMFs) ranged from 1.90 to 4.88. Positive correlations between the concentrations of branched PFCAs isomers and trophic levels were also observed but were without statistical significance. The relatively high biomagnification of linear isomers of PFCAs would lead to low percentages of branched PFCAs to total PFCAs in organisms at high trophic levels. This study for the first time clarified isomer-specific trophic transfers of PFCAs in a marine food web.			1					B	-		
D769	環境中運命	Bach, C; Dauchy, X; Boiteux, V; Colin, A; Hemard, J; Sagres, V; Rosin, C; Munoz, JF	The impact of two fluoropolymer manufacturing facilities on downstream contamination of a river and drinking water resources with per- and polyfluoroalkyl substances	2017	Environ. Sci. Pollut. Res. 2017 Feb:24(5):4916-4925. doi: 10.1007/s11356-016-8243-3.	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are emerging contaminants that have been detected in the environment, biota, and humans. Drinking water is a route of exposure for populations consuming water contaminated by PFAS discharges. This research study reports environmental measurement concentrations, mass flows, and the fate of dozens of PFASs in a river receiving effluents from two fluoropolymer manufacturing facilities. In addition to quantified levels of PFASs using LC-and GC-MS analytical methods, the total amount of unidentified PFASs and precursors was assessed using two complementary analytical methods, absorbable organic fluorine (AOF) determination and oxidative conversion of perfluoroalkyl carboxylic acid (PFCA) precursors. Several dozen samples were collected in the river (water and sediment) during four sampling campaigns. In addition, samples were collected in two well fields and from the outlet of the drinking water treatment plants after chlorination. We estimated that 4295 kg PFHxA, 1487 kg 6: 2FTSA, 965 kg PFNA, 307 kg PFUnDA, and 14 kg PFOAwere discharged in the river by the two facilities in 2013. High concentrations (up to 176 ng/g dw) of odd long-chain PFASs (PFUnDA and PFTrDA) were found in sediment samples. PFASs were detected in all 15 wells, with concentrations varying based on the location of the well in the field. Additionally, the presence of previously discharged PFASs was still measurable. Significant discrepancies between PFAS concentration profiles in the wells and in the river suggest an accumulation and transformation of PFCA precursors in the aquifer. Chlorination had no removal efficiency and no unidentified PFASs were detected in the treated water with either complementary analytical method. Although the total PFAS concentrations were high in the treated water, ranging from 86 to 169 ng/L, they did not exceed the currently available guideline values.		1	1					B	-		
D770	蓄積性	Omagamre, EW; Ojo, F; Zebelo, SA; Pitula, JS	Influence of Perfluorobutanoic Acid (PFBA) on the Developmental Cycle and Damage Potential of the Beet Armyworm Spodoptera exigua (Hubner) (Insecta: Lepidoptera: Noctuidae)	2020	Arch. Environ. Contam. Toxicol. 2020 Nov:79(4):500-507. doi: 10.1007/s00244-020-00780-5.	Perfluorobutanoic acid (PFBA), one of the short-chain replacement perfluoroalkyl substances, has been shown to accumulate in plants. The potential of PFBA to modulate the developmental cycle of the beet armyworm, Spodoptera exigua, a polyphagous pest, was investigated. Second-instar larvae were fed with PFBA-spiked artificial diets and leaves from soybean plants grown with PFBA-spiked irrigation water. Spiked PFBA concentrations were 200 mu g/kg for the artificial diet, whereas 405 to 15,190 ng/kg accumulated in the soybean leaves. The larvae fed with the PFBA-spiked diet showed a significant increase in weight gain compared with the controls over a 7-day exposure period. A similar weight gain trend was observed with larvae fed with the PFBA-containing soybean leaves, with the dose-response data fitting into a Brain-Cousens hormesis model with a 57% stimulation over controls. The artificial diet treatments showed 66.7% metamorphosed larva to pupa at 9 days after exposure (dpe) compared with 33.3% of the controls. The adult emergence at 16-dpe followed a similar trend with 57.7% and 33.3%, respectively, for the exposed and control groups. The duration of transition from larvae to adults was more symmetrical and 0.5 day faster for the exposed groups over controls. The beet armyworm caused more damage on leaves from the PFBA exposed plants in a nonmonotonic dose-response manner. The results suggest PFBA may have a stimulatory impact on some hormonal signaling pathways at low doses.	1							B	-		
D771	蓄積性	Christie, I; Reiner, JL; Bowden, JA; Botha, H; Cantu, TM; Govender, D; Guillette, MP; Lowers, RH; Luus-Powell, WJ; Pienaar, D; Smit, WJ; Guillette, LJ	Perfluorinated alkyl acids in the plasma of South African crocodiles (Crocodylus niloticus)	2016	Chemosphere 2016 Jul:154:72-78. doi: 10.1016/j.chemosphere.2016.03.072	Perfluorinated alkyl acids (PFAAs) are environmental contaminants that have been used in many products for over 50 years. Interest and concern has grown since 2000 on the widespread presence of PFAAs, when it was discovered that PFAAs were present in wildlife samples around the northern hemisphere. Since then, several studies have reported PFAAs in wildlife from many locations, including the remote regions of Antarctica and the Arctic. Although there are a multitude of studies, few have reported PFAA concentrations in reptiles and wildlife in the Southern Hemisphere. This study investigated the presence of PFAAs in the plasma of Nile crocodiles (Crocodylus niloticus) from South Africa. Crocodiles were captured from five sites in and around the Kruger National Park, South Africa, and plasma samples examined for PFAAs. Perfluorooctane sulfonate (PFOS) was the most frequent PFAA detected; with median values of 13.5 ng/g wet mass in crocodiles. In addition to PFOS, long chain per fluorinated carboxylic acids were also detected. Correlations between total length and PFAA load were investigated, as were differences in PFAA accumulation between sexes. No correlations were seen between crocodile size, nor were there sex-related differences. Spatial differences were examined and significant differences were observed in samples collected from the different sites ($p < 0.05$). Flag Boshielo Dam had the highest PFOS measurements, with a median concentration of 50.3 ng/g wet mass, when compared to the other sites (median concentrations at other sites below 14.0 ng/g wet mass). This suggests a point source of PFOS in this area. Published by Elsevier Ltd.								B	-		
D772	環境中運命	Cai, YZ; Wang, XH; Wu, YL; Zhao, SH; Li, YY; Ma, LY; Chen, C; Huang, J; Yu, G	Temporal trends and transport of perfluoroalkyl substances (PFASs) in a subtropical estuary: Jiulong River Estuary, Fujian, China	2018	Sci. Total Environ. 2018 Oct:639:263-270. doi: 10.1016/j.scitotenv.2018.05.042	The seasonal variations and spatial distributions of fifteen perfluoroalkyl substances (PFASs) were investigated in thewater of the subtropical Jiulong River Estuary (JRE) in Fujian, China. The concentrations and composition profiles of PFASs showed significant seasonal variations. Sigma PFASs concentrations ranged from 4.8 to 37.6 ng L-1, 12.2 to 110 ng L-1 and 3.3 to 43.0 ng L-1 in the dry, medium and wet seasons, respectively. Perfluorooctane sulfonate (PFOS) was found to be the most abundant PFAS in the dry season, with a composition of 33% +/- 5%, Perfluorohexanoic acid PFHxA (47% +/- 13%) and perfluoropentanoic acid (PFPeA) (52% +/- 15%) were the dominant compounds in the medium and wet seasons, respectively. Seasonal and spatial distributions ofSPFASs were different in the upstream and downstream sections. High concentration of PFHxA occurred in the medium season, and showed a linear decreasing trend from upstream to downstream. The majority of other PFASs did not show clear seasonal variation. Composition profiles indicated that the JRE was mainly contaminated by shortchain perfluoroalkyl carboxylic acids (PFCAs), shipbuilding industry, multiple wastewater and river runoff were identified as major potential sources.		1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D773	環境中運命	Gu, YR; Dong, ZJ; Zhang, X; Han, Q; Li, YB	Hydrated-electron-based short chain perfluorosulfonic acid decomposition in VUV/sulfite system	2020	Water Supply. 2020 Dec:20(8):3615-3624. doi: 10.2166/ws.2020.222.	Perfluorosulfonic acids (PFSAs) have attracted increasing attention due to their global distribution, high chemical stability and persistence. As a powerful reductant, hydrated electron (e(aq)(-)) shows extraordinary reactivity towards halogenated organic substances like PFSAs. In this study, e(aq)(-)-based photo-decomposition of perfluorohexane sulfonate (PFHxS) in a VUV/sulfite system was investigated. The k(obs) of PFHxS decomposition in the studied system was 0.0049 +/- 0.0005 min(-1), which was 24.5-fold faster than that in a sole VUV system. It was demonstrated that e(aq)(-) was the main reactive species responsible for PFHxS decomposition. PFHxS decomposition kinetics were accelerated at higher initial solution pH and sulfite dosage, but were restrained when higher initial PFHxS concentration was introduced. Co-existence of chloride showed slight enhancement of PFHxS decomposition, whereas nitrate and bicarbonate suppressed PFHxS decomposition. Accompanying PFHxS decomposition, short chain perfluorocarboxylic acids (PFCAs) were detected as main intermediate products. PFHxS decomposition started with C-S bond fracture, followed by perfluoroalkyl radical hydrolysis reactions and perfluorohexanoic acid (PFHxA) formation. Afterwards, PFHxA was defluorinated by stepwise loss of CF2 units to generate other short chain PFCAs.		1						B	-		
D774	環境中運命	Wang, CC; Lu, YL; Li, QF; Cao, XH; Zhang, M; Zhou, YQ; Song, S; Wang, P; Lu, XT; Yvette, B; Liu, ZY	Assessing the contribution of atmospheric transport and tourism activities to the occurrence of perfluoroalkyl acids (PFAAs) in an Alpine Nature Reserve	2019	Sci. Total Environ. 2019 Dec:697:133851. doi: 10.1016/j.scitotenv.2019.133851.	Perfluoroalkyl acids (PFAAs) are ubiquitous in the global environment, even in remote regions. With increasing production and application of PFAAs in China, their distribution patterns have been widely reported, however with less attention to inland northwestern regions. Long-range transport and direct releases from local activities have been regarded as the main reasons for PFAAs distribution in such a remote area. To identify and quantify the contributions of different sources to PFAAs occurrences, an investigation was conducted in the Tianchi lake, nature reserve. A total of 20 water samples, 8 soil, 4 sediment and 10 fresh snow samples were collected and analyzed in 2015. The mean PFAAs concentrations were 3.38 ng L-1 in surface water, 1.06 ng g(-1) dw in soil, 0.53 ng g(-1) dw in sediment, and 3.31 ng L-1 in fresh snow, respectively. High levels of PFAAs were observed in surface water (15.41 ng L-1) from Western Tianchi pond and surface snow (14.24 ng L-1) from the site near a ski resort around Tianchi Lake indicating potential pollution by local human activities. The correlation between individual concentrations among water, soil and snow indicated the snow deposition as an important source. Although with limited sample size, principal component analysis associated with multiple linear regression (PCA-MLR) and positive matrix factorization (PMF) analyses have identified two major sources, which are characterized as tourism activities with dominance of perfluorooctanoic acid (PFOA) and long-range transport with abundant perfluorobutanoic acid (PFBA). Their contributions to total levels were 41% and 52%, respectively. These two sources contributed differently to the PFAAs presences in Tianchi and Western Tianchi Lakes. Source analysis indicates that the western Tianchi lake with a relatively small catchment was affected mainly by local activities.	1							B	-		
D775	環境中運命	Ahrens, L; Yamashita, N; Yeung, LWY; Taniyasu, S; Horii, Y; Lam, PKS; Ebinghaus, R	Partitioning Behavior of Per- and Polyfluoroalkyl Compounds between Pore Water and Sediment in Two Sediment Cores from Tokyo Bay, Japan	2009	Environ. Sci. Technol. 2009 Sep:43(18):6969-6975. doi: 10.1021/es901213s.	The partitioning behavior of per-and polyfluoroalkyl compounds (PFCs) between pore water and sediment in two sediment cores collected from Tokyo Bay, Japan, was investigated. In addition, the fluxes and temporal trends in one dated sediment core were studied. Short-chain perfluoroalkyl carboxylic acids (PFCAs) (C <= 7) were found exclusively in pore water, while long-chain PFCAs (C >= 11) were found only in sediment. The perfluoroalkyl sulfonates (PFSAs), n-ethylperfluoro-1-octanesulfonamidoacetic acid (N-EtFOSAA), and perfluorooctane sulfonamide (PFOSA) seemed to bind more strongly to sediment than PFCAs. The enrichment of PFCs on sediment increased with increasing organic matter and decreasing pH. The perfluorocarbon chain length and functional group were identified as the dominating parameters that had an influence on the partitioning behavior of the PFCs in sediment The maximum Sigma PFC contamination in sediment was observed in 2001-2002 to be a flux of 197 pg cm(-2) yr(-1). Statistically significant increased concentrations in Tokyo Bay were found for perfluorooctanesulfonate (PFOS) (1956-2008), perfluorononanoic acid (PFNA) (1990-2008), and perfluoroundecanoic acid (PFUnDA) (1990-2008). Concentrations of PFOSA and N-EtFOSAA increased between 1985 and 2001, but after 2001, the concentration decreased significantly, which corresponded with the phase out of perfluorooctyl sulfonyl fluoride-based compounds by the 3M Company in 2000.			1					B	-		
D776	蓄積性	Dennis, NM; Hossain, F; Subbiah, S; Karnjanapiboonwong, A; Dennis, ML; McCarthy, C; Jackson, WA; Crago, JP; Salice, CJ; Anderson, TA	Species- and Tissue-Specific Chronic Toxicity Values for Northern Bobwhite Quail (Colinus virginianus) Exposed to Perfluorohexane Sulfonic Acid and a Binary Mixture of Perfluorooctane Sulfonic Acid and Perfluorohexane Sulfonic Acid	2022	Environ. Toxicol. Chem. 2022 Jan:41(1):219-229. doi: 10.1002/etc.5238.	Per- and polyfluoroalkyl substances (PFAS) are globally distributed and present in nearly every environmental compartment. Characterizing the chronic toxicity of individual PFAS compounds and mixtures is necessary because many have been reported to cause adverse health effects. To derive toxicity reference values (TRVs) and conduct ecotoxicological risk assessments (ERAs) of PFAS-contaminated ecosystems for wildlife, species-specific PFAS chronic toxicity values (CTVs) are needed. The present study quantified PFAS residues from liver and eggs of birds chronically exposed to perfluorohexanoic acid (PFHxA) or a mixture of perfluorooctane sulfonate (PFOS) and PFHxA that produced a no-observable-adverse-effect level (NOAEL) and/or a lowest-observable-adverse-effectlevel (LOAEL). The CTVs we present are lower than those previously reported for birds and should be considered in future regulatory evaluations. From the estimated species- and tissue-specific PFAS CTVs, we found that PFOS and perfluorohexane sulfonate (PFHxS) were more bioaccumulative than PFHxA in avian tissues, but PFHxA was more toxic to reproducing birds than either PFOS or a PFOS:PFHxS mixture. We further determined that avian toxicity was not necessarily additive with respect to PFAS mixtures, which could have implications for PFAS ERAs. The PFAS LOAEL CTVs can be used to predict reproductive and possible population-level adverse health effects in wild avian receptors.		1						B	-		
D777	環境中運命	Xia, XH; Chen, X; Zhao, XL; Chen, HT; Shen, MH	Effects of Carbon Nanotubes, Chars, and Ash on Bioaccumulation of Perfluorochemicals by Chironomus plumosus Larvae in Sediment	2012	Environ. Sci. Technol. 2012 Nov:46(22):12467-12475. doi: 10.1021/es303024x.	This study examined the effect of five types of carbonaceous materials (CMs) in sediment on bioaccumulation of perfluorochemicals (PFCs) by Chironomus plumosus larvae. The CMs included two multiwalled carbon nanotubes (MWCNT10 and MWCNT50), maize straw- and willow-derived chars, and maize straw-origin ash. The PFCs included perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnA), and perfluorododecanoic acid (PFDoA). The CMs with different concentrations (0-1.5% dry weight) were amended into sediments spiked with PFCs and aged for 60 d. The uptake rate constants (k(s)) for each PFC to larvae differed with different CM amendments ($p < 0.05$), while elimination rate did not change significantly ($p > 0.05$). Decreasing PFC concentration in larvae (C-B) was found with increasing CM concentration (f(CM)) in the sediments, and a linear positive correlation existed between 1/C-B and f(CM) ($p < 0.05$). The effect of CMs on PFC bioaccumulation agreed well with the CM properties; MWCNT10 with the highest specific surface area resulted in the lowest k(s) values and biota-sediment accumulation factors (BSAF), with a BSAF reduction of 66%-97% by a 1.5% amendment. The mechanism was explored by analyzing the aqueous phase concentrations of PFCs and the sorption of PFCs on sediments amended with CMs. The results suggested that the decreasing trend of PFCs in larvae was caused by the decreasing aqueous phase concentration with increasing CM concentration. In the studied conditions with low PFC concentrations, the bioaccumulation of PFCs was a linear partitioning between pore water and biota, and the sorption of PFCs to the sediment/C mixtures was a two domain linear distribution. This study suggests that both the type and concentration of carbonaceous materials in sediment can affect the bioaccumulation of PFCs to benthic organisms through changing their aqueous phase concentrations.			1					B	-		
D778	環境中運命	Tan, B; Wang, TY; Wang, P; Luo, W; Lu, YL; Romesh, K; Giesy, J	Perfluoroalkyl substances in soils around the Nepali Koshi River: levels, distribution, and mass balance	2014	Environ. Sci. Pollut. Res. 2014 Aug:21(15):9201-9211. doi: 10.1007/s11356-014-2835-6.	Perfluoroalkyl substances (PFASs) were analyzed in surface soils along the Koshi River in Nepal, a typical agricultural country with little industrialization and urbanization. Sixteen target PFASs were quantified in soils from a hilly region in central and eastern Nepal, but only ten PFASs were detected. Concentrations of total PFASs ranged from nd (below the detection limit) to 1.78 ng/g dw. The predominant PFASs in soils were perfluoro-octanoic acid (PFOA) and perfluoro-butanesulfonate (PFBS) with concentrations that ranged from nd to 0.26 ng/g dw and nd to 0.38 ng/g dw, respectively. Results of mass balance analysis also revealed weak associations among concentrations of PFASs, extractable organic fluorine (EOF), and total fluorine (TF). PFASs were relatively evenly distributed among locations. Due to the absence of direct emission of PFASs and slow development of local industry, PFASs in soils originated mostly from long-range atmospheric transport, consumer use, and disposal of PFASs-containing products. Uncontrolled disposal of domestic waste will be a challenge to controlling concentrations of PFASs in Nepal.				1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D779	環境中運命	Shafique, U; Schulze, S; Slawik, C; Bohme, A; Paschke, A; Schuurmann, G	Perfluoroalkyl acids in aqueous samples from Germany and Kenya	2017	Environ. Sci. Pollut. Res. 2017 Apr:24(12):11031-11043. doi: 10.1007/s11356-016-7076-4.	Continuous monitoring of chemicals in the environment is important to control their fate and to protect human health, flora, and fauna. Perfluoroalkyl acids (PFAAs) have been detected frequently in different environmental compartments during the last 15 years and have drawn much attention because of their environmental persistence, omnipresence, and bioaccumulation potential. Water is an important source of their transport. In the present study, distributions of PFAAs in river water, wastewater treatment plant (WWTP) effluent, and tap water from eastern part of Germany and western part of Kenya were investigated. Eleven perfluorocarboxylic acids (PFCAs) and five perfluorosulfonic acids (PFSAs) were analyzed using liquid chromatography/tandem mass spectrometry. Sum of mean concentrations of eight PFAAs detected in drinking tap water from Leipzig was 11.5 ng L-1, dominated by perfluorooctanoic acid (PFOA, 6.2 ng L-1). Sums of mean riverine concentrations of PFAAs detected in Plei beta e/White Elster, Saale, and Elbe (Germany) were 24.8, 54.3, and 26.8 ng L-1, respectively. Annual flux of PFAAs from River Saale was estimated to be 164 +/- 23 kg a(-1). The effluent of WWTP in Halle was found to contain four times higher levels of PFAAs than river water and was dominated by perfluorobutane sulfonate (PFBS) with 32 times higher concentration than the riverine level. It advocates that WWTPs are the point source of contaminating water bodies with PFAAs, and short-chain PFAAs are substituting long-chain homologues. Sums of mean riverine concentrations of PFAAs in Sosiani (Kenya) in samples from sparsely populated and densely populated areas were 58.8 and 109.4 ng L-1, respectively, indicating that population directly affected the emissions of PFAAs to surface waters. The discussion includes thorough review and comparison of recently published literature reporting occurrence of PFAAs in aqueous matrices.				1				B	-		
D780	蓄積性	Moon, HB; Kannan, K; Yun, S; An, YR; Choi, SG; Park, JY; Kim, ZG; Moon, DY; Choi, HG	Perfluorinated compounds in minke whales (Balaenoptera acutorostrata) and long-beaked common dolphins (Delphinus capensis) from Korean coastal waters	2010	Mar. Pollut. Bull. 2010 Jul:60(7):1130-1135. doi: 10.1016/j.marpolbul.2010.04.007.	This is the first study to report the concentrations and accumulation profiles of PFCs in marine mammals from Korea. The concentrations and profiles of 10 PFCs in the liver of minke whales and common dolphins from Korean coastal waters were recorded in this study. The mean concentrations of PFOS and PFUnDA were 3-20 times higher than that found for other PFCs analyzed. The concentrations of PFOS in cetaceans from Korea were relatively lower than those reported in other countries. Inter-species differences in the concentrations of PFOS, PFOSA and PFNA were found between two cetacean species, while no difference was observed in the concentrations of PFDA, PFUnDA and PFDoDA between the species. The dominant PFC compounds found in cetaceans were PFUnDA and PFOS, accounting for 70-80% of the PFCs. The accumulation profiles and correlation analysis indicated that two cetacean species have different exposure routes and metabolic capacity for PFCs.			1					B	-		
D781	蓄積性	Pasanisi, E; Cortes-Gomez, AA; Perez-Lopez, M; Soler, F; Hernandez-Moreno, D; Guerranti, C; Martellini, T; Fuentes-Mascorro, G; Romero, D; Cincinelli, A	Levels of perfluorinated acids (PFCAs) in different tissues of Lepidochelys olivacea sea turtles from the Escobilla beach (Oaxaca, Mexico)	2016	Sci. Total Environ. 2016 Dec:572:1059-1065. doi: 10.1016/j.scitotenv.2016.08.013	Lepidochelys olivacea is the most abundant and globally distributed sea turtle species in the world and thus, monitoring this species for persistent organic pollutants, such as perfluorinated chemicals, is fundamental for their protection. This study was the first to evaluate the occurrence of five PFCAs (PFOA, PFNA, PFDA, PFUnA, PFDoA) in liver and blood samples of Olive Ridley turtle population from the Escobilla beach (Oaxaca, Mexico). PFDA and PFUnA were the predominant PFCs in blood samples (detected in 93% and 84% of samples, respectively) and were also present in the highest concentrations. Liver samples showed higher PFCA concentrations than whole blood samples, with PFNA and PFDA the most abundant PFCs congeners in liver samples, detected in 65% and 47% of the samples, respectively. The measured levels of contaminants in the blood samples of Lepidochelys olivacea sea turtles were compared to the levels reported in the literature for other turtle species. While linear significant correlations between PFNA, PFDA and PFUnA concentrations in blood samples and curved carapace lengths were determined, no correlation was found for PFOA, supporting the hypothesis that sea turtles could have a higher ability to eliminate this perfluorinated chemical from their blood than other PFCAs. However, we do not know if the concentrations are species or sampling areas dependent.			1					B	-		
D782	蓄積性	Wen, W; Xiao, L; Hu, DX; Zhang, ZN; Xiao, YL; Jiang, XM; Zhang, SW; Xia, XH	Fractionation of perfluoroalkyl acids (PFAAs) along the aquatic food chain promoted by competitive effects between longer and shorter chain PFAAs	2023	Chemosphere. 2023 Mar:318:137931. doi: 10.1016/j.chemosphere.2023.137931.	Perfluoroalkyl acids (PFAAs) are proteinophilic pollutants. We hypothesized that fractionation of PFAAs may occur along a food chain. To testify this hypothesis, we investigated the bioconcentration, bioaccumulation, and fractionation of 11 kinds of PFAAs (C-F = 3-11) along an aquatic food chain consisting of D. magna, zebrafish, and cichlid. The results showed that the proportions of PFNA, PFOA, and all shorter chain PFAAs in the D. magna and fish tissues were lower than the ones in exposure water, opposing to the other longer chain PFAAs. Predation promoted such fractionation differences, and the proportions of PFNA, PFOA, and all shorter chain PFAAs in organisms decreased while those of the other longer chain PFAAs increased along the food chain. The results of isothermal titration calorimetry and molecular docking experiments showed that binding affinities of PFAAs and fish proteins increased with the number of perfluorinated carbons, resulting in a substitution of shorter chain PFAAs by their longer chain analogues. It also triggered the differences in the uptake and elimination of PFFAs and competitive bioaccumulation between longer and shorter chain PFAAs. This study suggests that fractionation should be considered in studying environmental behaviors and evaluating ecological risks of multiple PFAAs.			1					B	-		
D783	蓄積性	Gebbink, WA; Hebert, CE; Letcher, RJ	Perfluorinated Carboxylates and Sulfonates and Precursor Compounds in Herring Gull Eggs from Colonies Spanning the Laurentian Great Lakes of North America	2009	Environ. Sci. Technol. 2009 Oct:43(19):7443-7449. doi: 10.1021/es901755q.	Environmentally important perfluorinated carboxylates and sulfonates, as well as per- and polyfluorinated precursor compounds including several sulfonamides, telomer acids, and alcohols were determined in individual herring gull (Larus argentatus) eggs collected (in 2007) from 15 colonies located at Canadian and some American sites across the Laurentian Great Lakes of North America. The pattern of perfluorosulfonates (PFSAs; C-6, C-8, C-10 chain lengths) was dominated by PFOS (>90% of Sigma PFSA concentration) regardless of collection location. Concentrations of Sigma PFSA were significantly ($p < 0.03$) higher in eggs from Middle Island (western Lake Erie; 507 +/- 47 ng/g ww), Toronto Harbour (484 +/- 49 ng/g ww), and Strachan Island (486 +/- 59 ng/g ww) (Lake Ontario) compared to eggs from colonies on Lakes Superior, Michigan, and Huron. Perfluorocarboxylic acids (PFCAs) ranging in chain length from C-8 to C-15 were detected in the eggs, with PFUnA and PFTrA being the dominant compounds. PFOA and PFNA were more abundant in the Sigma PFCA in eggs from Lake Superior and Michigan colonies, and PFUnA and longer chain PFCAs were more abundant in the Sigma PFCA in eggs from Lake Erie and Ontario colonies. In contrast to Sigma PFSA, the highest concentrations of Sigma PFCA were found in eggs from Double Island, Lake Huron (113 +/- 12 ng/g ww) followed by eggs from colonies on Lakes Erie and Ontario. Among the PFOS or PFCA precursor compounds assessed (6:2, 8:2, and 10:2 fluorotelomer alcohols and acids and PFOSA), none were detectable in eggs from any sampling location. The exception was PFOSA (average concentration <1 ng/g ww), which suggests that PFOS in the gulls and subsequently in their eggs may be due, in part, to biotransformation of PFOSA to PFOS in the gull and/or in their diet and food web. The accumulation of PFSA and PFCA from mainly aquatic dietary sources was suggested, and were highly lake- and/or colony-dependent especially showing a northwest and southeast spatial trend and with higher concentrations in eggs from colonies in close proximity to highly urbanized and industrialized sites in Lakes Erie and Ontario.			1					B	-		
D784	環境中運命	Liu, YF; Ma, L; Yang, Q; Li, GH; Zhang, F	Occurrence and spatial distribution of perfluorinated compounds in groundwater receiving reclaimed water through river bank infiltration	2018	Chemosphere 2018 Nov:211:1203-1211. doi: 10.1016/j.chemosphere.2018.08.028	Perfiuorinated compounds (PFCs) in groundwater are of widespread concern due to their potential toxicity to human health and ecological systems. PFCs in rivers can infiltrate into groundwater through riverbank infiltration, potentially endangering the safety of drinking water and causing a deterioration in the groundwater environment. This study investigated the occurrence of PFCs in rivers and riverside groundwater from 2014 to 2017 in a city in north China. PFCs were detected in most of the groundwater samples, ranging from not detected to 64.8 ng L-1. The predominant PFCs in both river and groundwater samples were perfluorooctane sulfonate, perfluorooctanoic acid, perfluorobutane sulfonate and perfluorobutanoic acid. The PFC concentrations and major compounds were consistent in both the river and riverside groundwater samples at each site, suggesting that the adjacent river was the source of the PFCs in the riverside groundwater. The spatial distribution of the PFCs in the riverside groundwater was affected by the hydraulic connection between the groundwater and the river, the lithology of the aquifer and the properties of the compounds. The results indicated that PFCs were attenuated during riverbank infiltration and the ability of different riverbank lithologies to remove PFCs was in the order sandy clay > fine sand > sandy gravel. Perfiuorooctane sulfonate concentrations decreased sharply with increasing distances from river, whereas perfluorooctanoic acid, perfluorobutane sulfonate and perfluorobutanoic acid could by transported for greater distances in riverside groundwater. This study provides valuable information on PFCs in riverside groundwater affected by riverbank infiltration.	1			1				B	-		
D785	環境中運命	Dreyer, A; Matthias, V; Weinberg, I; Ebinghaus, R	Wet deposition of poly- and perfluorinated compounds in Northern Germany	2010	Environ. Pollut. 2010 May:158(5):1221-1227. doi: 10.1016/j.envpol.2010.01.030.	Twenty precipitation samples were taken concurrently with air samples at a northern German monitoring site over a period of 7 months in 2007 and 2008. Thirty four poly- and perfluorinated compounds (PFC) were determined in rain water samples by solid phase extraction and HPLC-MS/MS analysis. Seventeen compounds were detected in rain water with Sigma PFC concentrations ranging from 1.6 ng L(-1) to 48.6 ng L(-1). Perfluorooctanoate (PFOA) and perfluorobutanate (PFBA) were the compounds that were usually observed in highest concentrations. Calculated Sigma PFC deposition rates were between 2 and 91 ng m(-2) d(-1). These findings indicate that particle phase PFC are deposited from the atmosphere by precipitation. A relationship between PFC wet deposition and air concentration may be established via precipitation amounts. Trajectory analysis revealed that PFC concentration and deposition estimates in precipitation can only be explained if a detailed air mass history is considered.	1							B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D786	環境中運命	Chen, HT; Reinhard, M; You, LH; Gin, KYH	Effect of repeated sorption-desorption on irreversible and reversible absorption of hydrophobic perfluoroalkyl acids to freshwater sediment	2022	Environ. Technol. Innov. 2022 Nov:28:102673. doi: 10.1016/j.eti.2022.102673.	Understanding the factors governing irreversible and reversible sorption is essential to predict the influence of sediment on contaminant fate and transport in surface waters. This study used sediment of an urban water body to demonstrate irreversible accumulation and reversible absorption of perfluoroalkyl acids (perfluorooctane sulfonate (PFOS), perfluorononanoic (PFNA) and perfluorodecanoic acid (PFDA)) during two sorption-desorption (S-D) cycles. Absorption and desorption isotherms were consistent with sorption to irreversibly absorbing glassy sediment organic carbon (SOC) and liquid-liquid like partitioning to rubbery SOC. The observed absorption isotherms and the desorption isotherms were adequately fitted linear models. Irreversible absorption showed signs of saturation and the reversible partitioning diminished during the 2nd S-D cycle causing the composite sorption capacity to decrease. Results suggest that under the conditions tested, surface water sediment can act as sink for the studied PFAAs. Rubbery SOC can potentially release or absorb contaminants, thus acting as a concentration buffer. S-D cycling can cause irreversible absorption concentration to increase even when exposure occurs at lower concentrations (i.e. 5 mu g/L). log KOC values of sediment that underwent S-D cycling overlaps with the range of field date, suggesting that the sediment of surface water may have experienced some degree of S-D cycling.								B	-		
D787	環境中運命	Bjornsdotter, MK; Hartz, WF; Kallenborn, R; Jogsten, IE; Humby, JD; Karrman, A; Yeung, LWY	Levels and Seasonal Trends of C-1-C-4 Perfluoroalkyl Acids and the Discovery of Trifluoromethane Sulfonic Acid in Surface Snow in the Arctic	2021	Environ. Sci. Technol. 2021 Dec:55(23):15853-15861. doi: 10.1021/acs.est.1c04776.	C-1-C-4 perfluoroalkyl acids (PFAAs) are highly persistent chemicals that have been found in the environment. To date, much uncertainty still exists about their sources and fate. The importance of the atmospheric degradation of volatile precursors to C-1-C-4 PFAAs were investigated by studying their distribution and seasonal variation in remote Arctic locations. C-1-C-4 PFAAs were measured in surface snow on the island of Spitsbergen in the Norwegian Arctic during January-August 2019. Trifluoroacetic acid (TFA), perfluoropropanoic acid (PFPrA), perfluorobutanoic acid (PFBA), and trifluoromethane sulfonic acid (TFMS) were detected in most samples, including samples collected at locations presumably receiving PFAA input solely from long-range processes. The flux of TFA, PFPrA, PFBA, and TFMS per precipitation event was in the ranges of 22-1800, 0.79-16, 0.19-170, and 1.5-57 ng/m(2), respectively. A positive correlation between the flux of TFA, PFPrA, and PFBA with downward short-wave solar radiation was observed. No correlation was observed between the flux of TFMS and solar radiation. These findings suggest that atmospheric transport of volatile precursors and their subsequent degradation plays a major role in the global distribution of C-2-C-4 perfluoroalkyl carboxylic acids and their consequential deposition in Arctic environments. The discovery of TFMS in surface snow at these remote Arctic locations suggests that TFMS is globally distributed. However, the transport mechanism to the Arctic environment remains unknown.	1							B	-		
D788	蓄積性	Dietz, R; Bossi, R; Riget, FF; Sonne, C; Born, EW	Increasing perfluoroalkyl contaminants in east Greenland polar bears (Ursus maritimus): A new toxic threat to the Arctic bears	2008	Environ. Sci. Technol. 2008 Apr:42(7):2701-2707. doi: 10.1021/es7025938.	A well-defined subsample of 128 subadult (3-5 years) polar bears (Ursus maritimus) from 19 sampling years within the period 1984-2006 was investigated for perfluoroalkyl contaminants (PFCs), Linear regression analysis of logarithmic-transformed median concentrations showed significant annual increases for PFOS (4.7%), PFNA (6.1%), PFUnA (5.9%), PFDA (4.3%), PFTrA (8.5%), PFOA (2.3%), and PFDoA (5.2%). For four of the PFCs, a LOESS smoother model provided significantly better descriptions, revealing steeper linear annual increases for PFOSA of 9.2% after 1990 and between 18.6 and 27.4% for PFOS, PFDA, and PFTrA after 2000. Concentrations of Sigma PFCs, by 2006, exceeded the concentrations of all conventional OHCs (organohalogen compounds), of which several have been documented to correlate with a number of negative health effects. If the PFC concentrations in polar bears continue to increase with the steepest observed trends, then the lowest no-adverse-effect level (NOAEL) and lowest-adverse-effect level (LOAEL) detected for rats and monkeys will be exceeded in 2014-2024. In addition, the rapidly increasing concentrations of PFCs are likely to cause cumulative and combined effects on the polar bear, compounding the already detected threats from OHCs.			1					B	-		
D789	蓄積性	Vu, JP; McLamb, F; Feng, ZY; Griffin, L; Gong, SY; Shea, D; Szuch, MA; Scott, S; Gersberg, RM; Bozinovic, G	Locomotion and brain gene expression exhibit sex-specific non-monotonic dose-response to HFPO-DA during Drosophila melanogaster lifespan	2023	Neurotoxicology 2023 May:96:207-221. doi: 10.1016/j.neuro.2023.05.005	Background: Legacy per-and polyfluoroalkyl substances (PFAS), known for their environmental persistence and bio-accumulative properties, have been phased out in the U.S. due to public health concerns. A newer poly-merization aid used in the manufacture of some fluoropolymers, hexafluoropropylene oxide-dimer acid (HFPO-DA), has lower reported bioaccumulation and toxicity, but is a potential neurotoxicant implicated in dopami-nergic neurodegeneration.Objective: We investigated HFPO-DA's bio-accumulative potential and sex-specific effects on lifespan, locomo-tion, and brain gene expression in fruit flies.Methods: We quantified bioaccumulation of HFPO-DA in fruit flies exposed to 8.7 x 104 mu g/L of HFPO-DA in the fly media for 14 days via UHPLC-MS. Long-term effect on lifespan was determined by exposing both sexes to 8.7 x 102 - 8.7 x 105 mu g/L of HFPO-DA in media. Locomotion was measured following 3, 7, and 14 days of exposures at 8.7 x 101 - 8.7 x 105 mu g/L of HFPO-DA in media, and high-throughput 3 '-end RNA-sequencing was used to quantify gene expression in fly brains across the same time points.Results: Bioaccumulation of HFPO-DA in fruit flies was not detected. HFPO-DA-induced effects on lifespan, locomotion, and brain gene expression, and lowest adverse effect level (LOAEL) showed sexually dimorphic patterns. Locomotion scores significantly decreased in at least one dose at all time points for females and only at 3-day exposure for males, while brain gene expression exhibited non-monotonic dose-response. Differentially expressed genes correlated to locomotion scores revealed sex-specific numbers of positively and negatively correlated genes per functional category.Conclusion: Although HFPO-DA effects on locomotion and survival were significant at doses higher than the US EPA reference dose, the brain transcriptomic profiling reveals sex-specific changes and neurological molecular targets; gene enrichments highlight disproportionately affected categories, including immune response: female -specific co-upregulation suggests potential neuroinflammation. Consistent sex-specific exposure effects necessi-tate blocking for sex in experimental design during HFPO-DA risk assessment.					1			B	-		
D790	環境中運命	Meng, J; Zhou, YQ; Liu, SF; Chen, SQ; Wang, TY	Increasing perfluoroalkyl substances and ecological process from the Yongding Watershed to the Guanting Reservoir in the Olympic host cities, China	2019	Environ. Int. 2019 Dec;133(Pt B):105224. doi: 10.1016/j.envint.2019.105224.	Perfluoroalkyl substances (PFASs) have raised great attention, particularly in regions of rapid urbanization. Zhangjiakou and Beijing will jointly host the Winter Olympic Games in 2022, which will likely increase local PFASs pollution and their associated risks over the coming period. In this study, we identified ecological process of PFASs, including sources, environmental fate, and risks, from the Yongding Watershed to the Guanting Reservoir. The concentrations of total 12 PFASs in water of the Guanting Reservoir were higher than that from the Yongding Watershed, with mean of 48.9 and 33.7 ng/L, respectively. The concentrations of PFASs in sediment of the Yongding Watershed and the Guanting Reservoir were similar, with mean of 1.01 and 0.827 ng/g dry weight, respectively. Detected levels of PFASs in the Guanting Reservoir significantly increased during the past eight years, possibly due to an improving economy and a rapidly developed service industry. Moderate PFASs levels in fish of the Guanting Reservoir were detected relative to other lakes and reservoirs. The daily intake of PFASs via fish and water ranged from 4.96 to 15.0 ng/kg bw/day, with higher levels found in children relative to adults. In total, approximately 9.06 kg of PFASs from riverine flow and atmospheric deposition annually entered the Guanting Reservoir. PFASs from the Yongding River significantly contributed to the pollution of Guanting Reservoir, with predominance of perfluorobutanoic acid (PFBA) in water, and long-chain perfluorinated carboxylic acids (PFCAs) and perfluorooctane sulfonate (PFOS) in sediment in both the Yongding Watershed and the Guanting Reservoir. Most of the PFASs (23.5 kg) were stored in water of the Guanting Reservoir, while the annual storage of PFASs in sediment and fish was only 4.68 x 10(-2) kg and 4.36 x 10(-2) kg via deposition and accumulation, respectively. The results suggest that water quality management of the Yongding Watershed is necessary for effective control on PFASs pollution in the Guanting Reservoir.	1							B	-		
D791	蓄積性	Briels, N; Torgersen, LN; Castano-Ortiz, JM; Loseth, ME; Herzke, D; Nygard, T; Bustnes, JO; Ciesielski, TM; Poma, G; Malarvannan, G; Covaci, A; Jaspers, VLB	Integrated exposure assessment of northern goshawk (Accipiter gentilis) nestlings to legacy and emerging organic pollutants using non-destructive samples	2019	Environ. Res. 2019 Nov:178:108678. doi: 10.1016/j.envres.2019.108678.	In the present study, concentrations of legacy and emerging contaminants were determined in three non-destructive matrices (plasma, preen oil and body feathers) of northern goshawk (Accipiter gentilis) nestlings. Persistent organic pollutants (POPs), including polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs) and polybrominated diphenyl ethers (PBDEs), together with emerging pollutants, including per- and polyfluorinated alkyl substances (PFASs), novel brominated flame retardants (NBFRs), phosphorus flame retardants (PFRs) and Dechlorane Plus isomers (DPs) were targeted. Plasma, preen oil and feather samples were collected from 61 goshawk nestlings in Norway (Trondelag and Troms) in 2015 and 2016, and pollutant concentrations were compared between the three matrices. In plasma, PFASs were detected in the highest concentrations, ranging between 1.37 and 36.0 ng/mL, which suggests that the nestlings were recently and continuously exposed to these emerging contaminants, likely through dietary input. In preen oil, OCPs (169-3560 ng/g) showed the highest concentrations among the investigated compounds, consistent with their high lipophilicity. PFRs (2.60-314 ng/g) were the dominant compounds in feathers and are thought to originate mainly from external deposition, as they were not detected in the other two matrices. NBFRs and DPs were generally not detected in the nestlings, suggesting low presence of these emerging contaminants in their environment and/or low absorption. Strong and significant correlations between matrices were found for all POPs ($r(s) = 0.46$-0.95, $p < 0.001$), except for hexachlorobenzene (HCB, $r(s) = 0.20$, $p = 0.13$). Correlations for PFASs were less conclusive: linear perfluorooctane sulfonate (PFOS), perfluoroundecanoate (PFUnA), perfluorododecanoate (PFDoA) and perfluorotetradecanoate (PFTeA) showed strong and significant correlations between plasma and feathers ($r(s) = 0.42$-0.72, $p < 0.02$), however no correlation was found for perfluorohexane sulfonate (PFHxS), perfluorononanoate (PFNA) and perfluorotridecanoate (PFTriA) ($r(s) = 0.05$-0.33, $p = 0.09$-0.85). A lack of consistency between the PFAS compounds (contrary to POPs), and between studies, prevents concluding on the suitability of the investigated matrices for PFAS biomonitoring.					1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D792	蓄積性	Herzke, D; Nygard, T; Berger, U; Huber, S; Rov, N	Perfluorinated and other persistent halogenated organic compounds in European shag (Phalacrocorax aristotelis) and common eider (Somateria mollissima) from Norway: A suburban to remote pollutant gradient	2009	Sci. Total Environ. 2009 Dec:408(2):340-348. doi: 10.1016/j.scitotenv.2009.08.048.	Samples of two marine bird species, European shag (Phalacrocorax aristotelis) and common eider (Somateria mollissima) sampled at a remote coastal site in Norway were analysed for POPs and PFCs. Additionally samples of common eider were analysed from two other locations in Norway, representing a gradient from densely populated to remote. The variety, concentration and distribution of lipophilic POPs in comparison to PFCs were investigated. PCBs were the dominating group of contaminants in the analysed egg samples. Shag eggs had median sum PCBs levels of 4580 ng/g l.w. in 2004. Six different PBDE congeners could be detected in the shag eggs. BDE 47 and 100 were the main contributors with 24 and 27 ng/g l.w. respectively, sum PBDEs was 90 ng/g l.w. Relatively high concentrations of chlordanes were found witha total sum of 903 ng/g l.w. Of other OCs, toxaphene 26 and 52 together (sum 657 ng/g l.w.) and HCB (165 ng/g l.w.) were contributing majorly to the egg burden. Sum HCHs were low; only 54 ng/g l.w. PFOS was the main PFC in egg, plasma and liver samples. Similar median levels of 29,32 and 27 ng/g w.w. were observed. PFOSA, PFHxS, and PFDcA were observed additionally in all shag samples at minor concentrations with the exception of elevated levels observed in liver for PFOSA and PFDcA with median levels of 7.6 and 7.9 ng/g w.w., respectively. In common eider eggs, the POP concentrations decreased up to 1/8th along the sampled spatial gradient from suburban to remote. of the 9 detected PFCs, PFOS dominated all samples by one order of magnitude, followed by PFOA. Sum PFC concentrations were twice as high at the two fjord sites compared to the remote site. Shorter chained PFCAs like PFOA and PFNA could be detected in the eider eggs whilst being absent in shag eggs.			1					B	-		
D793	環境中運命	Johansson, JH; Shi, YL; Salter, M; Cousins, IT	Spatial variation in the atmospheric deposition of perfluoroalkyl acids: source elucidation through analysis of isomer patterns	2018	Environ. Sci.-Process Impacts 2018 Jul:20(7):997-1006. doi: 10.1039/c8em00102b.	To evaluate the relevance of different proposed sources of perfluoroalkyl acids (PFAAs) to air, their isomer patterns were analyzed in deposition samples collected from five geographical locations: two urban sites in China (>360 km from known operational fluorochemical manufacturing facilities), one remote marine site in the Azores archipelago and two Swedish sites representing urban and background conditions. Despite variable contributions from linear perfluorooctanoic acid (PFOA) in the samples, the pattern of branched PFOA isomers was similar to those of technical standards manufactured using electrochemical fluorination (ECF). This indicates that atmospheric fate processes have little influence on the isomer profiles of PFOA and that the relative contribution of PFOA manufactured using ECF (typically 20-26% branched isomers) and telomerization (typically one single linear isomer) can be determined in atmospheric deposition samples by analyzing the proportions of branched and linear isomers. In Chinese samples, branched isomers contributed 15-25% to the total loading of PFOA, indicating that the samples were dominated by ECF PFOA. Samples in the Azores had 8-10% contribution from branched PFOA isomers, indicating an approximately equal influence of ECF and telomer sources. Only three of the samples collected in Sweden displayed a quantifiable contribution from branched PFOA isomers (8-13% of overall PFOA loading in the samples). One branched PFNA isomer was observed in samples from the marine sites. Direct manufacturing discharges, transport of sea spray aerosols and degradation of precursors are all suggested to be contributing sources, albeit to different extents, to PFAAs in air at the different geographical locations where precipitation was sampled.			1					B	-	大気	
D794	環境中運命	Liu, JX; Wang, N; Szostek, B; Buck, RC; Panciroli, PK; Folsom, PW; Sulecki, LM; Bellin, CA	6-2 Fluorotelomer alcohol aerobic biodegradation in soil and mixed bacterial culture	2010	Chemosphere. 2010 Jan:78(4):437-444. doi: 10.1016/j.chemosphere.2009.10.044.	The first studies to explore 6-2 fluorotelomer alcohol [6-2 FTOH, F(CF2)(6)CH2CH2OH] aerobic biodegradation are described. Biodegradation yields and metabolite concentrations were determined in mixed bacterial culture (90 d) and aerobic soil (180 cl). 6-2 FTOH primary degradation half-life was less than 2 d in both. The overall mass balance in mixed bacterial culture (day 90) was similar to 60%. At day 90, the molar yield was 6% for 6-2 FTA [F(CF2)(6)CH2COOH], 23% for 6-2 FFLJA [F(CF2)(5)CF=CHCOOH], 16% for 5-2 sFTOH [F(CF2)(5)CHOHCH3] 6% for 5-3 acid [F(CF2)(5)CH2CH2COOH], and 5% for PFHxA [F(CF2)(5)COOH]. The overall mass balance in aerobic soil was similar to 67% (day 180). At day 180, the major terminal metabolites were PFPeA. [F(CF2)(4)COOH, 30%], PFHxA (8%), PFBA [F(CF2)(3)COOH, 2%], and 5-3 acid (15%). A new metabolite 4-3 acid [F(CF2)(4)CH2CH2COOH] accounted for 1%, 6-2 FTOH for 3%, and 5-2 sFrCH for 7%. Based on 8-2 FTOH aerobic biodegradation pathways, PFHxA was expected in greatest yield from 6-2 FTOH degradation. However, PRIM was observed in greatest yield in soil, suggesting a preference for alternate degradation pathways. Selected metabolites were also studied in aerobic soil. 5-3 Acid degraded to only 4-3 acid with a molar yield of 2.3%. 5-2 sFrOH degraded to PFPeA and PFHxA. and 5-2 FT Ketone [F(CF2)(5)COCH3] degraded to 5-2 sFrOH, suggesting that 5-2 sFrOH is the direct precursor to PFPeA and PFHxA. Another new metabolite, 5-3 ketone aldehyde [F(CF2)(5)COCH2CHO] was also identified in mixed bacterial culture. The formation of PFBA, PFPeA, and 4-3 acid indicates that multiple -CF2- groups in 6-2 FTOH were removed during microbial biodegradation.	1	1						B	-	生分解	
D795	環境中運命	Wu, JY; Li, G; Hua, ZL; Liang, ZY; Chu, KJ; He, XX	Per-, poly-fluoroalkyl substances (PFASs) pollution in benthic riverine ecosystem: Integrating microbial community coalescence and biogeochemistry with sediment distribution	2021	Chemosphere. 2021 Oct:281:130977. doi: 10.1016/j.chemosphere.2021.130977.	Per-, Poly-fluomalkyl substances (PFASs) accumulation in benthic environments is mainly determined by material mixing and represents a significant challenge to river remediation. However, less attention has been paid to the effects of sediment distribution on PFASs accumulation, and how PFASs influence microbial community coalescence and biogeochemical processes. In order to identify correlations between PFASs distribution and benthic microbial community functions, we conducted a field study and quantified the ecological constrains of material transportation on benthic microorganisms. Perfluorohexanoic acid (PFHxA) contributed most to the taxonomic heterogeneity of both archaeal (12.199%) and bacterial (13.675%) communities. Genera Methanoregula (R-2 = 0.292) and Bacillus (R-2 = 0.791) were identified as indicators that respond to PFASs. Phylogenetic null modeling indicated that deterministic processes (50.0-82.2%) dominated in spatial assembly of archaea, while stochasticity (94.4-97.8%) dominated in bacteria. Furthermore, spatial mixing of PFASs influenced broadly in nitrogen cycling of archaeal genomes, and phosphorus mineralization of bacterial genomes ($p < 0.05$). Overall, we quantified the effect of PFASs on community assembly and highlighted the constrains of PFASs influence on benthic geochemical potentials, which may provide new insights into riverine remediation.		1						B	-	生態系	
D796	環境中運命	Sunyer-Caldu, A; Golovko, O; Kaczmarek, M; Asp, H; Bergstrand, KJ; Gil-Solsona, R; Gago-Ferrero, P; Diaz-Cruz, MS; Ahrens, L; Hultberg, M	Occurrence and fate of contaminants of emerging concern and their transformation products after uptake by pak choi (Brassica rapa subsp. chinensis)	2023	Environ. Pollut. 2023 Feb:319:120958. doi: 10.1016/j.envpol.2022.120958.	Recovery and reuse of nutrients is a major challenge in agriculture. A new process contributing to a circular economy is the anaerobic digestion of food waste, which is a sustainable way of recycling nutrients as the digestate can be used as fertiliser in agriculture and horticulture. However, the digestate may be polluted with contaminants of emerging concern (CECs) that can be circulated back into the food chain, posing a risk to the environment and human health. In this work, the nutrient solution was spiked with 18 selected CECs frequently detected in food waste biogas facilities, and subsequent uptake and fate of these CECs were evaluated in pak choi grown in two different nutrient solutions (mineral and organic). All spiked compounds except two (propylpar-aben, fenbendazole) were taken up by pak choi plants, with perfluorobutanoic acid (PFBA) and sertraline dis-playing the highest concentrations (270 and 190 mu g/kg fresh weight, respectively). There were no statistically significant differences in uptake between mineral and organic nutrient solutions. Uptake of per-and poly-fluoroalkyl substances (PFAS) was negatively correlated with perfluorocarbon chain length and dependent on the functional group (r =-0.73). Sixteen transformation products (TPs) were tentatively identified using suspect screening, most of which were Phase II or even Phase III metabolites. Six of these TPs were identified for the first time in plant metabolism and their metabolic pathways were considered.	1							B	-	植物濃縮	
D797	環境中運命	Wan, Y; Wang, SL; Cao, XZ; Cao, YX; Zhang, L; Wang, H; Liu, JF	Perfluoroalkyl acids (PFAAs) in water and sediment from the coastal regions of Shandong peninsula, China	2017	Environ. Monit. Assess. 2017 MAR;189(3):100. doi: 10.1007/s10661-017-5807-8.	Perfluoroalkyl acids (PFAAs) have been observed in various environmental matrices globally in recent years. In this study, the levels, spatial distribution tendencies, and partitioning characteristics of the target 12 PFAAs were investigated in water and sediment from the coastal regions of Shandong peninsula in China, and two sediment core samples were also collected to study the vertical and historical variation of PFAAs. The ranges (means) of total PFAA concentrations were 23.69-148.48 ng/L (76.11 ng/L) in the water and 1.30-11.17 ng/g (5.93 ng/g) in the surface sediment, respectively. Among the target 12 PFAAs, perfluorooctanoic acid (PFOA) was the dominant component in water, followed by perfluorooctane sulfonate (PFOS) and perfluorohexanoic acid (PFHxA). PFOS, perfluoroundecanoic acid, and PFOA were the dominant components in sediment. For their spatial distribution, higher levels of PFAAs were found at the locations close to much developed cities. The PFAA concentrations showed an overall decreasing tendency with depth increase in the two sediment cores, which indicates that the extent of PFAAs pollution is aggravating trend in recent years. Results of the partition coefficient (K-d) show that the compounds with longer carbon chains (C >= 7) generally had higher K-d values, which suggest that long-chain PFAAs are prone to be adsorbed by sediment. In addition, the Log K-d of PFHxA, PFOA, and PFOS were significantly and positively correlated to the salinity of the water. The results of risk assessment suggest appreciable risk of PFAAs to the local ecosystem.		1						B	-	水と底泥	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D798	環境中運命	Chen, L; Chen, DJ; Zhou, SY; Lin, JY; Liu, Y; Huang, XF; Lin, QQ; Morel, JL; Ni, ZB; Wang, SZ; Qiu, RL	New Insights into the Accumulation, Transport, and Distribution Mechanisms of Hexafluoropropylene Oxide Homologues, Important Alternatives to Perfluorooctanoic Acid, in Lettuce (Lactuca sativa L.)	2023	Environ Sci Technol. 2023 Jul 4;57(26):9702-9712. doi: 10.1021/acs.est.2c09226.	Theaccumulation, transport, and distribution mechanismsof HFPO homologues in lettuce were investigated at the plant, tissue,and cell levels. HFPO-DA tended to accumulate in the edible parts,resulting in higher potential exposure risks. Hexafluoropropylene oxide (HFPO) homologues, which areimportantalternatives to perfluorooctanoic acid, have been frequently identifiedin crops. Although exposure to HFPO homologues via crops may posenon-negligible threats to humans, their impact on crops is still unknown.In this study, the accumulation, transport, and distribution mechanismsof three HFPO homologues in lettuce were investigated at the plant,tissue, and cell levels. More specifically, HFPO trimer acid and HFPOtetramer acid were primarily fixed in roots and hardly transportedto shoots (TF, 0.06-0.63). Conversely, HFPO dimer acid (HFPO-DA)tended to accumulate in lettuce shoots 2-264 times more thanthe other two homologues, thus resulting in higher estimated dailyintake values. Furthermore, the dissolved organic matter derived fromroot exudate enhanced HFPO-DA uptake by increasing its desorptionfractions in the rhizosphere. The transmembrane uptake of HFPO homologueswas controlled by means of a transporter-mediated active process involvinganion channels, with the uptake of HFPO-DA being additionally facilitatedby aquaporins. The higher accumulation of HFPO-DA in shoots was attributedto the larger proportions of HFPO-DA in the soluble fraction (55-74%)and its higher abundance in both vascular tissues and xylem sap. Ourfindings expand the understanding of the fate of HFPO homologues insoil-crop systems and reveal the underlying mechanisms of thepotential exposure risk to HFPO-DA.					1				B	-	レタス	
D799	蓄積性	Lasters, R; Groffen, T; Lopez-Antia, A; Bervoets, L; Eens, M	Variation in PFAA concentrations and egg parameters throughout the egg-laying sequence in a free-living songbird (the great tit, Parus major): Implications for biomonitoring studies	2019	Environ. Pollut. 2019 Mar:246:237-248. doi: 10.1016/j.envpol.2018.12.014	Over the past decades, there has been growing scientific attention and public concern towards perfluoroalkyl acids (PFAAs), due to their widespread presence in the environment and associations with adverse effects on various organisms. Bird eggs have often been used as less-invasive biomonitoring tools for toxicological risk assessments of persistent organic pollutants, including some PFAAs. Hereby, it is typically assumed that one random egg is representative for the PFAA concentrations of the whole clutch. However, variation of PFAA concentrations within clutches due to laying sequence influences can have important implications for the egg collection strategy and may impede interpretations of the quantified concentrations. Therefore, the main objective of this paper was to study variation patterns and possible laying sequence associations with PFAA concentrations in eggs of the great tit (Parus major). Eight whole clutches (4-8 eggs) were collected at a location in the Antwerp region, situated about 11 km from a known PFAA point source. The Sigma PFAA concentrations ranged from 8.9 to 75.1 ng g(-1) ww. PFOS concentrations ranged from 6.7 to 55.1 ng g(-1) ww and this compound was the dominant contributor to the total PFAA profile (74%), followed by PFDoA (7%), PFOA (7%), PFDA (5%), PFTrA (4%) and PFNA (3%). The within-clutch variation (70.7%) of the Sigma PFAA concentrations was much larger than the among-clutch variation (29.3%) and concentrations decreased significantly for some PFAA compounds throughout the laying sequence. Nevertheless, PFAA concentrations were positively and significantly correlated between some egg pairs within the same clutch, especially between egg 1 and egg 3. For future PFAA biomonitoring studies, we recommend to consistently collect the same egg along the laying sequence, preferably the first or third egg if maximizing egg exposure metrics is the main objective.			1						B	-		
D800	蓄積性	Chu, KJ; Lu, Y; Hua, ZL; Liu, YY; Ma, YX; Gu, L; Gao, C; Yu, L; Wang, YF	Perfluoroalkyl acids (PFAAs) in the aquatic food web of a temperate urban lake in East China: Bioaccumulation, biomagnification, and probabilistic human health risk	2022	Environ. Pollut. 2022 Mar:296:118748. doi: 10.1016/j.envpol.2021.118748.	The bioaccumulation and biomagnification of perfluoroalkyl acids (PFAAs) in temperate urban lacustrine ecosystems is poorly understood. We investigated the occurrence and trophic transfer of and probabilistic health risk from 15 PFAAs in the food web of Luoma Lake, a temperate urban lake in East China. The target PFAAs were widely distributed in the water (n-ary sumation PFAA: 77.09 +/- 9.07 ng/L), suspended particulate matter (SPM) (n-ary sumation PFAA: 284.07 +/- 118.05 ng/g dw), and sediment samples (n-ary sumation PFAA: 67.77 +/- 17.96 ng/g dw) and occurred in all biotic samples (n-ary sumation PFAA: 443.27 +/- 124.89 ng/g dw for aquatic plants; 294.99 +/- 90.82 for aquatic animals). PFBA was predominant in water and SPM, with 40.11% and 21.35% of the total PFAAs, respectively, while PFOS was the most abundant in sediments (14.11% of the total PFAAs) and organisms (14.33% of the total PFAAs). Sediment exposure may be the major route of biological uptake of PFAAs. The PFAA accumulation capacity was the highest in submerged plants, followed by emergent plants > bivalves > crustaceans > fish > floating plants. Long-chain PFAAs were biomagnified, and short-chain PFAAs were biodiluted across the entire lacustrine food web. PFOS exhibited the greatest bioaccumulation and biomagnification potential among the target PFAAs. However, biomagnification of short-chain PFAAs was also observed within the low trophic-level part of the food web. Human health risk assessment indicated that perfluorooctanesulfonate (PFOS) and perfluorooctanoic acid (PFOA) posed health risks to all age groups, while the other PFAAs were unlikely to cause immediate harm to consumers in the region. This study fills a gap in the knowledge of the transfer of PFAAs in the food webs of temperate urban lakes.	1								B	-		
D801	環境中運命	Wu, JY; Gu, L; Hua, ZL; Wang, DW; Xu, RY; Ge, XY; Chu, KJ	Removal of Per-, Poly-fluoroalkyl substances (PFASs) and multi-biosphere community dynamics in a bacteria-algae symbiotic aquatic ecosystem	2022	Environ. Pollut. 2022 Dec:314:120266. doi: 10.1016/j.envpol.2022.120266.	The presence of Per-, Poly-fluoroalkyl substances (PFASs) in aquatic ecosystems has drawn broad concerns in the scientific community due to their biological toxicity. However, little has been explored regarding PFASs' removal in phytoplankton-dominated environments. This study aimed to create a simulated bacteria-algae symbiotic ecosystem to observe the potential transportation of PFASs. Mass distributions showed that sand (63-2000 mu m), silt & clay (0-63 mu m), the phycosphere (> 3 mu m plankton), and the free-living biosphere (0.22-3 mu m plankton) contained 19.00, 7.78, 5.73 and 2.75% PFASs in their total mass, respectively. Significant correlations were observed between carbon chain lengths and removal rates (R-2 = 0.822, p < 10(-4)). Structural equation models revealed potential PFAS transportation pathways, such as water-phycosphere-free-living biosphere-sand-silt & -clay, and water-sand-silt & clay (p < 0.05). The presence of PFASs decreased the bacterial density but increased algal density (p < 0.01) in the planktonic environment, and PFASs with longer carbon chain lengths showed a stronger enhancement in microbial community successions (p < 0.05). In algal metabolisms, chlorophyll-a and carotenoids were the key pigments that resisted reactive oxygen species caused by PFASs. PFBA (perfluorobutyric acid) (10.38-14.68%) and PFTeDA (perfluorotetradecanoic acid) (10.33-15.96%) affected bacterial metabolisms in phycosphere the most, while in the free-living biosphere was most effected by PFPeA (perfluorovaleric acid) (13.21-13.99%) and PFDoA (perfluorododecanoic acid) (10.04-10.50%). The results of this study provide new guidance measures for PFAS removal and management in aquatic environments.	1								B	-		
D802	蓄積性	Zhang, B; He, Y; Yang, G; Chen, BY; Yao, YM; Sun, HW; Kannan, K; Zhang, T	Legacy and Emerging Poly- and Perfluoroalkyl Substances in Finless Porpoises from East China Sea: Temporal Trends and Tissue-Specific Accumulation	2022	Environ. Sci. Technol. 2022 May:56(10):6113-6122. doi: 10.1021/acs.est.1c00062.	Perfluoroalkyl sulfonates (PFSAs), perfluoroalkylcarboxylates (PFCAs), and emerging alternatives and precursors ofthese compounds were determined in tissues offinless porpoise(Neophocaena asiaeorientalis sunameri) collected from East ChinaSea in 2009-2010 and 2018-2019. The median hepaticconcentrations of emerging poly- and perfluoroalkyl substances(PFASs), including 6:2 chlorinated polyfluorinated ether sulfonate(6:2 Cl-PFESA), 8:2 chlorinated polyfluorinated ether sulfonate(8:2 Cl-PFESA), 2,3,3,3-tetrafluoro-2-propanoate (HFPO-DA),and 4,8-dioxa-3H-perfluorononanoate (ADONA) were 16.2, 2.16,< LOQ (limit of quantification) and < LOQ ng/g ww (wet weight), respectively. The concentrations of legacy substances,perfluorooctanesulfonate (PFOS), and perfluorooctanoate (PFOA), were 86.9 and 1.95 ng/g ww, respectively. The liverconcentrations of 6:2 Cl-PFESA, HFPO-DA, and perfluorohexanesulfonate (PFHxS) increased with time between 2009-2010 and2018-2019. Further, concentrations of PFOA showed a declining trend infinless porpoise, whereas PFOS and its precursor (i.e.,perfluorooctane sulfonamide [FOSA]) showed an increasing trend with time between 2009-2010 and 2018-2019. Analysis ofPFASs in nine different tissues/organs offinless porpoise (i.e., liver, heart, intestine, spleen, kidney, stomach, lung, muscle, and skin)revealed a similar distribution pattern between 6:2 Cl-PFESA and PFOS; however, the tissue distribution patterns differed betweenHFPO-DA and PFOA. The concentrations of PFAS alternatives in kidney were similar or lower than the prototype compoundsPFOS and PFOA (i.e., 8:2 Cl-PFESA < 6:2 Cl-PFESA approximate to PFOS; HFPO-DA < PFOA), implying slow renal excretion of PFASalternatives as that of legacy PFASs. The estimates of body burdens of PFASs in porpoises suggested comparable accumulation ofPFAS alternatives and legacy PFSAs and PFCAs. This study provides novel information on temporal trends and tissue distribution ofemerging PFASs in marine mammals in China			1		1				B	-		
D803	環境中運命	Xu, ZQ; Ma, XD; Wei, ZZ; Ren, GB; Wu, ZN; Man, QL; Zhou, B; Liu, HL; Yuan, DK	A novel fate and transport model for evaluating the presence and environmental risk of per-/poly-fluoroalkyl substances (PFASs) among multi-media in Lingang hybrid constructed wetland, Tianjin, China	2022	Chemosphere. 2022 Mar;291(Pt 1):132724. doi: 10.1016/j.chemosphere.2021.132724.	Accurately revealing and predicting the presence and risks of per-/poly-fluoroalkyl substances (PFASs) in constructed wetlands (CWs) is great significant for the construction and management of CWs, but very challenging. In this work, a novel fate and transport model was for the first time established to evaluate the spatially continuous distribution and environmental risks of PFASs among multi-media in Lingang hybrid CW fed by industry tailwater. 20 PFASs were detected from the Lingang CW, and the total concentration of the detected PFASs in water and sediments were in the range of 38.94-81.65 ng/L and 1.23-4.31 ng/g, respectively. PFOA, PFOS and PFBS were the main pollutants in water and sediments. A fate and transport model describing the distribution characteristics and fate of PFASs in Lingang hybrid CW was constructed, and its reliability was verified. The simulated results suggested that PFASs were mainly accumulated in sediments and long-chain PFASs were more easily adsorbed by sediments compared with short-chain PFASs. According to the principal component analysis-multiple linear regression (PCA-MLR), PFASs mainly came from the tailwater from the surrounding sewage treatment plants. Besides, the environmental risks were predicted by this novel model, suggesting that the risks still cannot be neglected due to the accumulation and continuous input of PFASs although the environmental risks of Lingang CW were low. This work provides a novel model for the under-standing of presence and risks of PFASs among multi-media in CWs.				1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D804	環境中運命	Rodriguez-Jorquera, IA; Silva-Sanchez, C; Strynar, M; Denslow, ND; Toor, GS	Footprints of Urban Micro-Pollution in Protected Areas: Investigating the Longitudinal Distribution of Perfluoroalkyl Acids in Wildlife Preserves	2016	PLoS One. 2016 Feb;11(2):e0148654. doi: 10.1371/journal.pone.0148654.	Current approaches to protect biodiversity by establishing protected areas usually gloss over water pollution as a threat. Our objective was to determine the longitudinal and seasonal distribution of perfluoroalkyl acids (PFAAs) in water column and sediments from a wastewater dominated stream that enters preservation areas. Water samples were collected along the longitudinal section (six sites, 1000 m away from each other) of the stream during the dry and wet seasons. Sediments were collected from three sites along the stream from three depths. Water and sediments were analyzed for PFAAs using high performance liquid chromatography-tandem mass spectrometry. Eleven PFAAs with 5 to 14 carbon atoms were detected in the water column at all sampling points, with a minor reduction at the last point suggesting a dilution effect. The most detected PFAAs was PFOS, followed by perfluorooctanoic acid (PFOA), and perfluorohexanoic acid (PFHxA). Seasonal differences in PFAAs concentrations suggested contribution of stormwater runoff during the wet season. All analyzed PFAAs in sediments were under the limit of quantification, likely due to the high proportion of sand and low organic matter. However, high concentrations of PFAAs were detected in the water column inside the protected areas, which includes PFOS in concentrations considered not safe for avian wildlife. Water samples appear to be more relevant than sediments to determine PFAAs micro-pollution in water bodies with sandy sediments. Inclusion of a management plans on micro-pollution research, monitoring, and mitigation is recommended for protected areas.		1						B	-		
D805	蓄積性	Wang, Q; Ruan, YF; Jin, LJ; Lu, GY; Ma, L; Yeung, LWY; Wang, WX; Lam, PKS	Oysters for legacy and emerging per- and polyfluoroalkyl substances (PFASs) monitoring in estuarine and coastal waters: Phase distribution and bioconcentration profile	2022	Sci. Total Environ. 2022 Nov:846:157453. doi: 10.1016/j.scitotenv.2022.157453.	Per- and polyfluoroalkyl substances (PFASs) are a diverse group of widely used anthropogenic chemicals that are environmentally persistent and bioaccumulative, especially in aquatic ecosystem. The heavily industrialized and urbanized Greater Bay Area in China represents a notable contamination source for PFASs, which may potentially influence the health of local oysters as a keystone species in local ecosystems and a popular seafood. In this study, samples of oysters and their surrounding waters were collected from the littoral zones of the Pearl River Estuary (PRE), China during winter 2020, where 44 PFASs, including 19 perfluoroalkyl acids (PFAAs), 8 emerging PFASs, and 17 PFAA precursors (or intermediates), were analyzed. Total PFAS concentrations ranged 13.8-58.8 ng/L in the dissolved phase, 3.60-11.2 ng/g dry weight (dw) in the suspended particulate matter (SPM), and 0.969-1.98 ng/g dw in the oysters. Most short-chain PFASs were present in the dissolved phase (>95%), while long-chain PFASs generally showed higher concentrations in the SPM. Log field-based bioconcentration factors (BCFs) of long-chain PFASs increased linearly ($r = 0.95$, $p < 0.01$) with increasing estimated log membrane-water (D-mw) and protein-water (D-pw) distribution coefficients. Perfluorohexanoic acid (PFHxA) and perfluoroheptanoic acid (PFHpA) exhibited higher measured BCFs than those estimated by their D-mw and D-pw. Considering the widespread occurrence of their precursors, the contribution of precursor transformation was likely to be a significant source of PFHxA and PFHpA. Oysters from the PRE littoral zones posed low risks to human health associated with PFAS consumption, which might be underestimated due to limited toxicity data available for PFAA precursors and emerging PFASs. This study sheds light on the practicality of applying oysters as biomonitors for timely PFAS monitoring in coastal environments.		1						B	-		
D806	環境中運命	Chen, Y; Wei, LJ; Luo, W; Jiang, N; Shi, YL; Zhao, P; Ga, B; Pei, ZG; Li, YM; Yang, RQ; Zhang, QH	Occurrence, spatial distribution, and sources of PFASs in the water and sediment from lakes in the Tibetan Plateau	2023	J. Hazard. Mater. 2023 Feb;443(Pt A):130170. doi: 10.1016/j.jhazmat.2022.130170.	Per-and polyfluoroalkyl substances (PFASs) are omnipresent globally and received increasing attention recently. However, there are limited data on PFASs in the Tibetan Plateau (TP), a remote high-altitude mountain region, which is regard as an important indicator region to study long-range transport behaviors of contaminants. This study investigates the occurrence, distribution, partitioning behavior, and sources of 26 PFASs in water and sediments from the four lakes of TP. The Sigma PFAS concentrations ranged from 338 to 9766 pg L-1 in water, and 12.2-414 pg g-1 dry weight in sediments. Perfluorobutanonic acid (PFBA) and perfluorooctane sulfonate (PFOS) were detected in all samples. Qinghai Lake had the highest Sigma PFAS concentrations in both water and sediments, while the Ranwu Lake had the lowest. The functional groups and CF2 moiety units were investigated as essential factors influencing the partition behavior. Principal component analysis (PCA) combined back-trajectory was used to infer possible sources of PFASs. The results suggested that the main source of PFASs in Yamdrok Lake, Namco Lake, and Ranwu Lake on southern TP were mainly originated from South Asia via long-range atmo-spheric transport (LRAT); while for the Qinghai Lake of northern TP, LRAT, local emissions, and tourism ac-tivities were the primary sources of PFASs.	1						B	-		
D807	環境中運命	Zushi, Y; Ye, F; Motegi, M; Nojiri, K; Hosono, S; Suzuki, T; Kosugi, Y; Yaguchi, K; Masunaga, S	Spatial distribution and loading amounts of particle sorbed and dissolved perfluorinated compounds in the basin of Tokyo Bay	2012	Chemosphere. 2012 Sep:88(11):1353-1357. doi: 10.1016/j.chemosphere.2012.05.038.	In this study, we analyzed over 30 types of PFCs, including precursors in both the dissolved phase and particle solid phase, in 50 samples of river water collected from throughout the Tokyo Bay basin. PFCs were detected in suspended solids (SSs) at levels ranging from <0.003-4.4 ng L-1 (0.11-2470 ng g(-1) dry weight). The concentrations of PFCs in the SS were one to two order(s) of magnitude lower than those of PFCs in the dissolved phase. Relatively high levels of PFCs (total of 35 PFCs) in SS were observed in urbanized areas. The concentration of PFCAs, including PFOA and PFNA, were significantly correlated with the geographic index as artificial area (R-2 of the linear regression curve in a double logarithmic plot: 0.09-0.55). Conversely, PFOS and FOSA were significantly correlated with the arterial traffic area (R-2 in a double logarithmic plot: 0.29-0.55). Those spatial trends were similar to the trends in dissolved PFCs. We estimated the loading amount of PFCs into Tokyo Bay from six main rivers and found that more than 90% of the total PFCs reached Tokyo Bay in the dissolved phase. However, 40.0-83.5% of the long chain PFCAs (C12-C15), were transported as particle sorbed PFCs. Rain runoff events might increase the loading amount of PFCs in SS. Overall, the results presented herein indicate that greater attention should be given to PFCs, especially for longer chain PFCs in SS in addition to dissolved PFCs.			1					B	-		
D808	環境中運命	Willemsen, JAR; Emunah, M; Bourg, IC	Molecular dynamics simulation of organic contaminant adsorption on organic-coated smectite clay	2022	Soil Sci. Soc. Am. J. 2022 Mar:86(2):238-252. doi: 10.1002/saj2.20364.	Molecular dynamics simulations are used to examine the adsorption and aggregation of tyrosine and glutamate molecules on a stack of smectite particles at three different organic loadings. The results reveal a strong affinity of the smectite surface for the organic molecules with the zwitterionic tyrosine molecules coating the exterior surfaces (and entering the interlayer region to a lesser extent), whereas the negatively charged glutamate molecules are generally found near the clay edge sites and in coordination with aqueous and coordinating Ca ions. Additional simulations examine the effects of the tyrosine and glutamate organic coatings on the adsorption of two organic contaminants, dimethyl phthalate (DMP) and perfluorobutanesulfonic acid (PFBS). The addition of these coatings did not prevent the DMP and PFBS molecules from accessing previously identified favorable adsorption domains. An analysis of the adsorption energetics shows an initial decrease in contaminant adsorption relative to pure mineral surfaces as tyrosine and glutamate are introduced to the system, followed by increasing adsorption with increasing organic loadings. Overall, this research advances the mechanistic understanding of the interplay between smectite surfaces, organic coatings, and organic contaminants.				1				B	-		
D809	環境中運命	Hamid, H; Li, LY; Grace, JR	Exploring indirect photolysis of 6:2 fluorotelomer sulfonate in landfill leachate under simulated sunlight: effect of humic acid and nitrate	2021	Environ. Sci. Pollut. Res. 2021 Feb:28(8):9508-9516. doi: 10.1007/s11356-020-11417-4.	Landfill leachate is exposed to sunlight through on- and off-site leachate treatment and disposal to surface water bodies. Very little is known about the potential phototransformation of fluorotelomer compounds in landfill leachates, which can undergo environmental oxidation and produce perfluorocarboxylic acids (PFCAs). This study investigated phototransformation of spiked 6:2 fluorotelomer sulfonate (FTS) (similar to 100 mu g/L) in leachate under simulated sunlight, using a metal halide lamp (wavelength, 390 to 750 nm). To understand the effects of nitrate and humic acid (HA), phosphate buffer (pH 7.1) containing nitrate and HA were spiked with 6:2 FTS and irradiated under simulated sunlight for 72 h. Following irradiation, 6:2 FTS and known transformation products (i.e., PFCAs) were quantified in the samples using LC-MS/MS. The results showed that 6:2 FTS was undergoing indirect photolysis in leachate (half-life of similar to 15 days), suggesting that indirect photolysis of 6:2 FTS is likely a relevant transformation pathway in sunlit aquatic environments. However, the spiked 6:2 FTS did not show any observable decrease in the presence of nitrate and HA over 72 h. Perfluorohexanoic acid (PFHxA) increased in irradiated leachate background samples (without 6:2 FTS spike) suggesting that phototransformation in sunlit leachate could lead to the formation of persistent PFCAs at environmental concentrations of the precursors. Future studies using probe compounds are recommended to better understand the roles of reactive species in phototransformation of 6:2 FTS.		1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D810	環境中運命	Rayner, JL; Slee, D; Falvey, S; Kookana, R; Bekele, E; Stevenson, G; Lee, A; Davis, GB	Laboratory batch representation of PFAS leaching from aged field soils: Intercomparison across new and standard approaches	2022	Sci. Total Environ. 2022 Sep;838(Pt 4):156562. doi: 10.1016/j.scitotenv.2022.156562.	Relating laboratory leaching methods to partitioning and transport of per- and poly-fluoroalkyl substances (PFAS) in field soils is challenging, making estimation of fluxes to groundwater and surface water uncertain. Existing laboratory leaching methods have limitations when assessing field leaching. For37 agedfield soils fromfive sites historically contaminated with PFAS over decades, we assess PFAS leaching using new and existing laboratory leaching methods to provide alternative methods better reflecting PFAS risks posed by its leaching and movement. Dominant PFAS in the soils were perfluorooctane sulfonic acid, perfluorohexane sulfonic acid, and perfluorohexanoic acid and to a lesser extent perfluorooctanoic acid. Leaching fromintact soil cores (Exp 1) was taken to reflect field conditions. These were compared to two new laboratory batch tests, saturate-spin (Exp 2) and saturate-tumble-spin (Exp 3), and two standard approaches; Australian Standard Leaching Procedure (ASLP, Exp 4) and the Leaching Environmental Assessment Framework (LEAF, Exp 5). The tests varied in terms of liquid:soil ratio, tumbling time and pH of the starting solution, with LEAF-1313 conducted across seven pHs (2-12). Correlations between leachate and soil concentrations were highest for Exp 4 and Exp 5 (R-2= 0.72-0.98) and lowest for Exp 3 (R-2= 0.53). The PFAS mass leached as a fraction of the total increased such that: soil core leaching (27 %) < saturate-spin (30 %) < saturate-tumble-spin (65 %) <= LEAF-1313 (65 to 88 % at pH 5-9) < ASLP (90 %). As a fraction of individual PFAS compounds in leachate compared with soil, the shorter chain PFAS (e.g., perfluorobutanoic acid) were higher in the leachate in all tests. Across all tests, the saturate-spin batch testmost closely represented intact soil core leaching and therefore potentially provides ameasure more analogous of in situ soil leaching at field sites. Other methods would apply to broader applications such as landfill disposal.	1	1						B	-		
D811	環境中運命	Wu, JY; Ding, FG; Shen, ZW; Hua, ZL; Gu, L	Linking microbiomes with per- and poly-fluoroalkyl substances (PFASs) in soil ecosystems: Microbial community assembly, stability, and trophic phylosymbiosis	2022	Chemosphere. 2022 Oct:305:135403. doi: 10.1016/j.chemosphere.2022.135403.	Microbiomes are vital in promoting nutrient cycling and plant growth in soil ecosystems. However, microbiomes face adverse effects from multiple persistent pollutants, including per- and poly-fluoroalkyl substances (PFASs). PFASs threaten the fertility and health of soil ecosystems, yet the response of microbial community stability and trophic transfer efficiencies to PFASs is still poorly understood. This study explored the spatial patterns of PFASs in topsoil environments from the West Taihu Lake Basin of China and links their presence to soil microbial community stability at compositional and functional levels. Our results revealed that PFBA (13.87%), PFTrDA (11.63%), PFDoA (11.02%), PFOA (10.99%), and PFOS (10.39%) contributed the most to the spatial occurrence of PFASs. Soil properties, including salinity (14.47%), uniformity (9.68%), dissolved inorganic carbon (8.62%), and clay content (8.18%), affected PFASs distribution the most. In soil microbiomes, eukaryotic taxa had wider niche breadths and stronger community stability than prokaryotes when exposed to PFASs ($p < 0.05$). The presence of PFBA and PFHpA inhibited the functional stability of archaeal and bacterial communities ($p < 0.05$). PFBA and PFPeA reduced the structural stability of heterotrophic bacteria and Myxobacteria, respectively ($p < 0.05$). Based on null modeling, PFPeA significantly regulated the assembly processes of most microbial subcommunities ($p < 0.01$). The trophic transferring efficiencies of autotrophic bacteria to metazoan organisms were directly stimulated by PFASs ($p < 0.05$), and the potential trophic transferring efficiencies of methanogenic	1							B	-		
D812	環境中運命	Fromel, T; Knepper, TP	Fluorotelomer ethoxylates: Sources of highly fluorinated environmental contaminants part I: Biotransformation	2010	Chemosphere. 2010 Sep:80(11):1387-1392. doi: 10.1016/j.chemosphere.2010.06.002.	Polyethoxylated 2-perfluoroalkylethanols ('fluorotelomer ethoxylates', F-(CF2-CF2-)(x)-(CH2-CH2-O)(y)-H, FTEO) are an important class of non-ionic fluorinated surfactants, which have been disregarded as potential source of per- and polyfluorinated organic pollutants despite their high production and application amounts. A commercial mixture of FTEO with a perfluoroalkyl chain length between 6 and 10 carbon atoms and an ethoxymer distribution between 0 and 13 was subjected to a biodegradation test. Monitoring of the aerobic biotransformation process by HPLC-ESI-MS/MS showed that FIE are rapidly transformed with a half-life of approximately 1 d. Structural elucidation of the biotransformation products with the help of hybrid quadrupole - linear ion trap tandem mass spectrometry revealed oxidation to the respective carboxylic acid followed by sequential shortening of ethoxylate units which led to FTEO carboxylates (FTEOC). The conversion rate of FTEOC was found to diminish with decreasing number of ethoxylate units and virtually ceased for compounds with seven intact ethoxy units. These short-chain FTEOC were not further degraded within 48 d. Nonetheless, perfluorohexanoic acid (PFHxA) and perfluorooctanoic acid (PFOA) were detected, whose formation is ascribed to degradation of residual fluorotelomer alcohols present in the commercial product. This article represents the first of two parts of a series concerning FTEO. Whilst this part is clearly focused on results of a biodegradation study of FTEO, part two will pinpoint analytical aspects, synthesis of biotransformation products and first evidence of environmental presence of the biotransformation products.		1						B	-		
D813	環境中運命	Xie, ZY; Wang, Z; Magand, O; Thollot, A; Ebinghaus, R; Mi, WY; Dommergue, A	Occurrence of legacy and emerging organic contaminants in snow at Dome C in the Antarctic	2020	Sci. Total Environ. 2020 Nov:741:140200. doi: 10.1016/j.scitotenv.2020.140200.	Concentrations of 9 organophosphate esters (OPEs), 16 perfluoroalkylated substances (PFASs) and 17 polycyclic aromatic hydrocarbons (PAHs) were investigated in surface snow samples collected at Dome C on the Antarctic Plateau in summer 2016. Tris(1-chloro-2-propyl) phosphate (TCPP), tris-(2-chloroethyl) phosphate (TCEP) and tri-n-butylphosphate (TnBP) were the dominant compounds of OPEs, with mean concentrations of 8157 +/- 4860, 1128 +/- 928 and 1232 +/- 1147 pg/L. Perfluorooctanoic acid (PFOA, mean: 358 +/- 71 pg/L) was the dominant compound of PFASs, and following by perfluoro-n-hexanoic acid (PFHxA, mean: 222 +/- 97 pg/L), perfluoro-n-heptanoic acid (PFHpA, 183 +/- 60 pg/L) and perfluoro-n-pentanoic acid (PFPeA, 175 +/- 105 pg/L). 2-(Heptafluoropropoxy)propanoic acid (HFPO-DA, mean: 9.2 +/- 2.6 pg/L) was determined in the Antarctic for the first time. Significantly positive correlations were observed between HFPO-DA and the short-chain PFASs, implying they have similar emission sources and long-range transport potential. High levels of 2-methylnaphthalene and 1-methylnaphthalene, as well as the ratios of PAH congeners indicated PAHs were attributable mostly to combustion origin. Occurrence and profiles of the indicators of OPEs, PFASs and PAHs, as well as air mass back-trajectory analysis provided direct evidences of human activities on Concordia station and posed obvious impacts on local environments in the Antarctic. Nevertheless, the exchange processes among different environmental matrices may drive the long-range transport and redistribution of the legacy and emerging Organic contaminants from coast to inland in the Antarctic.		1			1			B	-		
D814	蓄積性	Zhang, WL; Cao, HM; Liang, YN	Plant uptake and soil fractionation of five ether-PFAS in plant-soil systems	2021	Sci. Total Environ. 2021 Jun:771:144805. doi: 10.1016/j.scitotenv.2020.144805.	Considering the grave concerns caused by conventional per- and polyfluorinated substances (PFAS), production and use of fluoroalkylether compounds (ether-PFAS) have been on the rise. These ether-PFAS are deemed as PFAS replacement chemicals. To understand distribution of ether-PFAS in plant-soil systems, we investigated plant uptake of five selected ether-PFAS (i.e., PFMOPrA, PFMOBA, GenX, ADONA, Fsingle bond53B) by Carex comosa (longhair sedge) and the fractionation of these compounds in soil. Our results demonstrated that all five ether-PFAS in this study were taken up by C. comosa and translocated to plant shoots to different extents. Exposure concentration and time both positively affected plant uptake of ether-PFAS. Unlike the other four ether-PFAS, Fsingle bond53B with the longest carbon chain length and a sulfonic functional group was largely accumulated in C. comosa roots with limited translocation to plant shoots. Results from sequential extractions revealed that the five ether-PFAS had different distributions in soil with regard to extractable by water, basic methanol, acidic methanol and non-extractable. Concentration of ether-PFAS in water-soluble fraction increased with decreasing carbon chain length and logKow values and had a positive linear relationship with the mass of ether-PFAS in plant shoots ($R-2 = 0.64$) and in whole plants ($R-2 = 0.94$). Our results also indicated that the aging process could facilitate ether-PFAS to become non-extractable, hence reducing their mobility in soil and bioavailability to plants.					1			B	-		
D815	環境中運命	Liu, C; Liu, JX	Aerobic biotransformation of polyfluoroalkyl phosphate esters (PAPs) in soil	2016	Environ. Pollut. 2016 May:212:230-237. doi: 10.1016/j.envpol.2016.01.069	Microbial transformation of polyfluoroalkyl phosphate esters (PAPs) into perfluorocarboxylic acids (PFCAs) has recently been confirmed to occur in activated sludge and soil. However, there lacks quantitative information about the half-lives of the PAPs and their significance as the precursors to PFCAs. In the present study, the biotransformation of 6:2 and 8:2 diPAP in aerobic soil was investigated in semi dynamics reactors using improved sample preparation methods. To develop an efficient extraction method for PAPs, six different extraction solvents were compared, and the phenomenon of solvent enhanced hydrolysis was investigated. It was found that adding acetic acid could enhance the recoveries of the diPAPs and inhibit undesirable hydrolysis during solvent extraction of soil. However 6:2 and 8:2 monoPAPs, which are the first breakdown products from diPAPs, were found to be unstable in the six solvents tested and quickly hydrolyzed to form fluorotelomer alcohols. Therefore reliable measurement of the monoPAPs from a live soil was not achievable. The apparent DT50 values of 6:2 diPAP and 8:2 diPAP biotransformation were estimated to be 12 and > 1000 days, respectively, using a double first order in parallel model. At the end of incubation of day 112, the major degradation products of 6:2 diPAP were 5:3 fluorotelomer carboxylic acid (5:3 acid, 9.3% by mole), perfluoropentanoic acid (PFPeA, 6.4%) and perfluorohexanoic acid (PFHxA, 6.0%). The primary product of 8:2 diPAP was perfluorooctanoic acid (PFOA, 2.1%). The approximately linear relationship between the half-lives of eleven polyfluoroalkyl and perfluoroalkyl substances (PFAS5, including 6:2 and 8:2 diPAPs) that biotransform in aerobic soils and their molecular weights suggested that the molecular weight is a good indicator of the general stability of low-molecular-weight PFAS-based compounds in aerobic soils.		1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D816	蓄積性	Zhao, SY; Fang, SH; Zhu, LY; Liu, L; Liu, ZT; Zhang, YH	Mutual impacts of wheat (Triticum aestivum L.) and earthworms (Eisenia fetida) on the bioavailability of perfluoroalkyl substances (PFASs) in soil	2014	Environ. Pollut. 2014 Jan:184:495-501. doi: 10.1016/j.envpol.2013.09.032	Wheat and earthworms were exposed individually and together to soils contaminated with 11 perfluoroalkyl substances (PFASs). Wheat accumulated PFASs from soil with root concentration factors and bioconcentration factors that decreased as the number of perfluorinated carbons in the molecule increased. Earthworms accumulated PFASs from soil with biota-to-soil accumulation factors that increased with the number of carbons. Translocation factors (IF) of perfluorinated carboxylates (PFCAs) in wheat peaked at perfluorohexanoic acid and decreased significantly as the number of carbons increased or decreased. Perfluorohexane sulfonate produced the greatest TF of the three perfluorinated sulfonates (PFSAs) examined. Wheat increased the bioaccumulation of all 11 PFASs in earthworms and earthworms increased the bioaccumulation in wheat of PFCAs containing seven or less perfluorinated carbons, decreased bioaccumulation of PFCAs with more than seven carbons, and decreased bioaccumulation of PFSAs. In general, the co-presence of wheat and earthworms enhanced the bioavailability of PFASs in soil.		1						B	-		
D817	蓄積性	Wu, JY; Liu, WX; He, W; Xu, FL	Comparisons of tissue distributions and health risks of perfluoroalkyl acids (PFAAs) in two fish species with different trophic levels from Lake Chaohu, China	2019	Ecotox. Environ. Safe. 2019 Dec:185:109666. doi: 10.1016/j.ecoenv.2019.109666.	Perfluoroalkyl acids (PFAAs) are a type of persistent organic pollutants that are widely distributed in multiple environmental media and organisms and have a teratogenic effect on and toxicity to animals and humans. The residual levels of seventeen PFAAs in the tissues of two regular consumption fish species, Culter erythropterus and Aristichthys nobilis in Lake Chaohu were measured by a high-performance liquid chromatograph - mass spectrometer (HPLC-MS). The distributions of PFAAs and the effect of the lipid contents were analyzed, and the health risks of typical PFAAs were evaluated. The results showed that perfluorohexanoic acid (PFHxA) was the predominant contaminant (80.50 +/- 58.31 ng/g and 19.17 +/- 12.57 ng/g wet weight, ww), followed by perfluorooctanesulfonic acid (PFOS) (55.02 +/- 34.82 and 14.79 +/- 6.24 ng/g, ww) in both fish. The level of total PFAAs was the highest in the liver tissues of Culter erythropterus (359.87 ng/g, ww) and the lowest in the kidney tissues in A. nobilis (10.06 ng/g, ww). Due to the higher trophic level of C. erythropteru, the total PFAA concentrations were significantly higher in all tissues than those in A. nobilis. Liver muscle ratio of C. erythropteru was the highest, indicating the most accumulation in the liver. The concentrations of PFAAs in fish tissues were influenced by the lipid content, resulting in a difference between the lipid-normalized concentrations and the wet weight concentrations of the PFAAs. The non-carcinogenic risks of PFOS were higher than those of PFOA through the ingestion of C. erythropterus and A. nobilis. Both the carcinogenic and non-carcinogenic risks of C. erythropterus were greater than those of A. nobilis, and fish tissue intake could cause an increasing of risks up to 60%, indicating that long-term and large amount ingestion of carnivorous fish and related tissues with higher trophic level, such as C. erythropterus should be avoided.		1						B	-		
D818	環境中運命	Lenka, SP; Kah, M; Padhye, LP	Occurrence and fate of poly- and perfluoroalkyl substances (PFAS) in urban waters of New Zealand	2022	J. Hazard. Mater. 2022 Apr:428:128257. doi: 10.1016/j.jhazmat.2022.128257.	Information on the occurrence of PFAS in aquatic matrices of countries with no PFAS manufacturing, e.g., New Zealand, is limited. Also, the fingerprint of PFAS along an urban water cycle, following water path from wastewater treatment plant (WWTP) effluent to treated drinking water has not been widely assessed. Hence, 38 long-, short-, ultrashort-chain PFAS and fluorinated alternatives (including precursors) were monitored in this study by collecting composite samples from two urban WWTPs of New Zealand and grab samples from the water bodies receiving the WWTPs' effluents and a drinking water treatment plant, whose source water received the effluent of one of the studied WWTPs. n-ary sumation PFAS at concentrations 0.1 - 13 ng/L were detected in all wastewater samples, including influents and different treatment stages of the two WWTPs (WW1 and WW2). The fate of most PFAS was similar in the two WWTPs, despite large differences in WWTPs' PFAS loads in the influents, serving populations (1.6 vs 0.16 million), total capacities (300 vs 54 million liters per day), and designs (aerobic and anoxic secondary treatment vs aerobic only). The fate of PFAS in WWTPs appeared to be driven by a range of processes. For instance, a simultaneous increase (41.6%) in short-chain perfluorohexanoic acid (PFHxA) concentrations and decrease (49.7%) in precursor 6:2 fluorotelomer sulfonate (6:2 FTS) concentrations after secondary biological treatment suggested possible transformation of 6:2 FTS into PFHxA during the treatment. In contrast, the reason behind an average decrease of 35% in ultrashort-chain perfluoropropionic acid (PFPrA) concentrations after treatment was unclear, and further studies are recommended. The concentrations of a linear isomer of long-chain perfluorosulfonic acid (PFOS-L) decreased (48%) in the effluent, possibly due to its partitioning to sludge. Although the concentrations of PFAS in coastal waters suggested that the WW1 effluent is a potential source of PFAS, earlier dispersion model and no detection of PFAS in the receiving waters of WW2 implied that other sources, such as septic systems, peripheral industries, and the airport, could also be contributing to PFAS in coastal waters. The source of ultrashort-chain PFPrA (5.5 ng/L) detected in the treated drinking water produced from that river was unclear. The monitoring results confirm incomplete removal of PFAS in WWTPs, indicate a possible transformation of unknown precursors present in wastewater into short chain perfluoroalkylcarboxylic acids (PFCAs) during biological treatment, and reveal a possible accumulation of perfluoroalkylsulfonic acids (PFSAs) in the sludge, overall suggesting the circulation of PFAS in urban water systems.		1						B	-		
D819	環境中運命	Just, H; Goeckener, B; Laemmer, R; Wiedemann-Krantz, L; Stahl, T; Breurer, J; Gassmann, M; Weidemann, E; Bucking, M; Kowalczyk, J	Degradation and Plant Transfer Rates of Seven Fluorotelomer Precursors to Perfluoroalkyl Acids and F-53B in a Soil-Plant System with Maize (Zea mays L.)	2022	J. Agric. Food Chem. 2022 Jul:70(29):8920-8930. doi: 10.1021/acs.jafc.1c06838.	Fluorotelomer precursors in soil constitute a reservoir for perfluoroalkyl acids (PFAAs) in the environment. In the present study, precursor degradation and transfer rates of seven fluorotelomer precursors and F-53B (chlorinated polyfluoroallryl ether sulfonates) were investigated in pot experiments with maize plants (Zea mays L.). The degradation of fluorotelomer precursors to perfluoroalkyl carboxylic acids (PFCAs) and their uptake spectra corresponded to those of fluorotelomer alcohol (FTOH) in terms of the number of perfluorinated carbon atoms. Short-chain PFCAs were translocated into the shoots (in descending order perfluoropentanoic, perfluorobutanoic, and perfluorohexanoic acid), whereas long-chain PFCAs mainly remained in the soil. In particular, fluorotelomer phosphate diesters (diPAPs) were retained in the soil and showed the highest degradation potential including evidence of alpha-oxidative processes. F-53B did not degrade to PFAAs and its constituents were mainly detected in the roots with minor uptake into the shoots. The results demonstrate the important role of precursors as an entry pathway for PFCAs into the food chain.		1						B	-		
D820	環境中運命	Dal Ferro, N; Pellizzaro, A; Fant, M; Zerlottin, M; Borin, M	Uptake and translocation of perfluoroalkyl acids by hydroponically grown lettuce and spinach exposed to spiked solution and treated wastewaters	2021	Sci. Total Environ. 2021 Jun:772:145523. doi: 10.1016/j.scitotenv.2021.145523.	Perfluoroalkylated adds (PFAAs) are ubiquitous xenobiotic substances characterized by high persistence, bioaccumulation potential and toxicity, which have attracted global attention due to their widespread presence in both water and biota. In this study, the main objective was to assess PFAAs uptake and accumulation in lettuce (Lactuca sativa L) and spinach (Spinacia oferacea L.) when fed with reclaimed wastewaters that are usually discharged onto a surface water body. Lettuce and spinach were grown in hydroponic solutions, exposed to two different municipal wastewater treatment plant (WWTP) effluents and compared with a spiked-PFAAs aqueous solution (nominal concentration of 500 ng L-1 for each perfluoroalkyl acid). Eleven perfluoroalkyl carboxylic adds and three perfluoroalkyl sulfonic adds were determined in the hydroponic solution, as well as quantified at the end of the growing cycle in crop roots and shoots. Water and dry plant biomass extracts were analyzed by liquid chromatography-electrospray ionization tandem spectrometry LC-MS/MS technique. The bioconcentration factor of roots (RCF), shoots (LCF), and the root-shoot translocation factor (IF) were quantified. In general, results showed that PFAAs in crop tissues increased at increasing PFAAs water values. Moreover some PFAAs concentrations (espedaily PFBA, PF135, PFHxA, PFHpA. PFHxS) were different in both shoots and roots of lettuce and spinach, regardless of the type of water. The long C-chain PFAAs (>= 9) were always below the detection threshold in WWTPs effluents. However, when PFAAs were detected, similar bioconcentration parameters were found between crops regardless the type of water. A sigmoidal RCF pattern was found as the perfluorinated chain length increased, plus a linear IF decrease. Comparing bioconcentration factor results with findings of previous studies, lettuce RCF value of PFCAs with perfluorinated chain length <= 9 and PFSAS was up to 10 times greater.	1	1						B	-		
D821	環境中運命	Cook, EK; Olivares, CI; Antell, EH; Yi, S; Nickerson, A; Choi, YJ; Higgins, CP; Sedlak, DL; Alvarez-Cohen, L	Biological and Chemical Transformation of the Six-Carbon Polyfluoroalkyl Substance N-Dimethyl Ammonio Propyl Perfluorohexane Sulfonamide (AmPr-FHxSA)	2022	Environ. Sci. Technol. 2022 Nov:56(22):15478-15488. doi: 10.1021/acs.est.2c00261.	Sites impacted by aqueous film-forming foam (AFFF) contain co-contaminants that can stimulate biotransformation of polyfluoroalkyl substances. Here, we compare how microbial enrichments from AFFF-impacted soil amended with diethyl glycol monobutyl ether (found in AFFF), aromatic hydrocarbons (present in co-released fuels), acetate, and methane (substrates used or formed during bioremediation) impact the aerobic biotransformation of an AFFF-derived six-carbon electrochemical fluorination (ECF) precursor N-dimethyl ammonio propyl perfluorohexane sulfonamide (AmPr-FHxSA). We found that methane-and acetate-oxidizing cultures resulted in the highest yields of identifiable products (38 and 30%, respectively), including perfluorohexane sulfonamide (FHxSA) and perfluorohexane sulfonic acid (PFHxS). Using these data, we propose and detail a transformation pathway. Additionally, we examined chemical oxidation products of AmPr-FHxSA and FHxSA to provide insights on remediation strategies for AmPr-FHxSA. We demonstrate mineralization of these compounds using the sulfate radical and test their transformation during the total oxidizable precursor (TOP) assay. While perfluorohexanoic acid accounted for over 95% of the products formed, we demonstrate here for the first time two ECF-based precursors, AmPr-FHxSA and FHxSA, that produce PFHxS during the TOP assay. These findings have implications for monitoring poly-and perfluoroalkyl substances during site remediation and application of the TOP assay at sites impacted by ECF-based precursors.		1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D822	蓄積性	Shu, YL; Wang, Q; Hong, P; Ruan, YF; Lin, HJ; Xu, J; Zhang, HJ; Deng, ST; Wu, HL; Chen, LG; Leung, KMY	Legacy and Emerging Per- and Polyfluoroalkyl Substances Surveillance in Bufo gargarizans from Inlet Watersheds of Chaohu Lake, China: Tissue Distribution and Bioaccumulation Potential	2023	Environ Sci Technol. 2023 Sep 5;57(35):13148-13160. doi: 10.1021/acs.est.3c02660.	Amphibiansare sensitive biomonitors of environmental pollutantsbut reports regarding per- and polyfluoroalkyl substances (PFAS),a class of synthetic organofluorine substances, are limited. In thisstudy, samples of water and Chinese toads (Bufo gargarizo) were collected in Chaohu Lake, China. Tissue-specific bioaccumulationcharacteristics of 39 PFAS, including 19 perfluoroalkyl acids (PFAAs),8 emerging PFAS, and 12 PFAA precursors, were investigated, and thelevels of some biochemical indicators were determined. The highestPFAS concentrations were found in the liver [215.97 ng/g dry weight(dw)] of Chinese toads, followed by gonads (135.42 ng/g dw) and intestine(114.08 ng/g dw). A similar tissue distribution profile was foundbetween legacy and emerging PFAS in the toads, and the occurrenceof two emerging PFAS, 2,3,3,3-tetrafluoro-2-propanoate (HFPO-DA) and6:2 hydrogen-substituted polyfluorooctane ether sulfonate (6:2 H-PFESA)in the amphibians were for the first time reported. Field-based bioaccumulationfactors of HFPO-DA were higher than perfluorooctanoic acid, indicatingthe higher bioaccumulation potential of this emerging PFAS than thelegacy C8 compound. Males had significantly higher gonad PFAS levelsthan females while estradiol levels in gonads increased with increasingconcentrations of certain PFAS (e.g., 6:2 H-PFESA), implying thatPFAS may trigger estrogenic effects in the toads, especially for maletoads. This is the first report onthe tissue-specific bioaccumulationcharacteristic of PFAS precursor (e.g., 6:2 FTS, FPrPA, and N-EtFOSAA)and certain emerging PFAS (e.g., HFPO-DA, PFECHS, and 6:2 H-PFESA)in amphibians. The accumulation of certain emerging PFAS in gonadaltissue may pose the risk of affecting sex hormone levels in amphibians.					1			B	-		
D823	環境中運命	Lin, K; Han, TZ; Wang, R; Tan, LJ; Yang, X; Zhao, T; Chen, YS; Wan, MM	Spatiotemporal distribution, ecological risk assessment and source analysis of legacy and emerging Per- and Polyfluoroalkyl Substances in the Bohai Bay, China	2022	Chemosphere. 2022 Aug:300:134378. doi: 10.1016/j.chemosphere.2022.134378.	The Bohai Sea is one of the most polluted hotspots by per- and Polyfluoroalkyl substances (PFASs) in the world and studies on the vertical distribution of PFASs at different water layers and phase partitioning between water and suspended particulate matter (SPM) were still limited. 23 legacy and emerging PFASs were investigated in seawater and SPM throughout the Bay in this study. The average concentrations of ΣPFASs in seawater were 48.21 ng/L and 52.71 ng/L during the periods of wet and normal water, respectively. In general, the concentrations of ΣPFASs in surface water were higher than that in deep water. Legacy PFASs in seawater were dominated by PFOA and short-chain PFASs, while the emerging alternative HFPO-DA was detected in the whole water layer of the Bohai Bay with an average concentration of 1.09 ng/L. The spatial distribution showed that ΣPFASs were higher nearshore than inside the bay and higher in the south than that in the north of the bay. The average concentration of ΣPFASs in SPM was 9.02 ng/g. Long-chain PFASs and the emerging alternative 6:2 Cl-PFESA accounted for the major contaminants. The partition coefficients log Kd and ϕspm-w showed a linear positive correlation with carbon chain length. Preliminary risk assessments revealed that the ecological risk of common PFASs in the Bohai Bay was low, while PFOA was at moderate risk. The principal component analysis demonstrated that the production process of traditional fluorochemical factories, fire-fighting and emerging electroplating industries were the main sources of PFASs. This was the first comprehensive survey of emerging PFASs in different water depths and in SPM of the Bohai Bay during different seasons, which provided important scientific data for studying the ecological risks and pollution prevention of PFASs.					1			B	-		
D824	環境中運命	Wang, N; Buck, RC; Szostek, B; Sulecki, LM; Wolstenholme, BW	5:3 Polyfluorinated acid aerobic biotransformation in activated sludge via novel one-carbon removal pathways	2012	Chemosphere. 2012 Apr:87(5):527-534. doi: 10.1016/j.chemosphere.2011.12.056.	The polyfluorinated carboxylic acids 5:3 acid (C5F11CH2CH2CO2H) and 7:3 acid (C2F15CH2CH2CO2H) are major products from 6:2 FTOH (C6F13CH2CH2OH) and 8:2 FTOH (C8F12CH2CH2OH) aerobic biotransformation, respectively. The 5:3 and 7:3 acids were dosed into domestic WWTP activated sludge for 90d to determine their biodegradability. The 7:3 acid aerobic biodegradability was low, only 1.7 mol% conversion to perfluoroheptanoic acid (PFHpA), whereas no transformation was observed previously in soil. In stark contrast, 5:3 acid aerobic biodegradability was enhanced 10 times in activated sludge compared to soil. The 5:3 acid was not activated by acyl CoEnzyme A (CoA) synthetase, a key step required for further alpha- or beta-oxidation. Instead, 5:3 acid was directly converted to 4:3 acid (C4F9CH2CH2CO2H, 14.2 mol%) and 3:3 acid (C3F7CH2CH2CO2H, 0.9 mol%) via one-carbon removal pathways. The 5:3 acid biotransformation also yielded perfluoropentanoic acid (PFPeA, 5.9 mol%) and perfluorobutanoic acid (PFBA, 0.8 mol%). This is the first report to identify key biotransformation intermediates which demonstrate novel one-carbon removal pathways with sequential removal of -CF2- groups. Identified biotransformation intermediates (10.2 mol% in sum) were 5:3 Uacid, alpha-OH 5:3 acid, 5:2 acid, and 5:2 Uacid. The 5:2 Uacid and 5:2 acid are novel intermediates identified for the first time which confirm the proposed pathways. In the biodegradation pathways, the genesis of the one carbon removal is CO2 elimination from alpha-OH 5:3 acid. These results suggest that there are enzymatic mechanisms available in the environment that can lead to 6:2 FTOH and 5:3 acid mineralization. The dehydrogenation from 5:3 acid to 5:3 Uacid was the rate-limiting enzymatic step for 5:3 acid conversion to 4:3 acid.	1							B	-		
D825	環境中運命	Li, XQ; Hua, ZL; Zhang, JY; Gu, L	Interactions between dissolved organic matter and perfluoroalkyl acids in natural rivers and lakes: A case study of the northwest of Taihu Lake Basin, China	2022	Water Res. 2022 Jun:216:118324. doi: 10.1016/j.watres.2022.118324.	Understanding the interactions between dissolved organic matter (DOM) and perfluoroalkyl acids (PFAAs) is essential for predicting the distribution, transport, and fate of PFAAs in aquatic environments. Based on field investigations in the northwest of Taihu Lake Basin combined with laboratory experiments, we obtained DOM and PFAA concentrations as well as compositions and investigated key factors of DOM affecting PFAA variability and capture of PFAAs by DOM. Results indicated that the total concentrations of PFAAs were 73.4-689 ng/L in surface water and that PFAAs were dominated by C3-7 perfluoroalkyl carboxylic acids and perfluorooctane sulfonic acid. The main components of DOM included tyrosine-, fulvic-, and tryptophan-like substances. The Mantel test revealed a significant positive correlation between DOM and PFAAs ($P = 0.0001$). Fulvic-like substances were identified as the most crucial factors affecting PFAA variability. The laboratory experiments revealed that DOM can spontaneously aggregate into a microgel. Furthermore, 19.1-50.9% of PFAAs, DOM characteristic peaks, and several metals (Ca, Mg, Cu, and Fe) can be removed during aggregation, indicating the capacity of DOM binding organic/inorganic substances. The fulvic-like substances were more effectively removed than the protein-like substances. The distribution coefficients of all PFAAs except perfluorohexanoic acid significantly correlated with their perfluorinated carbon numbers ($r = 0.975$, $p<0.001$). Our results provided insights into the interactions between DOM and PFAAs, improving the understanding of the distribution, transport, and fate of PFAAs in aquatic environments.		1						B	-		
D826	環境中運命	Ke, YC; Tong, TL; Chen, JF; Huang, J; Xie, SG	Influences of hexafluoropropylene oxide (HFPO) homologues on soil microbial communities	2020	Chemosphere. 2020 Nov:259:127504. doi: 10.1016/j.chemosphere.2020.127504.	Hexafluoropropylene oxide (HFPO) homologues, as emerging perfluoroalkyl substances (PFASs) to replace legacy PFASs, have wide applications in the organofluorine industry and have been detected in the global environment. However, it is still unclear what effect HFPO homologues will exert on microbial abundance, community structure and function. The objective of this study was to assess potential impacts of HFPO homologue acids on archaea, bacteria, and ammonia-oxidizing archaea (AOA) and bacteria (AOB) in the soil environment. Grassland soil microcosms were supplemented with low (0.1 mg/kg) or high (10 mg/kg) dosages of dimer, trimer and tetramer acids of HFPO (HFPO-DA, HFPO-TA, and HFPO-TeA), respectively. The amendment of HFPO homologues acids initially decreased the abundance of archaea and bacteria but increased them in the later period. The addition of HFPO homologues acids raised AOA abundance but restrained AOB growth during the whole incubation. AOA and AOB community structures showed considerable variations. Potential nitrifying rate (PNR) showed an increase in the initial period followed by a decline in the later period. HFPO-DA had a lasting and suppressive effect on AOB and PNR even at a nearly environmental level. Overall, HFPO homologues with different carbon chain lengths had different impacts on soil microbial community and ammonia oxidation.					1			B	-		
D827	環境中運命	Bere, K; Xiong, X; Saringer, S; Douglas, G; Szilagyi, I	Microplastics as an adsorption and transport medium for per- and polyfluoroalkyl substances in aquatic systems: Polystyrene and undecafluorohexanoic acid interactions	2023	J. Mol. Liq. 2023 Aug:384:122285. doi: 10.1016/j.molliq.2023.122285.	The assessment of possible interactions between microplastic particles (MPP) and other emerging contaminants such as per-and polyfluoroalkyl substances (PFAS) of great importance due to their potentially conjunctive harmful effects on the environment. Here, the colloidal behaviour of a polystyrene MPP in the presence undecafluorohexanoic acid (UFHA), an alternative to the widely used C8 PFAS, was studied in aqueous dispersions. Adsorption of UFHA on MPP was confirmed, where it induced charge neutralization with overcharging at higher UFHA concentrations. Rates of MPP aggregation were rapid with neutral particles, while slow low and high UFHA doses, where considerable, alternate surface charge persisted and hence, fine particle dispersion was maintained. The addition of multivalent ions influenced the surface charge and aggregation features of MPP, in both their native form and in the presence of UFHA. Concurrent adsorption of electrolytes and UFHA was observed and strongly affected the rate of MPP aggregation under some experimental conditions. This study provides new insights into the possible interactions of PFAS with MPP, which may fundamentally influence the migration of these contaminants in aqueous environments. Aggregated particles will more likely accumulate in the sediments or at the air-water interface, while individual, highly stable MPP-PFAS composites have the potential to migrate together in water column.		1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D828	蓄積性	Rupp, J; Guckert, M; Berger, U; Drost, W; Mader, A; Nodler, K; Nurenberg, G; Schulze, J; Sohlmann, R; Reemtsma, T	Comprehensive target analysis and TOP assay of per- and polyfluoroalkyl substances (PFAS) in wild boar livers indicate contamination hot-spots in the environment	2023	Sci. Total Environ. 2023 May:871:162028. doi: 10.1016/j.scitotenv.2023.162028.	The suitability of wild boar liver as a bioindicator of per-and polyfluoroalkyl substances (PFAS) in the terrestrial en-vironment was investigated. Samples from 50 animals in three different areas associated with (1) contaminated paper sludges distributed on arable land (PS), (2) industrial emissions of PFAS (IE) and (3) background contamination (BC) were analyzed for 66 PFAS, including legacy PFAS, novel substitutes and precursors of perfluoroalkyl acids (PFAAs). Additionally, the Total Oxidizable Precursor (TOP) assay was performed to determine the formation potential of PFAAs from precursors. In total, 31 PFAS were detected with site-specific contamination profiles. PFAS concentrations in livers from area PS and IE (567 and 944 mu g kg-1 wet weight, respectively) were multiple times higher than from area BC (120 mu g kg-1). The dominating PFAS were the legacy compounds perfluorooctane sulfonic acid (PFOS) in areas PS and BC (426 and 82 mu g kg-1, respectively) and perfluorooctanoic acid (PFOA) in area IE (650 mu g kg-1). In area IE, the compounds 4,8-dioxa-3H-perfluorononanoic acid (DONA) and hexafluoropropylene oxide dimer acid (HFPO-DA) - which are used as substitutes for PFOA - were determined at 15 and 0.29 mu g kg-1, respectively. The for-mation potential of PFAAs was highest in area PS, but generally lower than the contamination with PFAAs. The pattern of perfluoroalkyl carboxylic acids (PFCAs) in wild boar liver reflects the contamination of the local soil at the two hot-spot areas IE and PS. This first comparison of PFAS contamination between wild boars and soil suggests that wild boar livers are suitable bioindicators for PFAS contamination in the terrestrial environment. Moreover, in terrestrial sam-ples from area IE, legacy PFAS were found to be retained for a longer period as compared to riverine samples (suspended particulate matter and chub filet).			1		1			B	-		
D829	蓄積性	Raine, JC; Su, S; Lin, E; Yang, ZL; Giesy, JP; Jones, PD	Prefertilization Exposure of Rainbow Trout Eggs to Per- and Polyfluoroalkyl Substances to Simulate Accumulation During Oogenesis	2021	Environ. Toxicol. Chem. 2021 Nov:40(11):3159-3165. doi: 10.1002/etc.5200.	Aqueous film-forming foams (AFFFs) are used in firefighting and are sources of per- and polyfluoroalkyl substances (PFAS) to the environment through surface runoff and groundwater contamination at defense and transportation sites. Little is known regarding the toxicity and bioaccumulation of newer AFFF formulations containing novel PFAS. To mimic maternal transfer of PFAS, prefertilization rainbow trout eggs were exposed to three PFAS using novel methodologies. Batches of unfertilized oocytes were exposed for 3 h to 0, 0.01, 0.1, 1, or 10 mu g/ml separately to perfluorooctanoic acid, perfluorohexanoic acid, or perfluorooctanesulfonic acid in either coelomic fluid or Cortland's solution. After exposure, the gametes were fertilized and rinsed with dechlorinated water. Egg yolk was aspirated from a subset of fertilized eggs for PFAS quantification. Each PFAS was detected in yolks of eggs exposed to the respective PFAS, and yolk concentrations were directly proportional to concentrations in aqueous media to which they were exposed. Exposure in coelomic fluid or Cortland's solution resulted in similar concentrations of PFAS in egg yolks. Ratios of PFAS concentrations in oocytes to concentrations in exposure media (oocyte fluid ratios) were <0.99 when exposed from 0.01 to 10 mu g/ml and <0.45 when exposed from 0.1 to 10 mu g/ml for both media and all three PFAS, demonstrating that the water solubility of the chemicals was relatively great. Prefertilization exposure of eggs effectively introduced PFAS into unfertilized egg yolk. This method provided a means of mimicking maternal transfer to evaluate toxicity to developing embryos from an early stage. This method is more rapid and efficient than injection of individual fertilized eggs and avoids trauma from inserting needles into eggs.		1						B	-		
D830	蓄積性	Guillette, TC; McCord, J; Guillette, M; Polera, ME; Rachels, KT; Morgeson, C; Kotlarz, N; Knappe, DRU; Reading, BJ; Strynar, M; Belcher, SM	Elevated levels of per- and polyfluoroalkyl substances in Cape Fear River Striped Bass (Morone saxatilis) are associated with biomarkers of altered immune and liver function	2020	Environ. Int. 2020 Mar:136:105358. doi: 10.1016/j.envint.2019.105358.	Per- and polyfluoroalkyl substances (PFAS) are anthropogenic chemicals of concern that persist in the environment. Environmental monitoring revealed high concentrations of hexafluoropropylene oxide dimer acid (HFPO-DA) and other novel PFAS in the lower Cape Fear River; however, there is limited information on PFAS exposures and effects of this contamination on aquatic biota. Serum concentrations of 23 PFAS in Striped Bass (Morone saxatilis) from the Cape Fear River (n = 58) and a reference population from an aquaculture laboratory on the Pamlico/Tar watershed (n = 29) were quantified using liquid chromatography and high-resolution mass spectrometry, and correlations between PFAS concentrations and health-related serum biomarkers were evaluated. Perfluorooctane sulfonate, the predominant PFAS in Cape Fear River Striped Bass serum, was detectable in every sample with serum concentrations reaching 977 ng/mL. Perfluorononanoic and perfluorodecanoic acid were also detected in all samples, with perfluorohexanesulfonic acid present in > 98% of the samples. HFPO-DA (range < 0.24-5.85 ng/mL) and Nafion byproduct 2 (range < 0.2-1.03 ng/mL) were detected in 48% and 78% of samples, respectively. The mean total PFAS concentration found in domestic Striped Bass raised in well-water under controlled aquaculture conditions was 40 times lower, with HPFO-DA detected in 10% of the samples, and Nafion byproduct 2 was not detected. The elevated PFAS concentrations found in the Cape Fear River Striped Bass were associated with biomarkers of alterations in the liver and immune system.					1			B	-		
D831	環境中運命	Gonzalez-Gaya, B; Casal, P; Jurado, E; Dachs, J; Jimenez, B	Vertical transport and sinks of perfluoroalkyl substances in the global open ocean	2019	Environ. Sci.-Process Impacts 2019 Nov:21(11):1957-1969. doi: 10.1039/c9em00266a.	The ubiquitous occurrence of perfluoroalkyl substances (PFAS) in the open ocean has been previously documented, but their vertical transport and oceanic sinks have not been comprehensively characterized and quantified at the oceanic scale. During the Malaspina 2010 circumnavigation expedition, 21 PFAS were measured at the surface and at the deep chlorophyll maximum (DCM) in the Atlantic, Indian and Pacific oceans. In this work, we report an extended data set of PFAS dissolved phase concentrations at the DCM. n-ary sumation PFAS at the DCM varied from 130 to 11 000 pg L-1, with a global average value of 500 pg L-1. Perfluorooctanesulfonate (PFOS) abundance contributed 39% of n-ary sumation PFAS, followed by perfluorodecanoate (PFDA, 17%), and perfluorohexanoate (PFHxA, 12%). The relative contribution of the remaining compounds was below 10%, with perfluorooctanoate (PFOA) contributing only 5% to PFAS measured at the DCM. Estimates of vertical diffusivity, derived from microstructure turbulence observations in the upper (<300 m) water column, allowed the derivation of PFAS eddy diffusive fluxes from concurrent field measurements of eddy diffusivity and PFAS concentrations. The PFAS concentrations at the DCM predicted from an eddy diffusivity model were lower than field-measured concentrations, suggesting a relevant role of other vertical transport mechanisms. Settling fluxes of organic matter bound PFAS (biological pump), oceanic circulation and potential, yet un-reported, biological transformations are discussed.		1						B	-		
D832	環境中運命	Thackray, CPP; Selin, NEE; Young, CJJ	A global atmospheric chemistry model for the fate and transport of PFCAs and their precursors	2020	Environ. Sci.-Process Impacts 2020 Feb:22(2):285-293. doi: 10.1039/c9em00326f.	Perfluorocarboxylic acids (PFCAs) are environmental contaminants that are highly persistent, and many are bio-accumulative and have been detected along with their atmospheric precursors far from emission sources. The overall importance of precursor emissions as an indirect source of PFCAs to the environment is uncertain. Previous studies have estimated the atmospheric source of PFCAs using models and degradation pathways of differing complexities, leading to quantitatively different results. We present results from simulations of atmospheric PFCA formation and fate using the chemical transport model GEOS-Chem. We simulate the most up-to-date chemistry available to our knowledge for the degradation of the precursors fluorotelomer alcohol (FTOH), fluorotelomer olefin (FTO), and fluorotelomer iodide (FTI), as well as the deposition and transport of the precursors, intermediates and end-products of the formation chemistry. We calculate yields of C3-C13 PFCAs formed from 4 : 2 to 12 : 2 fluorotelomer precursors and their deposition to the surface. We find that the ratio of long-chain to short-chain PFCAs increases strongly with distance from source regions. We compare our model results to remote deposition measurements and mid-latitude rainwater measurements. The model captures the observed relationship between rainwater abundance and PFCA chain length, as well as the average deposition rates at mid-latitude and Arctic sites, but underestimates the deposition of PFDoA, PFDA, and TFA at mid-latitudes and PFNA at the Devon Ice Cap. We provide estimates of cumulative PFCA deposition globally. We find that given the most recent emission inventory, the atmospheric source of PFCAs is 6-185 tonnes per year globally and 0.1-2.1 tonnes per year to the Arctic.			1					B	-		
D833	環境中運命	Liu, ZZ; Zhou, JQ; Xu, YL; Lu, JF; Chen, JY; Wang, J	Distributions and sources of traditional and emerging per- and polyfluoroalkyl substances among multiple environmental media in the Qiantang River watershed, China	2022	RSC Adv. 2022 Jul:12(33):21247-21254. doi: 10.1039/d2ra02385g.	The presence of per- and polyfluoroalkyl substances (PFASs) in the food chain poses a threat to human health. Water and the atmosphere are the major transport pathways for PFASs in the environment, while water, soil and sediment are sinks. Herein, the concentrations and distributions of traditional and emerging PFASs in multi-environmental media samples in the Qiantang River watershed were comprehensively investigated. Twenty-five PFASs, including seven emerging PFASs, were identified. The concentrations in water, soil, sediment and PM2.5 ranged from 3.58 to 786 ng L-1, 0.72 to 12.3 ng g(-1), 0.73 to 6.60 ng g(-1), and 93.9 to 255 pg m(-3), respectively, with mean concentrations of 149 ng L-1, 4.70 ng g(-1), 4.31 ng g(-1), and 156 pg m(-3). Perfluorooctanoic acid (PFOA) was the dominant contaminant in water, soil, and sediment, and perfluoropentanoic acid (PFPeA) was the dominant contaminant in PM2.5. Hexafluoropropylene oxide-dimer acid (HFPO-DA) and 6 : 2 chlorinated polyfluorinated ether sulfonate (6 : 2 Cl-PFESA), as substitutes for PFOA and perfluorooctane sulfonate (PFOS), were detected, indicating the gradual replacement of traditional PFOA and PFOS in this area. Perfluoro-3,6-dioxaheptanoic acid (NFDHA), as a component of the aqueous film-forming foam FN-3, was first detected in this area. Short-chain PFASs were mainly distributed in water and PM2.5, while long-chain PFASs were distributed in the solid phase, such as soil, sediment, and PM2.5. Based on principal component analysis (PCA), the major PFAS sources were emulsifiers from fluorine polymerization and surface-active agents from the textile, papermaking, leather, and other industries. In addition, correlation analysis showed that water was the main source and transport pathway of short-chain perfluoroalkyl carboxylic acid (PFCA), HFPO-DA, and NFDHA in this area, while the atmosphere combined with PM2.5 was the main transport pathway for both short- and long-chain PFCAs, PFOS, and 6 : 2 Cl-PFESA.					1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D834	環境中運命	Brendel, S; Fetter, E; Staude, C; Vierke, L; Biegel-Engler, A	Short-chain perfluoroalkyl acids: environmental concerns and a regulatory strategy under REACH	2018	Environ. Sci Eur. 2018 Feb:30:9. doi: 10.1186/s12302-018-0134-4.	Background: Short-chain PFASs (per-and polyfluoroalkyl substances) are widely used as alternatives to long-chain PFASs. Long-chain PFASs become gradually regulated under REACH (EC No. 1907/2006) and other international regulations, due to having persistent, bioaccumulative and toxic properties and/or being toxic for reproduction. The increasingly used short-chain PFASs are assumed to have a lower bioaccumulation potential. Nonetheless, they have other properties of concern and are already widely distributed in the environment, also in remote regions. The REACH Regulation does not directly address these emerging properties of concern, complicating the implementation of regulatory measures. Therefore, this study illustrates these environmental concerns and provides a strategy for a regulation of short-chain PFASs within REACH. Results: Short-chain PFASs have a high mobility in soil and water, and final degradation products are extremely persistent. This results in a fast distribution to water resources, and consequently, also to a contamination of drinking water resources. Once emitted, short-chain PFASs remain in the environment. A lack of appropriate water treatment technologies results in everlasting background concentrations in the environment, and thus, organisms are permanently and poorly reversibly exposed. Considering such permanent exposure, it is very difficult to estimate long-term adverse effects in organisms. Short-chain PFASs enrich in edible parts of plants and the accumulation in food chains is unknown. Regarding these concerns and uncertainties, especially with respect to the precautionary principle, shortchain PFASs are of equivalent concern to PBT substances. Therefore, they should be identified as substances of very high concern (SVHC) under REACH. The SVHC identification should be followed by a restriction under REACH, which is the most efficient way to minimize the environmental and human exposure of short-chain PFASs in the European Union. Conclusion: Due to an increasing use of short-chain PFASs, an effective regulation is urgently needed. The concerns of short-chain PFASs do not match the classical concerns as defined under REACH, but are not of minor concern. Therefore, it is of advantage to clearly define the concerns of short-chain PFASs. This might facilitate the following restriction process under REACH.								B	-		
D835	環境中運命	Krop, H; Eschauzier, C; van der Roest, E; Parsons, JR; de Voogt, P	Independent mode sorption of perfluoroalkyl acids by single and multiple adsorbents	2021	Environ. Sci.-Process Impacts 2021 Dec:23(12):1997-2006. doi: 10.1039/d1em00322d.	Infinite dilution partition coefficients, K-p,K-0, of a series of unbranched perfluoralkylacids, PFAAs with 3 to 8 CF2 units between water and commercially available weak anion exchange (WAX) and strong anion exchange (MAX) polymers, C-18-modified silica, hydrophilic-lipophilic balance polymer (HLB), and Al2O3 sorbents were determined with self-packed columns using an HPLC-MS/MS setup. The anionic WAX sorbent shows a much higher adsorption affinity (about 450 fold) for PFBA than was observed for the applied hydrophobic sorbent HLB. Since the incremental value for each CF2 group is smaller when the electrostatic adsorption process is observed, the hydrophobic partition coefficient of HLB supersedes the electrostatic one of WAX at around PFTeDA. Adsorption of PFAAs to Al2O3 was weak and did not show a clear chain length dependency. A recently developed independent mode (IM) adsorption model is a more accurate model to combine the electrostatic and hydrophobic interaction terms. This model predicts the correct behaviour of especially short chain PFAAs in soil or sediment sorption experiments. Factors increasing sorption efficiency of well- and ill-defined single and multiple adsorbents towards PFAAs are discussed. The IM model provides a method to optimise sorption remediation strategies of PFAAs in contaminated waters and proposes a two-step strategy, a starting hydrophobic step followed by an electrostatic one to remove more efficiently the short chain PFAAs.	1							B	-		
D836	蓄積性	Sun, X; Guo, L; Luo, DY; Yu, RQ; Yu, XJ; Liang, YQ; Liu, ZW; Wu, YP	Long-term increase in mortality of Indo-Pacific humpback dolphins (Sousa chinensis) in the Pearl River Estuary following anthropic activities: Evidence from the stranded dolphin mortality analysis from 2003 to 2017	2022	Environ. Pollut. 2022 Aug:307:119526. doi: 10.1016/j.envpol.2022.119526.	With the dramatic increase in anthropogenic threats to the Pearl River Estuary (PRE), the population size of the Indo-Pacific humpback dolphins (Sousa chinensis) has significantly decreased over the past decade. To understand the impact and potential risks of intense human activities on these dolphins, factors related to the mortality of humpback dolphins in the PRE were investigated by a detailed examination of 343 dolphin specimens stranded during 2003-2017. There was a significant ($p < 0.01$) increasing trend for humpback dolphin stranding, reflecting the accelerating rate of the population decline. A large proportion of strandings (35.88%) were neonates. A low recruitment rate implies slow population growth, and hence, limited capacity to resist anthropogenic stress. The most commonly diagnosed causes of death were vessel collision and net entanglement. The concentrations of trace metals, polychlorinated biphenyl (PCB) congeners, dichlorodiphenyltrichloroethane, polycyclic aromatic hydrocarbons, and most of per- and polyfluoroalkyl substances (PFASs) in the dolphin samples were greater than those previously reported in cetaceans globally. Furthermore, Cu, PCB77, PCB169, PCB81, PCB37, and PFASs (excluding PFBA, PFPeA, PFHxA, PFHxDA, and PFODA) were the major pollutants accumulated in neonates. 67% of PCB, 78% of Cu, and 100% of perfluorooctane sulfonate concentrations in the neonates exceeded the threshold for toxicological effects in marine mammals, suggesting that these compounds could be important factors contributing to the low survival rate of calves in this area. This study revealed that vessel transportation, fishing activities, and pollutant bioaccumulation are the three major causes of humpback dolphin mortality in the PRE. These results highlight the need for more efforts to restrict anthropogenic activities, especially vessel traffic, the catching of these marine animals and fishing, and pollutant discharge, in order to prevent vulnerable species from continuous population decline and further extinction.	1	1						B	-		
D837	環境中運命	Sun, HW; Zhang, XZ; Wang, L; Zhang, T; Li, FS; He, N; Alder, A	Perfluoroalkyl compounds in municipal WWTPs in Tianjin, China-concentrations, distribution and mass flow	2012	Environ. Sci. Pollut. Res. 2012 Jun:19(5):1405-1415. doi: 10.1007/s11356-011-0727-6.	Backgrounds Perfluorinated compounds (PFCs) have drawn much attention due to their environmental persistence, ubiquitous existence, and bioaccumulation potential. Wastewater treatment plants (WWTPs) are fundamental utilities in cities, playing an important role in preventing water pollution by lowering pollution load in waste waters. However, some of the emerging organic pollutants, like PFCs cannot be efficiently removed by traditional biological technologies in WWTPs, and some even increase in effluents compared to influents due to the incomplete degradation of precursors. Hence, WWTPs are considered to be a main point source in cities for PFCs that enter the aquatic environment. However, the mass flow of PFCs from WWTPs has seldom been analyzed for a whole city. Hence, in the present study, 11 PFCs including series of perfluoroalkyl carboxylic acids (PFCAs, C4-C12) and two perfluoroalkyl sulfonates (PFASs, C6 and C8) were measured in WWTP influents and effluents and sludge samples from six municipal WWTPs in Tianjin, China. Generation and dissipation of the target PFCs during wastewater treatment process and their mass flow in effluents were discussed. Results All the target PFCs were detected in the six WWTPs, and the total PFC concentration in different WWTPs was highly influenced by the population density and commercial activities of the corresponding catchments. Perfluorooctanoic acid (PFOA) was the predominant PFC in water phase, with concentrations ranging from 20 to 170 ng/L in influents and from 30 to 145 ng/L in effluents. Concentrations of perfluoroalkyl sulfonates decreased substantially in the effluent compared to the influent, which could be attributed to the sorption onto sludge, whereas concentrations of PFOA and some other PFCAs increased in the effluent in some WWTPs due to their weaker sorption onto solids and the incomplete degradation of precursors. Perfluorooctane sulfonic acid (PFOS) was the predominant PFC in sludge samples followed by PFOA, and their concentrations ranged from 42 to 169 g/kg and from 12 to 68 g/kg, respectively. Sludge-wastewater distribution coefficients (log K-d) ranged from 0.62 to 3.87 L/kg, increasing with carbon chain length of the homologues. The mass flow of some PFCs in the effluent was calculated, and the total mass flow from all the six municipal WWTPs in Tianjin was 26, 47, and 3.5 kg/year for perfluorohexanoic acid, PFOA, and PFOS, respectively.		1						B	-		
D838	環境中運命	Askeland, M; Clarke, BO; Cheema, SA; Mendez, A; Gasco, G; Paz-Ferreiro, J	Biochar sorption of PFOS, PFOA, PFHxS and PFHxA in two soils with contrasting texture	2020	Chemosphere. 2020 Jun:249:126072. doi: 10.1016/j.chemosphere.2020.126072.	The ability to immobilise PFAS in soil may be an essential interim tool while technologies are developed for effective long-term treatment of PFAS contaminated soils. Serial sorption experiments were undertaken using a pine derived biochar produced at 750 degrees C (P750). All experiments were carried out either in individual mode (solution with one PFAS at 5 mu g/L) or mix mode (solution with 5 mu g/L of each: PFOS, PFOA, PFHxS and PFHxA), and carried out in 2:1 water to soil solutions. Soils had biochar added in the range 0-5% w/w. Kinetic data were fitted to the pseudo-second order model for both amended soils, with equilibrium times ranging 0.5-96 h for all congeners. PFOS sorption was 11.1 +/- 4.5% in the loamy sand compared to 69.8 +/- 4.9% in the sandy clay loam. While total sorption was higher in the unamended loamy sand than sandy clay loam for PFHxA, PFOA and PFOS, the effect of biochar amendment for each compound was found to be significantly higher in amended sandy clay loam than in amended loamy sand. Application of biochar reduced the desorbed PFAS fraction of all soils. Soil type and experimental mode played a significant role in influencing desorption. Overall, the relationship between sorbent and congener was demonstrated to be highly impacted by soil type, however the unique physiochemical properties of each PFAS congener greatly influenced its unique equilibrium, sorption and desorption behaviour for each amended soil and mode tested.		1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D839	蓄積性	Wu, JY; Hua, ZL; Gu, L	Per-, poly-fluoroalkyl substances (PFASs) and planktonic microbiomes: Identification of biotic and abiotic regulations in community coalescence and food webs	2022	Environ. Pollut. 2022 Jun:302:119078. doi: 10.1016/j.envpol.2022.119078.	The importance of per-, poly-fluoroalkyl substances (PFASs) effects on riverine microbiomes is receiving increased recognition in the environmental sciences. However, few studies have explored how PFASs affect microbiomes across trophic levels, specifically through predator-prey interactions. This study examined the community profiles of planktonic archaea, bacteria, fungi, algae, protozoa, and metazoa in a semi-industrial and agricultural river alongside their interactions with 15 detected PFASs. As abiotic factors, PFASs affected community coalescence more than biogenic substances ($p < 0.05$). For biotic regulations, sub-communities in rare biospheres (including always rare taxa-ART and critically rare taxa-CRT) contributed to spatial community coalescence more than sub-communities in abundant biospheres (always abundant taxa-AAT and critically abundant taxa-CAT) ($p < 0.05$). Metazoa-bacteria (Modularity = 1.971) and protozoa-fungi (1.723) were determined to be the most stable predator-prey networks. Based on pathway models, short-chain PFBA (C4) was shown to weaken the trophic transfer efficiencies from heterotrophic bacteria (HB) to heterotrophic flagellates (HF) ($p < 0.05$). Long-chain PFTeDA (C14) promoted HB to amoeba ($p < 0.05$), which we postulate is the pathway for PFTeDA to enter the microbial food chain. Our preliminary results elucidated the influence of PFASs on planktonic microbial food webs and highlighted the need to consider protecting and remediating riverine ecosystems containing PFASs.	1							B	-		
D840	環境中運命	Gredelj, A; Nicoletto, C; Valsecchi, S; Ferrario, C; Polesello, S; Lava, R; Zanon, F; Barausse, A; Palmeri, L; Guidolin, L; Bonato, M	Uptake and translocation of perfluoroalkyl acids (PFAA) in red chicory (Cichorium intybus L.) under various treatments with pre-contaminated soil and irrigation water	2020	Sci. Total Environ. 2020 Mar:708:134766. doi: 10.1016/j.scitotenv.2019.134766.	Perfluoroalkyl acids (PFAAs), particularly short-chained ones, have high potential for crop uptake, posing a threat to human health in contaminated areas. There is a scarcity of studies using contaminated water as the medium for PFAAs delivery to crops, and a lack of data on the partitioning of PFAA mixtures in growing media. In this context, a controlled experimental study was carried out in a greenhouse to investigate the uptake of a PFAA mixture into red chicory, a typical crop from a major PFAA contamination hot-spot in northern Italy, under treatments with environmentally relevant concentrations in spiked irrigation water and soil, separately and simultaneously. To our knowledge, this is the first study involving multiple exposure media and laboratory adsorption/desorption batch tests as a way of assessing the decrease in the bioavailability of PFAAs from soil. Exposure concentrations for each of the 9 utilized PFAAs were 0, 1, 10 and 80 mu g/L in irrigation water and 0, 100 and 200 ng/g(dw) in soil, combined into 12 treatments. The highest bioaccumulation was measured for PFBA in roots (maximum of 43 mu g/g(dw)), followed by leaves and heads of the chicory plants in all treatments, with the concentrations exponentially decreasing with an increasing PFAA chain length in all plant compartments. The use of irrigation water as the delivery medium increased the transport of PFAAs to the aerial chicory parts, long-chain substances in particular. Additionally, the distribution of PFAAs in the soil was assessed by depth and compared with laboratory measured soil-water equilibrium partition coefficients, revealing only partial dependency of PFAAs bioavailability on the adsorption in soil.	1							B	-		
D841	環境中運命	Qi, L; Li, RW; Wu, YD; Lin, XS; Chen, G	Effect of solution chemistry on the transport of short-chain and long-chain perfluoroalkyl carboxylic acids (PFCAs) in saturated porous media	2022	Chemosphere. 2022 Sep;303(Pt 2):135160. doi: 10.1016/j.chemosphere.2022.135160.	Perfluorocarboxylic acids (PFCAs) are one of the most widely detected classes of PFAS in the global environment after decades of intensive use. This study investigated the impact of perfluorinated carbon chain length on the transport behavior of PFCAs by testing and modeling two short-chain (PFPeA and PFHxA) and two long-chain PFCAs (PFOA and PFDA) in laboratory water-saturated columns. Moreover, their transport behavior was examined under different solution chemistry conditions, including pH, ionic strength, and cationic type. The experimental and simulation results indicated that the chain length had a limited impact on transport behaviors of PFPeA, PFHxA, and PFOA under various pH and ionic strengths, evidenced by their tracer-like breakthrough curves. In contrast, the mobility of PFDA was significantly affected by pH and ionic strengths. Additionally, the transport of all four PFCAs was inhabited in the presence of the divalent cation Ca2+. This study could help predict migration behavior and assess the potential risk of PFCAs in the subsurface system.		1						B	-		
D842	蓄積性	Gu, Q; Wen, Y; Wu, H; Cui, XY	Uptake and translocation of both legacy and emerging per-and polyfluorinated alkyl substances in hydroponic vegetables	2023	Sci. Total Environ. 2023 Mar:862:160684. doi: 10.1016/j.scitotenv.2022.160684.	The extensive use of per- and polyfluorinated alkyl substances (PFASs) and their substitutes has resulted in their fre-quent detections in environmental matrices. However,limitedinformation is known abouttheir uptake into vegetablesand health risk through diet, particularly for those emerging alternatives. In this study, a total of 17 PFASs (namely 12legacy PFASs and 5 of their alternatives) were compared for their accumulation into four staple vegetables (lettuce,Chinese cabbage,chrysanthemum coronarium, and cucumber) in hydroponic system with single PFAS concentrationbeing 10 mu g/L, except for 8:2 chlorinated polyfluoroalkyl ether sulfonate (Cl-PFESA) as 0.5 mu g/L. The sum concentra-tions of 17 PFASs in edible parts were in the order of Chinese cabbage leaf (13,456 ng/g)>lettuce leaf (5996 ng/g)>cucumber fruit (4115 ng/g)>chrysanthemum coronariumstem (3999 ng/g). For perfluorooctanoate acid (PFOA) andits alternatives, hexafluoropropylene oxide trimer acid (HFPO-TA) preferentially accumulated in roots than PFOA withroot concentration factors being 35.7-99.9. Translocation to edible parts was more remarkable forhexafluoropropylene oxide dimer acid (HFPO-DA) compared with PFOA in lettuce and cucumber. Forperfluorooctanesulfonate acid (PFOS) and its alternatives, roots of all the four vegetables were found to more readilyaccumulate 8:2 Cl-PFESA than PFOS, but 8:2 Cl-PFESA was hardly translocated to the aerial parts. Significantly ($p<0.05$) higher edible concentrations of 8:2 and 6:2fluorotelomer sulfonic acids (FTSA) than that of PFOS were observed for cucumber					1			B	-		
D843	環境中運命	Feng, XM; Yi, SJ; Shan, GQ; Chen, X; Yang, Y; Yang, LP; Jia, YB; Zhu, YM; Zhu, LY	Occurrence of perfluoroalkyl substances in the environment compartments near a mega fluorochemical industry: Implication of specific behaviors and emission estimation	2023	J. Hazard. Mater. 2023 Mar:445:130473. doi: 10.1016/j.jhazmat.2022.130473.	With the stringent restrictions on long-chain per-and polyfluoroalkyl substances (PFASs), ether-PFASs are being widely used as alternatives. We estimated that the mega fluorochemical industrial park (FIP) in Shandong, China, had emitted a maximum of 5040 kg and 1026 kg of hexafluoropropylene oxides (HFPOs), and 7560 kg and 1890 kg of perfluorooctanoic acid (PFOA) to water and air during 2021. In the surface water, groundwater, outdoor dust, soil, tree leaf and bark collected in the vicinity of the FIP, PFOA was predominant, followed by HFPOs. The much higher percentage of HFPO dimer acid (HFPO-DA) in groundwater than in surface water verified that this compound was more mobile in porous media. The strong correlations between the main PFASs in outdoor dust and surface soil suggested that the soil PFASs were mainly derived from air deposition, particularly for HFPO trimer acid (HFPO-TA), which has a stronger binding affinity with particles than PFOA. High percentage of the hydroxylated product of 6:2 polyfluorinated ether sulfonic acid was observed in groundwater, implying reductive dechlorination might occur in groundwater. Strong correlations between PFASs in outdoor dust and those in tree leaf and bark magnified that tree could serve as a sampler to effectively monitor airborne PFASs. This study provides the first line of information about the discharge, transport, and fate of novel ether-PFASs in the multiple environmental media near a point source.					1			B	-		
D844	環境中運命	Eberle, M; Edelman, M; Denly, E; Rabah, N	Evaluation of the effects of PFAS soil adsorption and transformation in the presence of divalent cations under ambient conditions	2019	Remediation. 2019 Dec:30(1):15-25. doi: 10.1002/rem.21635.	A bench-scale study was conducted to evaluate the effect of divalent cations on the adsorption of perfluoroalkyl and polyfluoroalkyl substances (PFAS) onto soil particles. The study entailed batch testing of a synthetic soil mixture under a range of Epsom salt (soluble magnesium sulfate heptahydrate) concentrations. The synthetic soil was produced using a mix of sand, silt, clay, and organic matter that then was mixed and saturated with water collected from a PFAS-impacted water source. The results indicate that variable concentrations of magnesium (divalent cation) had a minor effect on the sorption of perfluorooctane sulfonate with the highest sorption occurring in the strongest solution of Epsom salt. An unanticipated result of the test involved apparent biomediated transformation of polyfluorinated alkylated sulfonates (fluorotelomers or FTS) to perfluorooctanoic acid, perfluoroheptanoic acid (PFHpA), and perfluorononanoic acid. We believe this is the first time the complete transformation of 6:2 FTS to PFHpA has been observed and reported under ambient surface water-like conditions within 6 months, a relatively short timeframe.			1					B	-		
D845	環境中運命	Zhang, X; Hu, TT; Yang, L; Guo, ZY	The Investigation of Perfluoroalkyl Substances in Seasonal Freeze-Thaw Rivers During Spring Flood Period: A Case Study in Songhua River and Yalu River, China	2018	Bull. Environ. Contam. Toxicol. 2018 Aug:101(2):166-172. doi: 10.1007/s00128-018-2381-x.	The occurrence of 15 perfluoroalkyl substances (PFASs) in water, sediments, and fish from Songhua River and Yalu River in Jilin Province, Northeast China, during their spring flood period were investigated for the first time. The short-chain perfluorobutanoic acid was the dominant PFAS in the water with the mean concentrations of 10 ng L-1 in Songhua River and 9.0 ng L-1 in Yalu River, and also dominant in sediments with the mean concentrations of 2.0 and 1.8 ng g(-1) dry weight. Perfluorodecane sulfonate was the predominant compound in fish. The detected frequencies and concentrations of perfluorooctane sulfonate and perfluorooctanoic acid were very low in the water, sediments, and fish. Low detected frequencies and concentrations of long-chain PFASs led to relative low sediment-water partition coefficients and bioaccumulation factors. The concentration levels of PFASs in the two rivers were lower than those in other major rivers in China.	1							B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D846	蓄積性	Sun, JM; Kelly, BC; Gobas, FAPC; Sunderland, EM	A food web bioaccumulation model for the accumulation of per- and polyfluoroalkyl substances (PFAS) in fish: how important is renal elimination?	2022	Environ. Sci.-Process Impacts 2022 Aug:24(8):1152-1164. doi: 10.1039/d2em00047d.	Per- and polyfluoroalkyl substances (PFAS) are a large class of highly fluorinated anthropogenic chemicals. Some PFAS bioaccumulate in aquatic food webs, thereby posing risks for seafood consumers. Existing models for persistent organic pollutants (POPs) perform poorly for ionizable PFAS. Here we adapt a well-established food web bioaccumulation model for neutral POPs to predict the bioaccumulation behavior of six perfluoroalkyl acids (PFAAs) and two perfluoroalkyl ether acids (HFPO-DA, 9-Cl-PF3ONS) produced as PFAA replacements. The new model includes sorption to blood plasma proteins and phospholipids, empirically parameterized membrane transport, and renal elimination for PFAAs. Improved performance relative to prior models without these updates is shown by comparing simulations to field and lab measurements. PFAS with eight or more perfluorinated carbons (eta(pfc) >= 8, i.e., C8 perfluorosulfonic acid, C10-C11 perfluorocarboxylic acid, 9-Cl-PF3ONS) are often the most abundant in aquatic food webs. The new model reproduces their observed bioaccumulation potential within a factor of two for >80% of fish species, indicating its readiness to support development of fish consumption advisories for these compounds. Results suggest bioaccumulation of eta(pfc) >= 8 PFAS is primarily driven by phospholipid partitioning, and that renal elimination is negligible for these compounds. However, specific protein binding mechanisms are important for reproducing the observed tissue concentrations of many shorter-chain PFAAs, including protein transporter-mediated renal elimination. Additional data on protein-binding and membrane transport mechanisms for PFAS are needed to better understand the biological behavior of shorter-chain PFAAs and their alternatives.					1			B	-		
D847	蓄積性	Zhao, HX; Guan, Y; Qu, BC	PFCA uptake and translocation in dominant wheat species (Triticum aestivum L.)	2018	Int. J. Phytoremediat. 2018 ;20:68-74. doi: 10.1080/15226514.2017.1337066	The comparative uptake of four perfluorinated carboxylic acids (PFCAs) by wheat (Triticum aestivum L.) grown in nutrient solution was investigated. Wheat is the main food crop in northern China and may become a potential pathway of human exposure to these PFCAs. The uptake of four PFCAs from water at a fixed concentration (1 mu g/mL) increased over time, approaching a steady state, and except for the short-chain perfluorobutanoic acid, most of the total mass of each of the PFCAs taken up by wheat was found to be at the root. The root concentration factor (RCF) and shoot/root concentration factor (SRCF) were calculated, and with the increase in carbon chain length, the RCFs increased but SRCFs decreased, which indicated that long-chain PFCAs had stronger root uptake and weaker translocation capacities than short-chain PFCAs. In addition, pH could obviously impact the uptake of four PFCAs in the roots and shoots of wheat, and the highest concentrations were found at pH D 7 when the pH increased from 4 to 10.	1							B	-		
D848	環境中運命	Li, Y; Feng, XM; Zhou, J; Zhu, LY	Occurrence and source apportionment of novel and legacy poly/perfluoroalkyl substances in Hai River basin in China using receptor models and isomeric fingerprints	2020	Water Res. 2020 Jan:168:115145. doi: 10.1016/j.watres.2019.115145.	A variety of fluorinated alternatives are being manufactured and applied as a consequence of stringent regulations on legacy poly/perfluoroalkyl substances (PFASs). In this study, 26 emerging and legacy PFASs were measured in the surface water (including dissolved phase and suspended particulate matter) and sediments taken from Hai River basin, China. The total concentrations of PFASs (Sigma PFASs) ranged from 1.74 to 172 ng/L, with perfluorooctanonate (PFOA) as the dominant compound (15.2% of the Sigma PFASs, median value). Emerging PFASs, such as dimer acid of hexafluoropropylene oxide dimer acid (HFPO-DA) and trimer acid (HFPO-TA), were widely detected in the water samples. Specifically, chlorinated polyfluorinated ether sulfonate (F-53B) was observed to be predominant in some sediment samples. A receptor model, Unmix, was introduced to identify the sources of PFASs in the surface water, and the results indicated that fire-fighting foam/fluoropolymer processing aids (36.6%) were the dominant source. The field-based sediment-water (organic carbon normalized) coefficients, K-oc, were correlated to the carbon chain lengths of the PFASs. A technique coupling one-way analysis of variance with chemical mass balance model was developed to trace the manufacturing sources of PFOA. Electrochemical fluorination (ECF) was the major PFOA manufacturing source with considerable contribution by telomerization. For the first time, the isomers of perfluorooctane sulfonamide (PFOSA) were quantified in the environmental samples. The lower proportion of branched (br(-)) PFOSA isomers and higher percentage of br-perfluorooctane sulfonate (PFOS) isomers in the water samples relative to their corresponding commercial products, provided more direct evidences that br-PFOSA isomers were biotransformed more easily than n-PFOSA, explaining the observed enrichment of br-PFOS in the aquatic environment.					1			B	-		
D849	環境中運命	Richards, LA; Kumari, R; White, D; Parashar, N; Kumar, A; Ghosh, A; Kumar, S; Chakravorty, B; Lu, CH; Civil, W; Lapworth, DJ; Krause, S; Polya, DA; Gooddy, DC	Emerging organic contaminants in groundwater under a rapidly developing city (Patna) in northern India dominated by high concentrations of lifestyle chemicals	2021	Environ. Pollut. 2021 Jan;268(Pt A):115765. doi: 10.1016/j.envpol.2020.115765.	Aquatic pollution from emerging organic contaminants (EOCs) is of key environmental importance in India and globally, particularly due to concerns of antimicrobial resistance, ecotoxicity and drinking water supply vulnerability. Here, using a broad screening approach, we characterize the composition and distribution of EOCs in groundwater in the Gangetic Plain around Patna (Bihar), as an exemplar of a rapidly developing urban area in northern India. A total of 73 EOCs were detected in 51 samples, typically at ng.L-1 to low mu g.L-1 concentrations, relating to medical and veterinary, agrochemical, industrial and lifestyle usage. Concentrations were often dominated by the lifestyle chemical and artificial sweetener sucralose. Seventeen identified EOCs are flagged as priority compounds by the European Commission, World Health Organisation and/or World Organisation for Animal Health: namely, herbicides diuron and atrazine; insecticides imidacloprid, thiamethoxam, clothianidin and acetamiprid; the surfactant perfluorooctane sulfonate (and related perfluorobutane sulfonate, perfluorohexane sulfonate, perfluorooctanoic acid and perfluoropentane sulfonate); and medical/veterinary compounds sulfamethoxazole, sulfanilamide, dapson, sulfathiazole, sulfamethazine and diclofenac. The spatial distribution of EOCs varies widely, with concentrations declining with depth, consistent with a strong dominant vertical flow control. Groundwater EOC concentrations in Patna were found to peak within similar to 10 km distance from the River Ganges, indicating mainly urban inputs with some local pollution hot-spots. A heterogeneous relationship between EOCs and population density likely reflects confounding factors including varying input types and controls (e.g. spatial, temporal), wastewater treatment infrastructure and groundwater abstraction. Strong seasonal agreement in EOC concentrations was observed. Co-existence of limited transformation products with associated parent compounds indicate active microbial degradation processes. This study characterizes key controls on the distribution of groundwater EOCs across the urban to rural transition near Patna, as a rapidly developing Indian city, and contributes to the wider understanding of the vulnerability of shallow groundwater to surface-derived contamination in similar environments.					1			B	-		
D850	蓄積性	Bangma, JT; Reiner, JL; Lowers, RH; Cantu, TM; Scott, J; Korte, JE; Scheidt, DM; McDonough, C; Tucker, J; Back, B; Adams, DH; Bowden, JA	Perfluorinated alkyl acids and fecundity assessment in striped mullet (Mugil cephalus) at Merritt Island national wildlife refuge	2018	Sci. Total Environ. 2018 Apr:619:740-747. doi: 10.1016/j.scitotenv.2017.11.141	This study investigated wild caught striped mullet (Mugil cephalus) at Merritt Island National Wildlife Refuge (MINWR) for levels of 15 perfluoroalkyl acids (PFAA) in tandem with individual fecundity measurements (Oocyte sub-stage 2 late, n = 42) and oocyte reproductive stages (Stages 1-5, n = 128). PFAA measurements were quantified in stripedmullet liver (n = 128), muscle (n = 49), and gonad (n = 10). No significant negative impacts of liver PFAA burden on wild-caught, mullet fecundity endpoints were observed in this study; however, changes in PFAA were observed in the liver as mullet progressed through different sub-stages of oocyte development. Of the PFAA with significant changes by sub-stage of oocyte development, the carboxylic acids (perfluorooctanoic acid, perfluorononanoic acid, and perfluorotridecanoic acid) increased in the liver with increasing sub-stage while the sulfonic acid and its precursor (perfluorooctanesulfonic acid (PFOS) and perfluorooctanesulfonamide, respectively) decreased in the liver with increasing sub-stage of oocyte development. This is a unique find and suggests PFAA change location of compartmentalization as mullet progress towards spawning. Investigations also revealed higher than expected median muscle and gonad levels of PFOS in striped mullet collected at MINWR (9.01 ng/g and 80.2 ng/g, respectively). Published by Elsevier B.V.								B	-		
D851	環境中運命	Gockener, B; Fliedner, A; Rudel, H; Fettig, I; Koschorreck, J	Exploring unknown per- and polyfluoroalkyl substances in the German environment - The total oxidizable precursor assay as helpful tool in research and regulation	2021	Sci. Total Environ. 2021 Aug:782:146825. doi: 10.1016/j.scitotenv.2021.146825.	Limnetic, marine and soil samples of the German environmental specimen bank (ESB) were analyzed for per- and polyfluoroalkyl substances (PFAS) using target analysis and a modified total oxidizable precursor (TOP) assay (direct TOP assay (dTOP)) that works without prior extraction. Target analysis determined Sigma PFAS concentrations in bream livers of 8.7-282 mu g kg(-1) wet weight (ww) in 2019, with highest contaminations in the Rhine and lower Elbe. In bream fillet, concentrations were lower (<0.5-10.6 mu g kg(-1) Sigma PFAS). Contamination of suspended particulate matter (SPM) was highest in the upper Elbe downstream the Czech border (5.5 mu g kg(-1) dry weight (dw) in 2018). Herring gull eggs from the North and Baltic Seas showed Sigma PFAS levels around 53.0-69.6 mu g kg(-1) ww in 2019. In soil, concentrations ranged between <0.5 and 4.6 mu g kg(-1) dw with highest levels in the Dueben Heath near Leipzig and the low mountain range Solling. PFOS dominated in most samples. Of the targeted precursors, only FOSA, EtFOSAA, MeFOSAA, 6:2-FtS and 6:2 diPAP were found. Replacement chemicals (ADONA, HFPO-DA, F-53B) were not detected. The dTOP assay revealed that considerable amounts of precursors were present at most riverine sampling sites. Particularly high precursor concentrations were observed in samples from the Upper Elbe at the Czech border and the Upper and Middle Rhine. In herring gull eggs and most soil samples, though, concentrations of precursors were low. Time trend analysis showed decreasing trends for most detected PFAS since 2005. In SPM, however, C4-C6 perfluoroalkyl carboxylic acids seem to increase indicating growing use of precursors based on shorter fluorinated chains. The results demonstrate that target analysis detects only a minor fraction of the PFAS burdens in environmental samples. The dTOP assay can support risk assessment and chemical monitoring with more comprehensive exposure data of the actual contamination.					1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D852	蓄積性	Barbosa, V; Maulvault, AL; Alves, RN; Kwadijk, C; Kotterman, M; Tediosi, A; Fernandez-Tejedor, M; Sloth, JJ; Granby, K; Rasmussen, RR; Robbens, J; De Witte, B; Trabalon, L; Fernandes, JO; Cunha, SC; Marque, A	Effects of steaming on contaminants of emerging concern levels in seafood	2018	Food Chem. Toxicol. 2018 Aug:118:490-504. doi: 10.1016/j.fct.2018.05.047	Seafood consumption is a major route for human exposure to environmental contaminants of emerging concern (CeCs). However, toxicological information about the presence of CeCs in seafood is still insufficient, especially considering the effect of cooking procedures on contaminant levels. This study is one among a few who evaluated the effect of steaming on the levels of different CeCs (toxic elements, PFCs, PAHs, musk fragrances and UV-filters) in commercially relevant seafood in Europe, and estimate the potential risks associated with its consumption for consumers. In most cases, an increase in contaminant levels was observed after steaming, though varying according to contaminant and seafood species (e.g. iAs, perfluorobutanoate, dibenzo(ah)anthracene in Mytilus edulis, HHCB-Lactone in Solea sp., 2-Ethylhexyl salicylate in Lophtus piscatorius). Furthermore, the increase in some CeCs, like Pb, MeHg, iAs, Cd and carcinogenic PAHs, in seafood after steaming reveals that adverse health effects can never be excluded, regardless contaminants concentration. However, the risk of adverse effects can vary. The drastic changes induced by steaming suggest that the effect of cooking should be integrated in food risk assessment, as well as accounted in CeCs regulations and recommendations issued by food safety authorities, in order to avoid over/underestimation of risks for consumer health.								B	-		
D853	環境中運命	Nascimento, RA; Nunoo, DBO; Bizkarguenaga, E; Schultes, L; Zabaleta, I; Benskin, JP; Spano, S; Leonel, J	Sulfluramid use in Brazilian agriculture: A source of per- and polyfluoroalkyl substances (PFASs) to the environment	2018	Environ. Pollut. 2018 Nov;242(Pt B):1436-1443. doi: 10.1016/j.envpol.2018.07.122.	N-Ethyl perfluorooctane sulfonamide (EtFOSA) is a perfluorooctane sulfonate (PFOS) precursor and the active ingredient in sulfluramid, a pesticide which is used extensively in Brazil for management of leaf cutting ants. Here we investigate the occurrence of EtFOSA, PFOS, and other per- and polyfluoroalkyl substances (PFASs) in soil, eucalyptus leaves, water (ground, riverine, and coastal (estuarine/marine)) and coastal sediment from an agricultural region of Bahia State, Brazil. This area contains a larger number of eucalyptus plantations where sulfluramid is suspected to be applied. Soil, leaves, and coastal water (marine/estuarine) contained Sigma PFAS concentrations of up to 5400 pg g(-1), 979 pg g(-1), and 1020 pg L-1, respectively, with PFAS profiles generally dominated by PFOS and perfluorooctane sulfonamide (FOSA). Coastal sediment contained Sigma PFAS concentrations of up to 198 pg g(-1), with PFOS, FOSA, and perfluorooctanoic acid (PFOA) being the most frequently observed PFASs. These substances are all potential EtFOSA transformation products, pointing to sulfluramid as a possible source. In riverine water, Sigma PFAS concentrations of up to 8930 pg L-1 were observed. PFOS and PFOA were detected in all river water samples. Groundwater also exhibited PFAS contamination (5730 pg L-1 EPFAS5), likely from sulfluramid use. The observation of other PFASs (e.g. perfluorobutanoic acid) in freshwater suggests that other PFAS sources (in addition to sulfluramid) may be important in this region. Overall, these data support the hypothesis that sulfluramid use contributes to the occurrence of PFASs in the Brazilian environment.	1						B	-		
D854	環境中運命	Viticoski, RL; Wang, DY; Feltman, MA; Mulabagal, V; Rogers, SR; Blersch, DM; Hayworth, JS	Spatial distribution and mass transport of Perfluoroalkyl Substances (PFAS) in surface water: A statewide evaluation of PFAS occurrence and fate in Alabama	2022	Sci. Total Environ. 2022 Aug:836:155524. doi: 10.1016/j.scitotenv.2022.155524.	Per- and polyfluoroalkyl substances (PFAS) have been previously detected near suspected sources in Alabama, but the overall extent of contamination across the state is unknown. This study evaluated the spatial distribution of 17 PEAS within the ten major river basins in Alabama and provided insights into their transport and fate through a mass flux analysis. Six PFAS were identified in 65 out of the 74 riverine samples, with mean Sigma(6)PFAS levels of 35.2 ng L-1. The highest Sigma(6)PFAS concentration of 237 ng L-1 was detected in the Coosa River, a transboundary river that receives discharges from multiple sources in Alabama and Georgia. PFAS distribution was not observed to be uniform across the state: while the Coosa, Alabama, and Chattahoochee rivers presented relatively high mean Sigma(6)PFAS concentrations of 191, 100 and 28.8 ng L-1, respectively, PFAS were not detected in the Conccuh, Escatawpa, and Yellow rivers. Remaining river systems presented mean Sigma(6)PFAS concentrations between 7.94 and 24.7 ng L-1. Although the short-chain perfluoropentanoic acid (PEPeA) was the most detected analyte (88%), perfluorobutanesulfonic acid (MS) was the substance with the highest individual concentration of 79.4 ng L-1. Consistent increases in the mass fluxes of PEAS were observed as the rivers flowed through Alabama, reaching up to 63.3 mg s(-1), indicating the presence of numerous sources across the state. Most of the mass inputs would not have been captured if only aqueous concentrations were evaluated, since concentration is usually heavily impacted by environmental conditions. Results of this study demonstrate that mass flux is a simple and powerful complementary approach that can be used to broadly understand trends in the transport and fate of PEAS in large river systems.				1			B	-		
D855	環境中運命	Khan, MY; Song, JO; Narimani, M; da Silva, G	Thermal decomposition mechanism and kinetics of perfluorooctanoic acid (PFOA) and other perfluorinated carboxylic acids: a theoretical study	2022	Environ. Sci.-Process Impacts 2022 Dec:24(12):2475-2487. doi: 10.1039/d2em00259k.	Perfluorinated carboxylic acids (PFCAs), particularly perfluorooctanoic acid (PFOA), are broadly used for chemical synthesis and as surfactants, but they pose a serious threat to humans and wildlife because of toxicity concerns, environmental stability, and tendency to bioaccumulate. PFCA waste is commercially treated in incinerators, however, their exact degradation mechanisms are still unknown. In the present work, we report the decomposition mechanism and kinetics of straight-chain PFCAs using quantum chemistry and reaction rate theory calculations. Degradation mechanisms and associated kinetic parameters are determined for the complete series of straight-chain PFCAs from perfluorononanoic acid (C8F17COOH, C9) to fluoroformic acid (FCOOH, C1). Our results show that PFCA decomposition follows an analogous mechanism to perfluorinated sulfonic acids, where HF elimination from the acid head group produces a three membered ring intermediate, in this case a perfluorinated alpha-lactone. These perfluorinated alpha-lactones are short-lived intermediates that readily degrade into perfluorinated acyl fluorides and CO, thus shortening the perfluorinated chain by one C atom. Because perfluorinated acyl fluorides are known to hydrolyse to PFCAs, repeated cycles of carboxylic acid decomposition followed by acyl fluoride hydrolysis provides a mechanism for the complete mineralization of PFCAs to HF, CO, CO2, COF2, and CF2 during thermal decomposition in the presence of water vapor. These results provide a theoretical basis for future detailed chemical kinetic studies of incineration reactors and will assist in their design and optimisation so as to more efficiently decompose PFCAs and related waste.			1				B	-		
D856	蓄積性	Routti, H; Gabrielsen, GW; Herzke, D; Kovacs, KM; Lydersen, C	Spatial and temporal trends in perfluoroalkyl substances (PFASs) in ringed seals (Pusa hispida) from Svalbard	2016	Environ. Pollut. 2016 Jul:214:230-238. doi: 10.1016/j.envpol.2016.04.016	This study investigates concentrations of perfluoroalkyl carboxylates (PFCAs), perfluoroalkyl sulfonates (PFSAs) and perfluoroalkane sulfonamides (FASA) in plasma from ringed seals sampled in the period 1990-2010 (n = 71) in Svalbard, Norway. Perfluorooctane sulfonate was dominant among the perfluoroalkyl substances. PFCAs were dominated by perfluoroundecanoate followed by perfluorononanoate. C-4-C-8 PFCAs and perfluorooctane sulfonamide (FOSA) were detected in <= 42% of the samples. PFSA and PFCA concentrations were higher in seals sampled from Kongsfjorden, a fjord influenced by strong inflows of Atlantic Water compared to seals from fjords dominated by Arctic Water (e.g. Billefjorden). Sex, age and body condition of the seals did not influence PFAS concentrations. Due to the confounding effect of year and sampling area, temporal trends were assessed only in seals sampled from Kongsfjorden (5 years, n = 51). PFHxS and PFOS concentrations did not show significant linear trends during the whole study period, but a decrease was observed since 2004. Concentrations of all of the detected PFCAs (C-9-C-13 PFCAs) increased until 2004 after which they have declined or stabilized.			1				B	-		
D857	環境中運命	O'Rourke, E; Hynes, J; Losada, S; Barber, JL; Pereira, MG; Kean, EF; Hailer, F; Chadwick, EA	Anthropogenic Drivers of Variation in Concentrations of Perfluoroalkyl Substances in Otters (Lutra lutra) from England and Wales	2022	Environ. Sci. Technol. 2022 Feb:56(3):1675-1687. doi: 10.1021/acs.est.1c05410.	Per- and polyfluoroalkyl substances (PFASs) are ubiquitous environmental contaminants that have been linked to adverse health effects in wildlife and humans. Here, we report the presence of PFASs in Eurasian otters (Lutra lutra) in England and Wales and their association with anthropogenic sources. The following 15 compounds were analyzed: 10 perfluoroalkyl carboxylic acids (PFCAs), 4 perfluoroalkyl sulfonic acids (PFSAs), and perfluorooctane sulfonamide, in livers of 50 otters which died between 2007 and 2009. PFASs were detected in all otters analyzed, with 12/15 compounds detected in >= 80% of otters. Perfluorooctane sulfonate (PFOS) accounted for 75% of the Sigma PFAS profile, with a maximum concentration of 6800 mu g/kg wet weight (ww). Long-chain (>= C8) PFCAs accounted for 99.9% of the Sigma PFCA profile, with perfluorodecanoic acid and perfluorononanoic acid having the highest maxima (369 mu g/kg ww and 170 mu g/kg ww, respectively). Perfluorooctanoic acid (PFOA) concentrations were negatively associated with the distance from a factory that used PFOA in polytetrafluoroethylene manufacture. Most PFAS concentrations in otters were positively associated with load entering wastewater treatment works (WWTW) and with arable land, suggesting that WWTW effluent and sewage sludge-amended soils are significant pathways of PFASs into freshwaters. Our results reveal the widespread pollution of British freshwaters with PFASs and demonstrate the utility of otters as effective sentinels for spatial variation in PFAS concentrations.			1				B	-		
D858	環境中運命	Nguyen, VT; Gin, KYH; Reinhard, M; Liu, CH	Occurrence, fate, and fluxes of perfluorochemicals (PFCs) in an urban catchment: Marina Reservoir, Singapore	2012	Water Sci. Technol. 2012 ;66:2439-2446. doi: 10.2166/wst.2012.475	A study was carried out to characterize the occurrence, sources and sinks of perfluorochemicals (PFCs) in the Marina Catchment and Reservoir, Singapore. Salinity depth profiles indicated the reservoir was stratified with lower layers consisting of sea water (salinity ranging from 32 to 35 g L-1) and a brackish surface layer containing approximately 14-65% seawater. The PFC mixture detected in catchment waters contained perfluoroalkyl carboxylates (PFCAs), particularly perfluorooctanoate (PFOA), perfluorohexanoate (PFHpA), perfluorooctane sulfonate (PFOS) and PFC transformation products. PFC concentrations in storm runoff were generally higher than those in dry weather flow of canals and rivers. PFC concentration profiles measured during storm events indicated 'first flush' behavior, probably because storm water is leaching PFC compounds from non-point sources present in the catchment area. Storm runoff carries high concentrations of suspended solids (SS), which suggests that PFC transport is via SS. In Marina Bay, PFCs are deposited in the sediments along with the SS. In sediments, the total PFC concentration was 4,700 ng kg(-1), approximately 200 times higher than in the bottom water layers. Total perfluoroalkyl sulfonates (PFSAs), particularly PFOS and 6:2 fluoro telomer sulfonate (6:2 FtS) were dominant PFCs in the sediments. PFC sorption by sediments varied with perfluorocarbon chain length, type of functional group and sediment characteristics. A first approximation analysis based on SS transport suggested that the annual PFC input into the reservoir was approximately 35 +/- 12 kg y(-1). Contributions of SS, dry weather flow of river/canals, and rainfall were approximately 70, 25 and 5%, respectively. This information will be useful for improving strategies to protect the reservoir from PFC contamination.		1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D859	環境中運命	Munoz, G; Budzinski, H; Labadie, P	Influence of Environmental Factors on the Fate of Legacy and Emerging Per- and Polyfluoroalkyl Substances along the Salinity/Turbidity Gradient of a Macrotidal Estuary	2017	Environ. Sci. Technol. 2017 Nov:51(21):12347-12357. doi: 10.1021/acs.est.7b03626.	This study aimed at bridging knowledge gaps regarding the land-sea transport of per- and polyfluoroalkyl substances (PFASs) through riverine discharge into coastal waters. The present survey was conducted in the Gironde estuary (southwestern France) where PFASs were ubiquitously detected albeit at low levels. Emerging Sigma PFASs such as fluorotelomer sulfonates or polyfluoroalkyl phosphate diesters accounted for a relatively minor proportion of Sigma PFASs, while perfluorooctanesulfonate, perfluorohexanesulfonate, and perfluorohexanoate were the predominant congeners. Multiple linear regressions provided insights into the relative influence of factors controlling PFAS sediment levels. In that respect, the organic carbon fraction (strongly correlated to sediment grain size) appeared as a more important controlling factor than black carbon or distance from upstream sources for long-chain perfluoroalkyl acids. In the maximum turbidity zone (suspended solids up to 2600 mg L-1), the particle-associated fraction was almost consistently >50% for long-chain perfluoroalkyl carboxylates and sulfonates (>= C8 and >= C6, respectively). Empirical models of K-D partitioning coefficients were derived by integrating, for the first time, both particle-concentration and salting-out effects. These results represent significant progress toward the development of numerical transport models integrating both PFAS partitioning and 3D-hydrosedimentary dynamics, with a view to estimate PFAS mass budgets at the land-sea interface.		1						B	-		
D860	蓄積性	Muller, CE; LeFevre, GH; Timofte, AE; Hussain, FA; Sattely, ES; Luthy, RG	COMPETING MECHANISMS FOR PERFLUOROALKYL ACID ACCUMULATION IN PLANTS REVEALED USING AN ARABIDOPSIS MODEL SYSTEM	2016	Environ. Toxicol. Chem. 2016 May:35(5):1138-1147. doi: 10.1002/etc.3251.	Perfluoroalkyl acids (PFAAs) bioaccumulate in plants, presenting a human exposure route if present in irrigation water. Curiously, accumulation of PFAAs in plant tissues is greatest for both the short-chain and long-chain PFAAs, generating a U-shaped relationship with chain length. In the present study, the authors decouple competing mechanisms of PFAA accumulation using a hydroponic model plant system (Arabidopsis thaliana) exposed to a suite of 10 PFAAs to determine uptake, depuration, and translocation kinetics. Rapid saturation of root concentrations occurred for all PFAAs except perfluorobutanoate, the least-sorptive (shortest-chain) PFAA. Shoot concentrations increased continuously, indicating that PFAAs are efficiently transported and accumulate in shoots. Tissue concentrations of PFAAs during depuration rapidly declined in roots but remained constant in shoots, demonstrating irreversibility of the translocation process. Root and shoot concentration factors followed the U-shaped trend with perfluoroalkyl chain length; however, when normalized to dead-tissue sorption, this relationship linearized. The authors therefore introduce a novel term, the sorption normalized concentration factor, to describe PFAA accumulation in plants; because of their hydrophobicity, sorption is the determining factor for long-chain PFAAs, whereas the shortest-chain PFAAs are most effectively transported in the plant. The present study provides a mechanistic explanation for previously unexplained PFAA accumulation trends in plants and suggests that shorter-chained PFAAs may bioaccumulate more readily in edible portions.								B	-		
D861	蓄積性	Lescord, GL; Kidd, KA; De Silva, AO; Williamson, M; Spencer, C; Wang, XW; Muir, DCG	Perfluorinated and Polyfluorinated Compounds in Lake Food Webs from the Canadian High Arctic	2015	Environ. Sci. Technol. 2015 Mar:49(5):2694-2702. doi: 10.1021/es5048649.	Per- and polyfluorinated alkyl substances (PFASs) enter Arctic lakes through long-range atmospheric transport and local contamination, but their behavior in aquatic food webs at high latitudes is poorly understood. This study compared the concentrations of perfluorocarboxylates, perfluorosulfonates, and fluorotelomer sulfonates (FTS) in biotic and abiotic samples from six high Arctic lakes near Resolute Bay, Nunavut, Canada. Two of these lakes are known to be locally contaminated by a small airport and Arctic char (Salvelinus alpinus) from these lakes had over 100 times higher total [PFAS] when compared to fish from neighboring lakes. Perfluorononanoate (PFOA) and perfluorooctanesulfonate (PFOS) dominated in char, benthic chironomids (their main prey), and sediments, while pelagic zooplankton and water were dominated by lower chain acids and perfluorodecanesulfonate (PFDS). This study also provides the first measures of perfluoroethylcyclohexanesulfonate (PFECHS) and FTS compounds in water, sediment, juvenile char, and benthic invertebrates from lakes in the high Arctic. Negative relationships between [PFAS] and delta N-15 values (indicative of trophic position) within these food webs indicated no biomagnification. Overall, these results suggest that habitat use and local sources of contamination, but not trophic level, are important determinants of [PFAS] in biota from freshwater food webs in the Canadian Arctic.			1					B	-		
D862	蓄積性	Surma, M; Hliwa, P; Sznajder-Katarzynska, K; Wiczkowski, W; Topolska, J; Zielinski, H	Perfluoroalkyl Substance Contamination Levels of Pike (Esox lucius L.) and Roach (Rutilus rutilus L.) from Selected Masurian Lakes in Eastern Europe	2021	Environ. Toxicol. Chem. 2021 Dec:40(12):3317-3327. doi: 10.1002/etc.5223.	Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are of increased concern because of their bioaccumulation in humans and the biota, the health risk they pose to humans and other animals, and their persistence in the environment. In the present study, the occurrence of PFAS in selected tissues from pike (Esox lucius L.) and roach (Rutilus rutilus L.) collected from two lakes in the Masurian Lake District (Poland) in eastern Europe was addressed. Ten PFAS were analyzed in the tissue of the brain, liver, kidneys, gonads, and muscles by micro-high-performance liquid chromatography coupled with tandem mass spectrometry. Only perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid, and perfluorodecanoic acid were detected above the limit of quantification. Concentrations in pike and roach from Elckie Lake and Hancza Lake were estimated to be 14/27 and 4.4/3.2 ng/g wet weight, respectively. The contributions of PFOS and PFOA to the sum of PFAS calculated for particular tissues for each fish species were higher than those of the other analyzed compounds: PFOS was found to be predominant in fish from Elckie Lake, whereas PFOA predominated in fish from Hancza Lake. It was noted that PFAS concentrations in tissues declined in the following order: kidney > gonads approximate to brain > liver > muscle. The sum of the greatest estimated PFAS concentration was 9.7 ng/g wet weight in kidneys of pike collected from Hancza Lake. No correlation was noted between PFAS concentration and fish size. The information provided in our study gives a better understanding of the potential dependencies in PFAS distribution and accumulation in biota.			1					B	-		
D863	蓄積性	Bustnes, JO; Bardsen, BJ; Herzke, D; Bangjord, G; Bourgeon, S; Fritsch, C; Eulaers, I	Temporal Trends of Organochlorine and Perfluorinated Contaminants in a Terrestrial Raptor in Northern Europe Over 34 years (1986-2019)	2022	Environ. Toxicol. Chem. 2022 Jun:41(6):1508-1519. doi: 10.1002/etc.5331.	Fourteen legacy organochlorine (OC) contaminants and 12 perfluoroalkyl substances (PFASs) were measured in eggs of tawny owls (Strix alueco) in central Norway (1986-2019). We expected OCs to have reached stable equilibrium levels due to bans, and that recent phase-out of some PFASs would have slowed the increase of these compounds. Sigma OC comprised on average approximately 92% of the measured compounds, whereas Sigma PFAS accounted for approximately 8%. However, whereas the Sigma OC to Sigma PFAS ratio was approximately 60 in the first 5 years of the study, it was only approximately 11 in the last 5 years. Both OC pesticides and polychlorinated biphenyls (PCBs) showed substantial declines over the study period (similar to 85%-98%): hexachlorocyclohexanes and chlordanes seemed to be levelling off, whereas p,p'-dichlorodiphenyldichloroethylene (p,p'-DDE) and hexachlororbenzene (HCB), and most PCB congeners still seemed to decline at a more or less constant rate. While the concentration of perfluorooctane sulfonic acid (PFOS), the dominating PFAS, was reduced by approximately 43%, other perfluorinated sulfonates (PFSAs) showed only minor changes. Moreover, the median concentrations of seven perfluorinated carboxylic acids (PFCAs) increased approximately five-fold over the study period. Perfluorononanoic acid and perfluoroundecanoate acid, however, seemed to be levelling off in recent years. In contrast, perfluorododecanoic acid, perfluorodecanoate acid, perfluorotridecanoic acid, and perfluorotetradecanoic acid seemed to increase more or less linearily. Finally, perfluorooctanoic acid (PFOA) was increasingly likely to be detected over the study period. Hence, most legacy OCs and PFOS have not reached a lower threshold with stable background levels, and voluntary elimination of perfluoroalkyl carboxylates still has not resulted in declining levels in tawny owls in central Norway.			1					B	-		
D864	環境中運命	Theobald, N; Caliebe, C; Gerwinski, W; Huhnerfuss, H; Lepom, P	Occurrence of perfluorinated organic acids in the North and Baltic seas. Part 1: distribution in sea water	2011	Environ. Sci. Pollut. Res. 2011 Aug:18(7):1057-1069. doi: 10.1007/s11356-011-0451-2.	Due to their high water solubilities and mobilities, persistent, polar perfluorinated compounds (PFCs) such as perfluorinated carboxylates and sulfonates are likely to end up in the oceans. In part 1 of this study, their distribution in North and Baltic Sea water is reported, being of special interest because these seas are surrounded by highly industrialized countries with high population densities. A combination of solid-phase extraction and liquid chromatography coupled with tandem mass spectrometry was used after optimisation to determine nine PFCs with chain lengths of C-4 to C-10 in water samples at ultra-trace levels. The observed concentration distribution and gradients were explained by oceanographic mixing processes and currents. The big rivers were identified as major input sources. At the mouth of the river Elbe, concentrations of 9 ng/L were observed for perfluorooctanoate (PFOA), and 8 ng/L for perfluorooctylsulfonate (PFOS); all other PFC concentrations ranged from 0.6 to 1.7 ng/L. At coastal stations, concentrations decreased to 3.8 ng/L (PFOA) and 1.8 ng/L (PFOS), dropping to 0.13 and 0.09 ng/L, respectively, towards the open sea. Along the Dutch coast, high perfluorobutylsulfonate concentrations (3.9 ng/L) were observed as regional characteristics. In the Baltic Sea, fairly even PFC distributions with low gradients were observed. Again, PFOA and PFOS were the major compounds (up to 1.1 and 0.9 ng/L). The results underline the necessity to include PFCs in marine monitoring programs. Water was found to be a good matrix for monitoring environmental levels, sources, and transport pathways of PFCs.				1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D865	環境中運命	Hori, H; Nagaoka, Y; Murayama, M; Kutsuna, S	Efficient decomposition of perfluorocarboxylic acids and alternative fluorochemical surfactants in hot water	2008	Environ. Sci. Technol. 2008 Oct:42(19):7438-7443. doi: 10.1021/es800832p.	Decomposition Of C-5-C-9 perfluorocarboxylic acids (PFCAs) and perfluoroether carboxylic acids (alternatives to PFCA-based surfactants) in hot water in a sealed reactor was investigated. Although PFCAs showed almost no decomposition in hot water at 80 degrees C in the absence of persulfate (S2O82-), the addition Of S2O82- to the reaction system led to efficient decomposition, even at this relatively low temperature. The major products in the aqueous and gas phases were F- ions and CO2, respectively, and short-chain PFCAs were also detected in the aqueous phase. For example, when an aqueous solution containing perfluorooctanoic acid (PFOA, 374 mu M) and S2O82- (50.0 mM) was heated at 80 degrees C for 6 h, PFOA concentration in the aqueous phase fell below 1.52 mu M (detection limit of HPLC with conductometric detection), and the yields of F- ions [i.e., (moles of F- formed)/(moles of fluorine content in initial PFOA)] and CO2 [i.e, (moles Of CO2 formed)/(moles of carbon content in initial PFOA)] were 77.5% and 70.2%, respectively. This method was also effective in decomposing perfluoroether carboxylic acids, such as CF3OC2F4OCF2COOH, CF3OC2F4OC2F4OCF2COOH, and C2F5OC2F4OCF2COOH, which are alternatives to PFCA-based surfactants, producing F- and CO2 with yields of 82.9-88.9% and 87.7-100%, respectively, after reactions at 80 degrees C for 6 h. In addition, the method was successfully used to decompose perfluorononanoic acid in a floor wax solution. When PFOA was treated at a higher temperature (150 degrees C) other decomposition reactions occurred: the formation of F- and CO2 was dramatically decreased, and 1H-perfluoroalkanes (CnF2n+1H, n = 4-7) formed in large amounts. This result clearly indicates that treatment with high-temperature water was not suitable for the decomposition of PFCAs to F-: surprisingly, the relatively low temperature of 80 degrees C was preferable.			1					B	-		
D866	環境中運命	Shih, KM; Wang, F	Adsorption behavior of perfluorochemicals (PFCs) on boehmite: influence of solution chemistry	2013	PROCEDIA ENVIRON SCI 2013:18:106-113. doi: 10.1016/j.proenv.2013.04.015	With global distribution, persistence nature, and strong bioaccumulation, the fate and transport of perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) in natural environment have recently attracted strong attentions. As boehmite is a common form of hydrated aluminum oxide existing in soils and sediments, this study successfully revealed the adsorption behavior of PFOS and PFOA on boehmite and the influence from solution chemistry. The results of kinetic experiments show that the adsorption equilibrium can be achieved within 48 hours and the boehmite surface is generally receptive to PFOS and PFOA adsorption. The adsorption isotherms estimated the maximum adsorption capacities of PFOS and PFOA on boehmite to be 0.877 mu g/m(2) and 0.633 mu g/m(2), respectively. The increase of pH can lead to a moderate decrease of PFOS and PFOA adsorption, owing to the increase of ligand exchange reaction and the decrease of electrostatic interaction. With the compression of electrical double layers, the competitive adsorption from the other ions and the Ca2+ bridging effect between perfluorochemicals have demonstrated their negative influence for PFOS and PFOA adsorption on boehmite surface. Finally, humic acid (HA) also showed significant retardant effects on the sorption of perfluorooctanesulfonate (PFOS) and perfluorobutanesulfonate (PFBuS) on boehmite.				1				B	-		
D867	蓄積性	Lucia, M; Verboven, N; Strom, H; Miljeteig, C; Gavrilo, MV; Braune, BM; Boertmann, D; Gabrielsen, GW	Circumpolar contamination in eggs of the high-arctic ivory gull Pagophila eburnea	2015	Environ. Toxicol. Chem. 2015 Jul:34(7):1552-1561. doi: 10.1002/etc.2935.	The ivory gull Pagophila eburnea is a high-Arctic species threatened by climate change and contaminants. The objective of the present study was to assess spatial variation of contaminant levels (organochlorines [OCs], brominated flame retardants [BFRs], perfluorinated alkyl substances [PFASs], and mercury [Hg]) in ivory gulls breeding in different areas across the Arctic region as a baseline for potential future changes associated with climate change. Contaminants were already determined in eggs from Canada (Seymour Island; except PFASs), Svalbard in Norway (SvenskOya), and 3 sites in Russia (Nagurskoe, Cape Klyuv, and Domashny). New data from Greenland allowed the investigation of a possible longitudinal gradient of contamination. The most quantitatively abundant OCs were p,p-dichlorodiphenyldichloroethylene (DDE) and polychlorobiphenyls. Mercury concentrations were higher in Canada compared with other colonies. Eggs from Nagurskoe often were characterized by higher OC and BFR concentrations. Concentrations gradually decreased in colonies situated east of Nagurskoe. In contrast, PFAS concentrations, especially perfluorooctanoate and perfluorononanoate, were higher in Greenland. Some of the contaminants, especially Hg and p,p-DDE, exceeded published thresholds known to disrupt the reproductive success of avian species. Overall, the levels of OCs, BFRs, and PFASs did not suggest direct lethal exposure to these compounds, but their potential synergetic/additive sublethal effects warrant monitoring.			1					B	-		
D868	蓄積性	De Silva, AO; Mabury, SA	Isolating isomers of perfluorocarboxylates in polar bears (Ursus maritimus) from two geographical locations	2004	Environ. Sci. Technol. 2004 Dec:38(24):6538-6545. doi: 10.1021/es049296p.	The source of involatile, anthropogenic perfluorocarboxylate anions (PFCAs) in biota from remote regions is of heightened interest due to the persistence, toxicity, and bioaccumulation of these materials. Large-scale production of fluorinated compounds is carried out primarily by one of two methods: electrochemical fluorination (ECF) and telomerization. Products of the two processes may be distinguished based on constitutional isomer pattern as ECF products are characteristically comprised of a variety of constitutional isomers. The objective of this research was to develop a method for identifying the constitutional isomer profile of PFCAs in environmental samples and to apply the method to polar bear livers from two different locations. Resolution of constitutional isomers of derivatized PFCAs (8-13 carbons) was accomplished via GC-MS. Seven isomers of an authentic ECF perfluorooctanoate (PFOA) standard were separated. The linear isomer comprised 78% of this standard. Isomer profiles of PFCAs in liver samples of 15 polar bears (Ursus maritimus) from the Canadian Arctic and eastern Greenland were determined by GC-MS. The PFOA isomer pattern in Greenland polar bear samples showed a variety of branched isomers while only the linear PFOA isomer was determined in Canadian samples. Samples of both locations had primarily (>99%) linear isomers of perfluorononanoate and perfluorotridecanoate. Branched isomers of perfluorodecanoate, perfluoroundecanoate, and perfluorododecanoate were determined in the polar bear samples. Unlike the PFOA isomer signature, only a single branched isomer peak on the chromatograms was observed for these longer chain PFCAs. The presence of branched isomers suggests some contribution from ECF sources. However, in comparison to the amount of branched isomers in the ECF PFOA standard, such minor percentages of branched PFCAs may suggest additional input from an exclusively linear isomer source.			1					B	-		
D869	蓄積性	Xia, XH; Rabearisoa, AH; Jiang, XM; Dai, ZN	Bioaccumulation of Perfluoroalkyl Substances by Daphnia magna in Water with Different Types and Concentrations of Protein	2013	Environ. Sci. Technol. 2013 Oct:47(19):10955-10963. doi: 10.1021/es401442y.	Perfluoroalkyl substances (PFASs) are sometimes regarded as proteinophilic compounds, however, there is no research report about the effect of environmental protein on the bioaccumulation of PFASs in waters. In the present study we investigated influences of protein on the bioaccumulation of six kinds of PFASs by Daphnia magna in water; it included perfluorooctane sulfonate, perfluorooctanoic acid, perfluorononanoic acid, perfluorodecanoic acid, perfluoroundecanoic acid, and perfluorododecanoic acid. Two types of protein including bovine albumin from animal and soy peptone from plant were compared and the effects of protein concentration were investigated. Both types of protein at high concentrations (10 and 20 mg L-1) suppressed the bioaccumulation of PFASs. When protein concentration increased from 0 to 20 mg the decreasing ratios of the PFAS body burden (35.3-52.9%) in Daphnia magna induced by bovine albumin were significantly higher than those (22.0-36.6%) by soy peptone. The dialysis bag experiment results showed that the binding of PFASs to protein followed the Freundlich isotherm, suggesting it is not a linear partitioning process but an adsorption-like process. The partition coefficients of PFASs between bovine albumin and water were higher compared to soy peptone; this resulted in higher reducing rates of freely dissolved concentrations of PFASs with increasing bovine albumin concentration, leading to a stronger suppression of PFAS bioaccumulation. However, the presence of both types of protein with a low concentration (1 mg L-1) enhanced the bioaccumulation of PFASs. Furthermore, the water-based bioaccumulation factor based on the freely dissolved concentrations of PFASs even increased with and the depuration rate constants of PFASs from Daphnia magna decreased with protein concentration, suggesting that protein would not only reduce the bioavailable concentrations and uptake rates of PFASs but also lower the elimination rates of PFASs in Daphnia magna. Because these two opposite effects would change with different protein concentrations in water, the net effect of protein on PFAS bioaccumulation would also vary with protein concentration.			1					B	-		
D870	蓄積性	Liu, CH; Chang, VWC; Gin, KYH	OXIDATIVE TOXICITY OF PERFLUORINATED CHEMICALS IN GREEN MUSSEL AND BIOACCUMULATION FACTOR DEPENDENT QUANTITATIVE STRUCTURE-ACTIVITY RELATIONSHIP	2014	Environ. Toxicol. Chem. 2014 Oct:33(10):2323-2332. doi: 10.1002/etc.2679.	Concerns regarding perfluorinated chemicals (PFCs) have risen in recent years because of their ubiquitous presence and high persistency. However, data on the environmental impacts of PFCs on marine organisms are very limited. Oxidative toxicity has been suggested to be one of the major toxic pathways for PFCs to induce adverse effects on organisms. To investigate PFC-induced oxidative stress and oxidative toxicity, a series of antioxidant enzyme activities and oxidative damage biomarkers were examined to assess the adverse effects of the following 4 commonly detected compounds: perfluoro-octanesulfonate, perfluoro-ocanoic acid, perfluorononanoic acid, and perfluorodecanoic acid, on green mussel (Perna viridis). Quantitative structure-activity relationship (QSAR) models were also established. The results showed that all the tested PFCs are able to induce antioxidant response and oxidative damage on green mussels in a dose-dependent manner. At low exposure levels (0 mu g/L-100 mu g/L), activation of antioxidant enzymes (catalase [CAT] and superoxide dismutase [SOD]) was observed, which is an adaptive response to the excessive reactive oxygen species induced by PFCs, while at high exposure levels (100 mu g/L-10 000 mu g/L), PFCs were found to inhibit some enzyme activity (glutathione S-transferase and SOD) where the organism's ability to respond in an adaptive manner was compromised. The oxidative stress under high PFC exposure concentration also led to lipid and DNA damage. PFC-induced oxidative toxicity was found to be correlated with the bioaccumulation potential of PFCs. Based on this relationship, QSAR models were established using the bioaccumulation factor (BAF) as the molecular descriptor for the first time. Compared with previous octanol-water partition coefficient-dependent QSAR models, the BAF-dependent QSAR model is more suitable for the impact assessment of PFCs and thus provides a more accurate description of the toxic behavior of these compounds.			1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D871	環境中運命	Wang, SQ; Cai, YZ; Ma, LY; Lin, XP; Li, Q; Li, YY; Wang, XH	Perfluoroalkyl substances in water, sediment, and fish from a subtropical river of China: Environmental behaviors and potential risk	2022	Chemosphere. 2022 Feb;288(Pt 1):132513. doi: 10.1016/j.chemosphere.2021.132513.	Perfluoroalkyl substances (PFAS) in water, sediment and fish were analyzed from a subtropical river, Jiulong River in the southeast of China, to character the sources, seasonal variations, bioconcentration and potential risk. PFAS in water, sediment, muscle and liver tissues of fish ranged from 2.5 to 410 ng L-1, 0.24-1.9 ng g(-1) dw, 25-100 and 35-1100 ng g(-1) ww, respectively. Generally, perfluomhexanoic acid (PFHxA) was the dominant compound in water, while, perfluomoctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) were the dominant compounds in sediment and fish tissues. High concentrations of PFAS in water were found near the machinery manufacturing and paper packaging plants in the north branch of Jiulong River. PFAS during the dry season were significantly ($P < 0.01$) higher than that during the normal season and wet season. The K-d of PFAS increased with the carbon chain length, and perfluoroalkyl sulfonic acids (PFSAs) exhibited higher K-d values than perfluoroalkyl carboxylic acids (PFCAs), indicating these long chain PFAS tended to be adsorbed by sediment. Long chain PFAS exhibited high bioconcentration factors (BCFs), while short and medium carbon chain PFAS had weak bioconcentration capacity. The hazard ratios (HR) suggested that frequent consumption of river fish may pose health risks to local population.		1						B	-		
D872	環境中運命	Wang, XW; Zhang, HW; He, XS; Liu, JF; Yao, ZL; Zhao, HB; Yu, DY; Liu, BS; Liu, TF; Zhao, WL	Contamination of per- and polyfluoroalkyl substances in the water source from a typical agricultural area in North China	2023	Front. Environ. Sci. 2023 Jan:10:1071134. doi: 10.3389/fenvs.2022.1071134.	There is limited information on contaminations of per- and polyfluoroalkyl substances (PFASs) in the water source affected by agricultural activities. The contamination of PFASs was investigated in the sources of agricultural groundwater and nearby surface water from an important vegetable production base supply for Beijing and Tianjin, located in North China. sigma(13)PFAS concentrations ranged from 0.321 to 8.285 ng/L, with an average concentration of 2.022 ng/L in the groundwater and 19.673 ng/L in the surface water. With the increase in the carbon chain length, the mean concentrations of PFASs in groundwater generally showed a decreasing trend. The dominated congeners of short-chain perfluorobutanesulfonate and perfluorooctanoate acid (PFOA) were detected in all groundwater samples, with mean concentrations of 0.944 and 0.654 ng/L. The difference was that PFOA and perfluorooctanesulfonate (PFOS) were the dominant congeners in nearby surface water, with concentrations of 7.585 and 3.421 ng/L. Thus, the concentrations of PFOA and PFOS in the surface water were about 8.5 times higher than those in the groundwater, indicating that sigma(13)PFAS concentrations might decrease with the water migration from the overground to the underground. In addition, significant correlations were observed between PFASs and DOC/TN related to agricultural activities, suggesting a certain relationship existed between PFAS conger distributions and organic carbon/nutrients in water. Health risk assessment indicated that the PFAS exposure caused insignificantly immediate harm to residents in the studied area. This survey provided information on the sources, spatial distribution, and potential migration characteristics of PFASs in a typical agricultural area of North China.				1			B	-		
D873	蓄積性	Schultes, L; Sandblom, O; Broeg, K; Bignert, A; Benskin, JP	Temporal Trends (1981-2013) of Per- and Polyfluoroalkyl Substances and Total Fluorine in Baltic cod (Gadus morhua)	2020	Environ. Toxicol. Chem. 2020 Feb:39(2):300-309. doi: 10.1002/etc.4615.	Temporal trends from 1981 to 2013 of 28 per- and polyfluoroalkyl substances (PFASs) were investigated in liver tissue of cod (Gadus morhua) sampled near southeast Gotland, in the Baltic Sea. A total of 10 PFASs were detected, with n-ary sumation (28)PFAS geometric mean concentrations ranging from 6.03 to 23.9 ng/g ww. Perfluorooctane sulfonate (PFOS) was the predominant PFAS, which increased at a rate of 3.4% per year. Most long-chain perfluoroalkyl carboxylic acids increased at rates of 3.9 to 7.3% per year except for perfluorooctanoate (PFOA), which did not change significantly over time. The perfluoroalkyl acid precursors perfluorooctane sulfonamide (FOSA) and 6:2 fluorotelomer sulfonic acid were detected, of which the former (FOSA) declined at a rate of -4.4% per year, possibly reflecting its phase-out starting in 2000. An alternate time trend analysis from 2000 to 2013 produced slightly different results, with most compounds increasing at slower rates compared to the entire study period. An exception was perfluorohexane sulfonate (PFHxS), increasing at a faster rate of 3.7% measured from 2000 on, compared to the 3.0% per year measured starting from 1981. Analysis of the total fluorine content of the samples revealed large amounts of unidentified fluorine; however, its composition (organic or inorganic) remains unclear. Significant negative correlations were found between concentrations of individual PFASs (with the exception of PFOS) and liver somatic index. In addition, body length was negatively correlated with PFOA and perfluorononanoate, but positively correlated with perfluorododecanoate (PFDoDA) and FOSA. Additional studies on endocrine, immunological, and metabolic effects of PFAS in marine fish are essential to assess the environmental risk of these substances.			1					B	-		
D874	環境中運命	Filipovic, M; Berger, U	Are perfluoroalkyl acids in waste water treatment plant effluents the result of primary emissions from the technosphere or of environmental recirculation?	2015	Chemosphere 2015 Jun:129:74-80. doi: 10.1016/j.chemosphere.2014.07.082	Wastewater treatment plants (WWTP) have been suggested to be one of the major pathways of perfluoroalkyl acids (PFAAs) from the technosphere to the aquatic environment. The origin of PFAAs in WWTP influents is either from current primary emissions or a result of recirculation of PFAAs that have been residing and transported in the environment for several years or decades. Environmental recirculation can then occur when PFAAs from the environment enter the wastewater stream in, e.g., tap water. In this study 13 PFAAs and perfluorooctane sulfonamide were analyzed in tap water as well as WWTP influent, effluent and sludge from three Swedish cities: Bromma (in the metropolitan area of Stockholm), Bollebygd and Umea. A mass balance of the WWTPs was assembled for each PFAA. Positive mass balances were observed for PFHxA and PFOA in all WWTPs, indicating the presence of precursor compounds in the technosphere. With regard to environmental recirculation, tap water was an important source of PFAAs to the Bromma WWTP influent, contributing >40% for each quantified sulfonic acid and up to 30% for the carboxylic acids. The PFAAs in tap water from Bollebygd and Umea did not contribute significantly to the PFAA load in the WWTP influents. Our results show that in order to estimate current primary emissions from the technosphere, it may be necessary to correct the PFAA emission rates in WWTP effluents for PFAAs present in tap water, especially in the case of elevated levels in tap water.			1					B	-		
D875	環境中運命	Liu, T; Qian, X; Wang, S; Wang, H; Wei, S; Chen, H	Occurrence and transport of perfluoroalkyl acids (PFAAs) in a Yangtze River water diversion project during water diversion and flooding	2021	Water Res. 2021 Oct:205:117662. doi: 10.1016/j.watres.2021.117662.	Water diversion is increasingly utilized for water supply, flood control, irrigation, and water quality improvement in many water bodies globally. Our findings indicate that micropollutants such as perfluoroalkyl acids (PFAAs) can be transported via dual-source water diversion projects during water diversion and flood discharge, which may negatively impact both receiving water bodies. However, the sources, spatiotemporal variations, and fluxes of PFAAs under water diversion projects remain unclear. Here we report patterns of 18 PFAA compounds in the surface water at 14 sites of a dual-source water diversion project (Wangyu River) connecting the Yangtze River and Taihu Lake in China. We found multiple contamination hotspots with PFHxA and PFOA dominantly originating from industrial and domestic sources during water diversion from the Yangtze River to Taihu Lake. During the severe flooding in summer 2020, PFAA concentrations ranged from 82.0 to 114.0 ng L-1, while the concentrations and relative contributions of individual perfluoroalkane sulfonic acids (PFSAs) increased along the mainstream due to the tributaries' contribution and high contamination level in the lake. Based on the spatiotemporal patterns of PFAA pollution, the flux of total PFAAs including both dissolved-phase and SS-phase into Taihu Lake was estimated as 26.6 kg in January 2020 as a reference value for water diversion. To our knowledge, this is the first report to describe the sources, occurrences, and transport of PFAAs in a dual-source water diversion project during water diversion and flooding. The results provide a novel perspective regarding the ecological safety of dual-source water diversion projects.			1					B	-		
D876	環境中運命	Wilkinson, JL; Hooda, PS; Swinden, J; Barker, J; Barton, S	Spatial distribution of organic contaminants in three rivers of Southern England bound to suspended particulate material and dissolved in water	2017	Sci. Total Environ. 2017 Sep:593:487-497. doi: 10.1016/j.scitotenv.2017.03.167	The spatial distribution of pharmaceuticals, personal care products (PPCPs) and other emerging contaminants (ECs) such as plasticisers, perflourinated compounds (PFCs) and illicit drug metabolites in water and bound to suspended particulate material (SPM) is not well-understood. Here, we quantify levels of thirteen selected contaminants in water (n = 88) and their partition to suspended particulate material (SPM, n = 16) in three previously-unstudied rivers of Greater London and Southern England during a key reproduction/spawning period. Analysis was conducted using an in-house validated method for Solid Phase Extraction followed by High-Performance Liquid Chromatography-Tandem Mass-Spectrometry. Analytes were extracted from SPM using an optimised method for ultrasonic-assisted solvent extraction. Detection frequencies of contaminants dissolved in water ranged from 3% (ethinylestradiol) to 100% (bisphenol-A). Overall mean concentrations in the aqueous-phase ranged from 14.7 ng/L (benzoylecgonine) to 159 ng/L (bisphenol-A). Sewage treatment works (STW) effluent was the predominant source of pharmaceuticals, while plasticisers/perfluorinated compounds may additionally enter rivers via other sources. In SPM, detection frequencies ranged from 44% (PFOA) to 94% (hydroxyacetophenone). Mean quantifiable levels of analytes bound to SPM ranged from 13.5 ng/g dry SPM (0.33 ng bound/L water) perfluorononanoic acid to 2830 ng/g dry SPM (14.3 ng bound/L water) perfluorooctanesulfonic acid. Long chain (>C7) amphipathic and acidic PFCs were found to more preferentially bind to SPM than short chain PFCs and other contaminants (Kd = 34.1-75.5 vs <5 respectively). Per capita daily contributions of studied contaminants entering rivers ranged from 0.157 mu g/person/day of benzoylecgonine (cocaine metabolite) to 58.6 mu g/person/day of bisphenol-A. The large sample size of this work (n = 104) enabled ANOVA followed by Tukey HSD post-hoc tests to establish significant trends in PPCP/EC spatial distribution from headwaters through downstream stretches of studied rivers. Novel findings include environmental Kd calculations, the occurrence of contaminants in river headwaters, increases in contaminant metabolite concentrations downstream of STW effluents revealing possible in-river degradation or de-conjugation, the influence of polarity and acidity in the partition of contaminants to particulate-material, among others.			1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D877	環境中運命	Wang, XP; Chen, MK; Gong, P; Wang, CF	Perfluorinated alkyl substances in snow as an atmospheric tracer for tracking the interactions between westerly winds and the Indian Monsoon over western China	2019	Environ. Int. 2019 Mar:124:294-301. doi: 10.1016/j.envint.2018.12.057	Snow is an efficient scavenger for the deposition of contaminants. Atmospheric transport and snow deposition jointly control the distribution of pollutants in remote mountain/polar regions. But can the contaminants contained within snow be used to reflect the interactions of air circulation patterns? The physicochemical properties of perfluoroalkyl substances (PFASs) are unique because of their high water solubilities. Taking advantage of this, 15 surface-snow and 3 snow-pit samples were collected across a vast area of western China (spanning 20 degrees of latitude and 25 degrees of longitude), to investigate the concentrations, composition profiles (fingerprints), and deposition fluxes of PFASs. Both a high concentration (3974 pg/L) and deposition flux (4.0 mu g/m(2)/yr) for a total of 16 PFASs were found in the snow at Yulong, the most southern sample site, possibly because of its close proximity to source regions of pollutants in South Asia and high rate of snow deposition. Perfluorobutanoic acid was the most commonly found chemical in snow, but in general the PFAS composition in the snow of western China showed large spatial differences, with long-chain (C > 10) PFASs being relatively dominant in the north and west of the region and short-chain (C < 6) PFASs in the south and east. On the basis of the different compositions of PFASs in the snow of western China and the previously reported features of pollutant sources in Europe and India, we found that PFASs in snow can be used as an atmospheric tracer for tracking the interactions between westerly winds and the Indian Monsoon. The belt along 33 degrees N is a key location where both the Indian Monsoon and westerly winds can arrive/interact; however, the contribution of the monsoon was found to be above 70%, while that of the westerly winds can be lower than 30%. The western part of the 33 degrees N belt was found to be more vulnerable to the Indian Monsoon, and could be grouped into the monsoon domain, while the influence of the westerly winds increased from west to east along the belt. This finding is opposite to previous results, which reported that the western part of the 33 degrees N belt was mainly under the influence of the westerly winds, and for the first time quantifies the relative contribution of westerly winds and the Indian Monsoon to the atmospheric transport of chemicals.	1							B	-		
D878	蓄積性	Sedlak, MD; Benskin, JP; Wong, A; Grace, R; Greig, DJ	Per-and polyfluoroalkyl substances (PFASs) in San Francisco Bay wildlife: Temporal trends, exposure pathways, and notable presence of precursor compounds	2017	Chemosphere 2017 Oct:185:1217-1226. doi: 10.1016/j.chemosphere.2017.04.096	Concentrations of perfluorooctane sulfonate (PFOS) in San Francisco Bay (SF Bay) wildlife have historically been among the highest reported globally. To track continuing exposures to PFASs and assess the impact of the 2002 phase-out of production of PFOS and related chemicals in the US, nine perfluoroalkyl carboxylic acids (PFCAs; C4-C12), three perfluoroalkyl sulfonic acids (PFSAs; C4, C6, C8) and perfluorooctane sulfonamide (PFOSA, a PFOS precursor) were measured in SF Bay cormorant eggs in 2012 and harbor seal serum sampled between 2009 and 2014. PFOS remained the dominant perfluoroalkyl acid (PFAA) in both cormorant eggs (36.1-466 ng/g) and seals (12.6-796 ng/g) from 2012 and 2014, respectively. Concentrations in seal and bird eggs from the South Bay have declined approximately 70% in both matrices. To elucidate potential pathways of exposure, prey fish, sediments and wastewater effluent were analyzed for PFASs, and in the case of sediment and effluent, a suite of PFAA precursors. PFOS was the dominant PFAA in prey fish and sediment. In effluent,, different mixtures of PFAAs were measured, with PFOS, PFHxA, and PFOA detected in the highest concentrations. Polyfluoroalkyl phosphate diesters (PFCA-precursors) were observed at concentrations over an order of magnitude higher than PFCAs in sediment, highlighting their importance as a potential, on-going source of PFCAs to SF Bay wildlife. These findings suggest that the PFOS phase-out has resulted in reduced burdens to wildlife in SF Bay, but that exposure to diverse and incompletely characterized PFASs continues.		1						B	-		
D879	蓄積性	Tao, L; Kannan, K; Kajiwara, N; Costa, MM; Fillmann, G; Takahashi, S; Tanabe, S	Perfluorooctanesulfonate and related fluorochemicals in albatrosses, elephant seals, penguins, and Polar Skuas from the Southern Ocean	2006	Environ. Sci. Technol. 2006 Dec:40(24):7642-7648. doi: 10.1021/es061513u.	Perfluorinated chemicals (PFCs) have been used as surfactants in industrial and commercial products for over 50 years. Earlier studies of the geographical distribution of PFCs focused primarily on the Northern Hemisphere, while little attention was paid to the Southern Hemisphere. In this study, livers from eight species of albatrosses, blood from elephant seal, and blood and eggs from penguins and polar skua collected from the Southern Ocean and the Antarctic during 1995 - 2005 were analyzed for 10 PFCs. In addition, for comparison with the Southern Ocean samples, we analyzed liver, sera, and eggs from two species of albatrosses from Midway Atoll in the North Pacific Ocean. Perfluorooctanesulfonate (PFOS) and perfluorooctanoic acid (PFOA) were found in livers of albatrosses from the Southern Ocean. PFOS was the major contaminant, although the concentrations were < 5 ng/g, wet wt, in 92% of the albatross livers analyzed. PFOA was detected in 30% of the albatross livers, with a concentration range of < 0.6 - 2.45 ng/g, wet wt. Other PFCs, including long-chain perfluorocarboxylates (PFCAs), were below the limits of quantitation in livers of albatrosses from the Southern Ocean. In liver, sera, and eggs of albatrosses from the North Pacific Ocean, long-chain PFCAs (perfluorononanoate, perfluorodecanoate, perfluoroundecanoate, and perfluorododecanoate) were found at concentrations similar to those of PFOS and PFOA. The mean concentration of PFOS in livers of Laysan albatrosses from the North Pacific Ocean (5.1 ng/g, wet wt) was higher than that in several species of albatrosses from the Southern Ocean (2.2 ng/g, wet wt). Species-specific differences in the concentrations of PFOS were noted among Southern Ocean albatrosses, whereas geographical differences in PFOS concentrations among the Indian Ocean, South Pacific Ocean, and South Atlantic Ocean were insignificant. Concentrations of PFOS and PFOA were, respectively, 2- and 17-fold higher in liver than in sera of Laysan albatrosses. PFOS was found in the blood of elephant seals from Antarctica at concentrations ranging from < 0.08 to 3.52 ng/mL. PFOS was found in eggs (2.1 - 3.1 ng/g) and blood (< 0.24 - 1.4 ng/mL) of polar skuas but was not detected in penguins from Antarctica. Our study documents the existence of low but detectable levels of PFOS and PFOA in Southern Hemisphere fauna, suggesting distribution of these compounds on a global scale.			1					B	-		
D880	環境中運命	Lv, JP; Guo, CS; Liang, SX; Zhang, Y; Xu, J	Partitioning behavior, source identification, and risk assessment of perfluorinated compounds in an industry-influenced river	2019	Environ. Sci Eur. 2019 SEP 10;31(1):55. doi: 10.1186/s12302-019-0251-8.	Background The widespread application of perfluorinated compounds (PFCs) makes them ubiquitously distributed in the environment. Investigation of contamination profiles, distribution, possible sources and risks of PFCs in Liaohe River, an industry-influenced river in northeast China was conducted in the present study. Results The total PFCs concentrations (n-ary sumation PFCs) were in the range 0.38-127.88 ng/L (average value of 36.41 ng/L) in water and 1.72-10.44 ng/g dry weight (average of 4.99 ng/g) in sediment. Perfluorooctanoic acid (PFOA) was the dominant individual in water and sediment phases, in the range 0.38-73.94 ng/L in water and below detection limit (BDL) to 7.88 ng/g dw in the sediments. The organic carbon normalized partition coefficients (K-oc) ranged from 2.46 L/kg (PFHxA) to 4.29 L/kg (PFUnDA). The average K-oc values for perfluorocarboxylic acids (PFCAs) increased by 0.13-0.62 log unit with each increasing CF2 moiety, and the K-oc values were lower than perfluoroalkyl sulfonates (PFASs). The sources of PFCs identified from diagnostic ratios suggested that the contaminants were mainly from the emission of manufacturing processes and precursors degradation. Result from risk assessment indicated that the immediate health impact through intaking water was negligible, but the levels of PFOA in surface water might cause effects on aquatic ecosystem. The mass inventories of n-ary sumation PFCs and PFOA were estimated to be 328.74 t and 103.43 t in the study area, respectively, suggesting that the sediment in Liaohe River may act as a potential PFCs source to the surrounding areas. Conclusion This study demonstrated that PFCs were widely presented in the water and sediments of Liaohe River. In general, PFCAs had higher concentrations and detection frequency than PFSAs, and PFCAs with short carbon chains had much higher detection frequencies than long-carbon chain compounds in water. Among all PFC homologues, the average K-oc increased with the increased carbon chain. K-oc values were higher for PFSAs than PFCAs. The risk assessment suggested that PFOA in water may exert adverse effect on the aquatic ecosystem. Liaohe River was likely acting as a PFCs source to the surrounding area.			1					B	-		
D881	蓄積性	Qi YJ, Zhou Z, Shi YL, Meng ZF.	[Pollution levels of perfluorochemicals in chicken eggs and duck eggs from the markets in Beijing]	2013	Huan Jing Ke Xue. 2013 Jan;34(1):244-50.	Pollution levels of perfluorochemicals in eggs purchased from the markets in Beijing had been investigated. The egg samples of chicken and duck were collected from the 59 stalls of 14 main eggs wholesale markets in Beijing, respectively. Systematic analyses were made for seventeen kinds of perfluorochemicals (11 perfluorinated carboxylates (PFCAs), 3 perfluorinated sulfonates (PFSAs), perfluorooctane sulfonamide (FOSA), 2-perfluorooctylethanoic acid (FOEA) and 2H-perfluoro-2-decenoic acid (FOUEA) by a high performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS). The results showed that there was a certain perfluorochemical contamination in all egg samples. Nine kinds of perfluorochemicals were detected in chicken eggs, perfluorononanoic acid (PFNA), perfluoroheptanoic acid (PFHpA) and perfluorooctanoate acid (PFOA) are dominant, and their average concentrations were 0.105, 0.073 and 0.069 ng x g(-1), respectively. Ten kinds of perfluorochemicals were detected in the duck eggs, perfluorooctane sulfonate (PFOS) and PFOA are dominant, and their average concentrations were 0.378 and 0.296 ng x g(-1), respectively. Perfluoropentanoic acid (PFPeA), perfluorotetradecanoic acid (PFTA), perfluorobutane sulfonate (PFBS) and 2-perfluorooctylethanoic acid (FOEA) were not detected in all samples. The total concentration of PFCs in the duck eggs was 3.4 times of that in the chicken eggs. A strong positive correlation (r = 0.954) was not only observed between of PFNA and PFHpA in chicken eggs, but also found between perfluoroundecanoic acid (PFUnDA) and perfluorotridecanoic acid (PFTrDA) in duck eggs (r = 0.915). The results of health-based risk assessment showed that there was little immediate risk of exposure to PFOS and PFOA via the consumption of chicken eggs and duck eggs purchased from the markets in Beijing.			1	1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D882	環境中運命	Kowalczyk J, Riede S, Schafft H, Breves G, Lahrssen-Wiederholt M.	Can perfluoroalkyl acids biodegrade in the rumen simulation technique (RUSITEC)?	2015	Environ Sci Eur. 2015;27(1):30. doi: 10.1186/s12302-015-0063-4. Epub 2015 Nov 23.	Background: The behaviour of perfluoroalkyl acids (PFAAs) in tissues of ruminants has been shown to differ from that of monogastrics (J Agric Food Chem 61(12):2903-2912 doi:10.1021/jf304680j, 2013; J Agric Food Chem 62(28):6861-6870, 2014). This may be a consequence of the complex microbial ecosystem in the rumen. To evaluate this hypothesis, the recovery of PFAAs was studied using the rumen simulation technique as an indication for biodegradation in rumen. The PFAA-recovery from a microbial fermentation of feed containing PFAAs was compared to the same feed in the absence of ruminal microorganisms (MOs). Results: Release of PFAAs from feed into fermentation fluid was found to be faster for perfluorobutane sulfonic acid (PFBS) than for perfluorooctane sulfonic acid (PFOS). Differences between perfluoroalkyl carboxylic acids (PFCAs) could not be observed. Proportions of PFAAs recovered in the fermentation fluids decreased by increasing chain lengths for the perfluoroalkyl sulfonic acids (PFSAs) (31 % PFBS, 28 % perfluorohexane sulfonic acid [PFHxS], 20 % perfluoroheptane sulfonic acid [PFHpS], 11 % PFOS) and PFCAs (33 % perfluorohexane carboxylic acid [PFHxA], 32 % perfluoroheptane carboxylic acid [PFHpA], 24 % perfluorooctanoic acid [PFOA]). In contrast, levels in feed increased with increasing chain length for both PFSAs and PFCAs. Conclusion: The attachment of MOs to feed particles was assumed to account for higher PFAA levels in fermented feeds and for lower levels in the fermentation fluids. Total recovery of PFAAs was significantly lower in presence of ruminal MOs compared to experimental procedure under sterile conditions. Although, there are optimal reductive conditions for MOs in rumen, our results do not univocally indicate whether PFAAs were degraded by ruminal fermentation.		1		1				B	-		
D883	環境中運命	Li QL, Cheng XH, Zhao Z, Guo MR, Yuan M, Hua X, Fang XG, Sun HW.	[Distribution and Fluxes of Perfluoroalkyl and Polyfluoroalkyl Substances in the Middle Reaches of the Yellow River (Weinan-Zhengzhou Section)]	2019	Huan Jing Ke Xue. 2019 Jan 8;40(1):228-238. doi: 10.13227/j.hjkx.201805240.	Surface water samples were collected in the middle reaches of the Yellow River (Weinan-Zhengzhou section) and all 28 perfluoroalkyl and polyfluoroalkyl substance (PFAS) levels were measured using high-performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS). The results show that the levels of PFASs in the water and particle phase are 18.4-56.9 ng·L-1 and 26.8-164 ng·g-1, respectively. Perfluorohexanoic acid (PFHxA) in the water and particle phases is the main pollutant, accounting for 27% and 16% of the total concentrations, respectively, and 3H-perfluoro-3-[(3-methoxy-propoxy)-propanoate] acid (ADONA) and chlorinated polyfluorinated ethersulfonic acids (6:2 and 8:2 Cl-PFESA) were detected in the particle phase, indicating that the use of PFAS alternatives gradually increases. The lgKd of PFASs between the water and particle phase ranges from 2.95±0.553 (PFPeA) to 3.85±0.237 (8:2 FTUCA)and the adsorption of fluorotelomer carboxylic acids (FTCAs) and fluorotelomer unsaturated carboxylic acids (FTUCAs) on particulate matter increases with increasing of carbon chain length. Perfluoroalkane sulfonic acids (PFSAs) are more easily adsorbed by particulate matter than perfluoroalkyl carboxylic acids (PFCAs). The fluxes of PFASs in the Weinan-Zhengzhou section of the Yellow River show a decrease at first and then increase, indicating that this section receives pollution inputs from the upstream and tributaries. In addition, the results show that the fluxes of PFASs in the water phase are greater than those in the particle phase.		1						B	-		
D884	環境中運命	Wang SL, Sun JS, Yang YW, Zhang M.	[Spatial Distribution of Perfluoroalkyl Acids and Transformation of Their Precursors in River Water Samples and Effluents of Wastewater Treatment Plans in a Typical Tourism City]	2018	Huan Jing Ke Xue. 2018 Dec 8;39(12):5494-5502. doi: 10.13227/j.hjkx.201805161.	Perfluoroalkyl acids (PFAAs) are commonly detected in various environmental media and can cause potential risks to the ecological environment and human health. The levels and spatial distribution of 15 types of PFAAs and 3 types of PFAA precursors in the main river water and effluents of three sewage treatment plants (STPs) of Rizhao City were systematically investigated based on methods such as ultra-performance liquid chromatography-tandem mass spectrometry (UPLC-MS/MS), solid phase extraction and enrichment, and hydroxyl radical (·OH) oxidation to explore the pollution characteristics of PFAAs and the contribution of their precursors to environmental pollution in different water bodies of typical tourist cities. The results of this study reveal that 15 types of PFAAs and only perfluorooctane sulfoneamide (FOSA) among the precursors are detectable in most of the water samples. The total concentration of PFAAs (∑PFAAs) in the river water and sewage effluents is 3.79-45.58 ng·L-1 and 54.04-105.64 ng·L-1, respectively. The predominant PFAAs are perfluorooctanesulfonic acid (PFOS), perfluorohexanesulfonic acid (PFHxS), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA). The ∑PFAAs value of the river samples is notably lower than that of sewage treatment plant (STP) effluents. An increasing tendency was observed from the upstream to the downstream of the rivers. After hydroxyl radical oxidation treatment, the PFAA concentrations of rivers and STPs increase notably. The increased concentrations of perfluorinated carboxylic acids (PFCAs) with 4-12 perfluoroalkyl carbon chains (∑△PFCAC4~C12) in the STP effluents are much higher than those in the river, which might be induced by the degradation of precursors during the sewage treatment processes. The results of this research provide basic data and technical support for environmental pollution prevention of new emerging pollutants in tourist cities.				1				B	-		
D885	蓄積性	Wang XF, Wang Q, Li ZG, Huang K, Li LD, Zhao DH.	[Contamination Characteristics and Safety Risk Assessment of Perfluorinated Alkylated Substances in Aquatic Products from Guangzhou]	2019	Huan Jing Ke Xue. 2019 Apr 8;40(4):1931-1938. doi: 10.13227/j.hjkx.201809113.	o investigate the contamination characteristics of PFASs in aquatic products, 254 samples belonging to 6 species, including fishes, crustaceans, cephalopods, etc., were collected from Guangzhou, and 23 PFASs were determined by UPLC-MS/MS. The total detection rates of the various sample species ranged from 93.5% to 100%, and the concentrations of PFASs were relatively higher in the fishes and crustaceans. 13 PFAS components were detected in the fish samples, but only 6 PFAS components were detected in haliotis samples, and obvious differences were observed among the different species sampled. PFOA and PFOS were the predominant pollutants, with detection rates of 75.6% and 76.8%. The concentrations of PFOS were in the range of 0.19-192.27 μg·kg-1, which were obviously higher than those of the other PFAS components, and their total contamination contribution factor reached the highest percentage of 35.15%. PFOS was a major contributing factor to the PFAS contamination of fishes, crustaceans, siphonopods, and processed products; however, the predominant pollutant in Haliotis samples was PFBA. The results of the risk assessment indicated that the concentrations of PFOA and PFOS would not give rise to timely harm to the consumers.	1						B	-		
D886	環境中運命	Yang HF, Shi B, Zhou YQ, Yang L, Meng J, Chen LQ, Wang TY.	[Spatial Characteristics and Ecological Risks of Perfluoroalkyl Substances in Coastal Urbanized Areas of China and South Korea]	2020	Huan Jing Ke Xue. 2020 Apr 8;41(4):1607-1618. doi: 10.13227/j.hjkx.201910153.	This study concentrated on the 15 perfluoroalkyl substances (PFASs) in the coastal areas of China and South Korea, an urbanized area with intensive human activities. In total, 126 water samples and 125 sediment samples were collected and determined by HPLC-MS/MS. Fifteen PFASs were detected at least once in all the sites. The total concentrations of PFASs in water and sediment samples ranged from 6.75 ng·L-1 to 20982 ng·L-1 and from 0.229 ng·g-1 to 53.8 ng·g-1 (dw), respectively. The concentrations of PFASs in waters and sediments were relatively high in China, and PFOA was the predominant PFAS. In contrast, short chain compounds such as PFBA and PFPeA played a major role in water, and PFOS, PFBA, and PFOA dominated the sediment samples in South Korea. The partition coefficients of PFASs were closely related to the fraction of organic carbon in the sediment and the carbon chain length of PFASs. Among the 15 compounds, the partition coefficients of 9 were significantly correlated with the fraction of organic carbon ($r>0.21$, $P<0.05$), and the partition coefficient steadily increased with the increase of the carbon chain length. The results of ecological risk assessment suggested that the coastal urbanized areas of China and South Korea are still at a low risk. However, some specific areas also showed PFAS pollution. More attention should be paid to the potential health risks.	1						B	-		
D887	環境中運命	Shi R, Mao RY, Zhang M, Lü YL, Song S, Zhao JX.	[Distribution, Sources, and Ecological Risks of Polyfluoroalkyl Substances in the Surface Water of the Wuliangsuhai Watershed]	2021	Huan Jing Ke Xue. 2021 Feb 8;42(2):663-672. doi: 10.13227/j.hjkx.202005216.	Polyfluoroalkyl substances (PFASs) enter the environment through multi-media diffusion and long-distance migration during the long-term manufacture and use of products containing PFASs. This study analyzed 17 PFASs in surface water samples collected from the Wuliangsuhai watershed in the wet and dry seasons, and investigated the temporal and spatial distribution characteristics, potential sources, and ecological risks of PFASs in the study area. PFASs were detected in all surface water samples at concentrations ranging from 4.00 to 263.45 ng·L-1. The spatial distribution of PFASs was affected by local human activities and showed two main types of characteristics. The first type was associated with Yellow River and canal water, which had relatively low concentrations of PFASs and was dominated by perfluorobutanoic acid (PFBA). The second type was associated with drain and lake water receiving industrial, agricultural, and domestic wastewater from the Hetao irrigation area, which had relatively high levels of PFASs and was dominated by perfluorooctanoic acid (PFOA). The PFAS concentrations in water samples collected during the dry season were higher than those collected in the wet season, being affected by the increased production of short-chain PFASs and seasonal changes in the amount of water from the Yellow River. The results of PFOS/PFOA, PFOA/PFNA, and PFHpA/PFOA indicated that the PFASs in the study area originate from atmospheric deposition and point source pollution. The risk assessment results showed that the current risk level from PFOA and PFOS in the study area is relatively low but their long-term cumulative effects cannot be ignored due to the cumulative characteristics and long-distance migration ability of PFASs.	1		1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D888	環境中運命	Lin X, Wang S, Li Q, Li Y, Yamazaki E, Yamashita N, Wang X.	Occurrence, partitioning behavior and risk assessments of per- and polyfluoroalkyl substances in water, sediment and biota from the Dongshan Bay, China	2022	Chemosphere. 2022 Mar;291(Pt 3):132812. doi: 10.1016/j.chemosphere.2021.132812. Epub 2021 Nov 8.	Twenty-five per- and polyfluoroalkyl substances (PFASs) were analyzed in water, sediment and biota from the Dongshan Bay (DSB) to study their seasonal variations, composition profiles, potential pollution sources, partitioning behavior and risk assessments. The total concentrations of PFASs (ΣPFASs) in water ranged from 3.2 to 6.5 ng L-1 (mean 4.0 ng L-1) during the dry season, and 0.11-4.5 ng L-1 (mean 1.3 ng L-1) during the wet season. Perfluoro-butane sulfonic acid (PFBS), perfluoro-butanoic acid (PFBA) and perfluoro-octanoic acid (PFOA) were dominated and frequently detected in water. ΣPFASs in sediment were 0.15-0.37 ng g-1 dw (mean 0.24 ng g-1 dw) with the long-chain PFASs perfluoro-octane sulfonic acid (PFOS) dominating. High concentrations of PFASs in land-based drainage outlets (2.0-384.6 ng L-1 in water) and Zhangjiang estuary indicated that land-based discharges and the river discharge were the main sources. High concentration (366.1 ng L-1) and proportion (94%) of PFBA on one drainage outlet agreed with the trend that PFBA was as an alternative to long-chain PFASs. ΣPFASs in biota ranged from 0.11 to 0.40 ng g-1 ww, and only long-chain PFASs were detected. The partition coefficients (log Kd) of PFASs between water and sediment ranged from 1.13 to 2.90, increased with carbon chain length, implied long-chain PFASs are more likely to adsorb to sediment. Results of ecological and health risk assessments indicated that PFASs had no significant risk for the aquatic organisms and local residents.	1			1				B	-		
D889	蓄積性	Jouanneau W, Léandri-Breton DJ, Corbeau A, Herzke D, Moe B, Nikiforov VA, Gabrielsen GW, Chastel O.	A Bad Start in Life? Maternal Transfer of Legacy and Emerging Poly- and Perfluoroalkyl Substances to Eggs in an Arctic Seabird	2022	Environ Sci Technol. 2022 May 17;56(10):6091-6102. doi: 10.1021/acs.est.1c03773. Epub 2021 Dec 7.	In birds, maternal transfer is a major exposure route for several contaminants, including poly- and perfluoroalkyl substances (PFAS). Little is known, however, about the extent of the transfer of the different PFAS compounds to the eggs, especially for alternative fluorinated compounds. In the present study, we measured legacy and emerging PFAS, including Gen-X, ADONA, and F-53B, in the plasma of prelaying black-legged kittiwake females breeding in Svalbard and the yolk of their eggs. We aimed to (1) describe the contaminant levels and patterns in both females and eggs, and (2) investigate the maternal transfer, that is, biological variables and the relationship between the females and their eggs for each compound. Contamination of both females and eggs were dominated by linPFOS then PFUnA or PFTriA. We notably found 7:3 fluorotelomer carboxylic acid—a precursor of long-chain carboxylates—in 84% of the egg yolks, and provide the first documented finding of ADONA in wildlife. Emerging compounds were all below the detection limit in female plasma. There was a linear association between females and eggs for most of the PFAS. Analyses of maternal transfer ratios in females and eggs suggest that the transfer is increasing with PFAS carbon chain length, therefore the longest chain perfluoroalkyl carboxylic acids (PFCAs) were preferentially transferred to the eggs. The mean ΣPFAS in the second-laid eggs was 73% of that in the first-laid eggs. Additional effort on assessing the outcome of maternal transfers on avian development physiology is essential, especially for PFCAs and emerging fluorinated compounds which are under-represented in experimental studies.								B	-		
D890	環境中運命	Wu YQ, Song S, Shi YJ, Liu Y, Yang SJ.	[Screening and Control Measures for New Priority Pollutants in Surface Water of Tianjin]	2022	Huan Jing Ke Xue. 2022 Aug 8;43(8):4074-4086. doi: 10.13227/j.hjkx.202111166.	Emerging pollutants are frequently detected in surface water, threatening the regional aquatic ecosystem and human health. Due to their complex types and large differences in risk and toxicity, research based on the comprehensive assessment of the pollution characteristics to determine the new priority pollutants remains incomplete. This study established a multi-criterion scoring method targeting 41 emerging pollutants with the goal of protecting aquatic organisms and human health, using five key indicators including environmental exposure level, persistence, bioaccumulation, ecological risk, and health risk of pollutants. The emerging pollutants were screened and identified in the surface water of Tianjin. The priority levels of different congeners were divided, and the ecological and health risks of pollutants in the priority control list were evaluated. The results showed that 41 emerging pollutants were generally detected in the study area. The average concentration of sulfonamide antibiotics (SAs) and other drugs (Others) were the largest, with 200.04 ng·L-1 and 176.30 ng·L-1, respectively, followed by perfluorinated compounds (PFASs, 57.98 ng·L-1). In terms of pollutant categories, high-priority emerging pollutants were dominated by PFASs, accounting for 50%. Medium-priority emerging pollutants were still dominated by PFASs (26.32%), but the proportion was lower. Low-priority emerging pollutants were dominated by SAs, accounting for 31.25%. Perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), carbamazepine (CBZ), caffeine (CAF), perfluorohexyl sulfonic acid (PFHxA), and clarithromycin (CLA) were defined as a priority control list. Compared with other pollutants, PFOS and PFOA had higher scores in persistence, bioaccumulation, and health risk, whereas CBZ and CAF had higher scores in ecological risk. The average risk quotient (RQ) of CAF was 4.8, which indicated a relatively high ecological risk. Health risk indicated that the potential risk caused by PFOA (average hazard quotient was 0.018) cannot be ignored. For the priority control list, because of the high removal rate of CAF in sewage treatment plants, the construction of a pipe network and riverside belt with high vegetation coverage should be strengthened to reduce the impact of untreated sewage discharge and rainfall runoff. Pollutants with low removal rates in sewage treatment plants should be treated with combined technologies to improve the removal efficiency. In addition, industry substitution work should be accelerated to reduce emissions of PFOS, PFOA, and PFHxA.		1						B	-		
D891	蓄積性	Liang X, Zhou J, Yang X, Jiao W, Wang T, Zhu L.	Disclosing the bioaccumulation and biomagnification behaviors of emerging per/polyfluoroalkyl substances in aquatic food web based on field investigation and model simulation	2023	J Hazard Mater. 2023 Mar 5;445:130566. doi: 10.1016/j.jhazmat.2022.130566. Epub 2022 Dec 7.	Emerging poly/perfluoroalkyl substances (PFASs) have been widely detected in the environment, but their bioaccumulation and biomagnification behaviors are not well understood. We collected surface water, sediment, and various aquatic organisms from Lake Taihu, China. Several emerging PFASs, such as fluorotelomer sulfonates (FTSs), hexafluoropropylene oxides (HFPOs), and chlorinated polyfluoroalkyl ether sulfonic acids (Cl-PFESAs) were frequently detected in water and sediment samples. The concentrations of HFPO trimer acid (HFPO-TA), 4,8-dioxa-3 H-per-fluorononanoate, and FTSs were remarkably higher than those reported previously, indicating that their application is increasing in Taihu Basin. These emerging PFASs displayed higher sediment/water partitioning coefficients (log Koc) than the corresponding perfluoroalkyl acids (PFAAs) with the same perfluorinated carbon chain length. HFPOs and Cl-PFESAs were more labile to deposit in fish livers than perfluorooctanoic and perfluorooctane sulfonic acids, respectively. Both field investigations and model simulations indicated that HFPO-TA and Cl-PFESAs, as well as the hydrogen-substituted analogs of 6:2 Cl-PFESA (6:2 H-PFESA), were biomagnified along the aquatic food chain. The bioaccumulation model simulation revealed that the accumulation of these emerging PFASs in fish was mainly through dietary intake, whereas gill respiration and fecal excretion facilitated their elimination. Metabolic transformation might also contribute to their elimination relative to the legacy ones.				1				B	-		
D892	蓄積性	Ojemaye CY, Pampanin DM, Sydnes MO, Green L, Petrik L.	The burden of emerging contaminants upon an Atlantic Ocean marine protected reserve adjacent to Camps Bay, Cape Town, South Africa	2022	Heliyon. 2022 Dec 24;8(12):e12625. doi: 10.1016/j.heliyon.2022.e12625. eCollection 2022 Dec.	The presence and levels of fifteen chemicals of emerging concerns, including five perfluorinated compounds (PFCs), two industrial chemicals, seven pharmaceuticals and one personal care product, were evaluated in biota, seawater and sediments obtained from near-shore coastal zone in Camps Bay, Cape Town, South Africa. Eight compounds were found in seawater, and between nine to twelve compounds were quantified in marine invertebrates, sediment and seaweed. Diclofenac was the prevalent pharmaceutical with a maximum concentration of 2.86 ng/L in seawater, ≥110.9 ng/g dry weight (dw) in sediments and ≥67.47 ng/g dw in marine biotas. Among PFCs, perfluoroheptanoic acid was predominant in seawater (0.21-0.46 ng/L). Accumulation of perfluorodecanoic acid (764 ng/g dw) as well as perfluorononanoic acid and perfluorooctanoic acid (504.52 and 597.04 ng/g dw, respectively) was highest in samples of seaweed. The environmental risk assessment carried out in this study showed that although individual pollutants pose a low acute and chronic risk, yet individual compounds each had a high bioaccumulation factor in diverse marine species, and their combination as a complex mixture in marine organisms might have adverse effects upon aquatic organisms. Data revealed that this Atlantic Ocean marine protected environment is affected by the presence of numerous and diverse emerging contaminants that could only have originated from sewage discharges. The complex mixture of persistent chemicals found bioaccumulating in marine organisms could bode ill for the propagation and survival of marine protected species, since many of these compounds are known toxicants.			1					B	-		
D893	蓄積性	Li Y, Yao J, Pan Y, Dai J, Tang J.	Trophic behaviors of PFOA and its alternatives perfluoroalkyl ether carboxylic acids (PFECAs) in a coastal food web	2023	J Hazard Mater. 2023 Jun 15;452:131353. doi: 10.1016/j.jhazmat.2023.131353. Epub 2023 Apr 3.	With the increasing restrictions and concerns about legacy poly- and perfluoroalkyl substances (PFAS), the production and usage of alternatives, i.e., perfluoroalkyl ether carboxylic acids (PFECAs), have risen recently. However, there is a knowledge gap regarding the bioaccumulation and trophic behaviors of emerging PFECAs in coastal ecosystems. The bioaccumulation and trophodynamics of perfluorooctanoic acid (PFOA) and its substitutes (PFECAs) were investigated in Laizhou Bay, which is located downstream of a fluorochemical industrial park in China. Hexafluoropropylene oxide trimer acid (HFPO-TrA), perfluoro-2-methoxyacetic acid (PFMOAA) and PFOA constituted the dominant compounds in the ecosystem of Laizhou Bay. PFMOAA was dominant in invertebrates, whereas the long-chain PFECAs preferred to accumulate in fishes. The PFAS concentrations in carnivorous invertebrates were higher than those in filter-feeding species. Considering migration behaviors, the ΣPFAS concentrations followed the order oceanodromous fish < diadromous fish < non-migratory fish. The trophic magnification factors (TMFs) of long-chain PFECAs (HFPO-TrA, HFPO-TeA and PFO5DoA) were >1, suggesting trophic magnification potential, while biodilution for short-chain PFECAs (PFMOAA) was observed. The intake of PFOA in seafood may constitute a great threat to human health. More attention should be given to the impact of emerging hazardous PFAS on organisms for the health of ecosystems and human beings.				1				B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D894	蓄積性	Sun J, Xing L, Chu J.	Global ocean contamination of per- and polyfluoroalkyl substances: A review of seabird exposure	2023	Chemosphere. 2023 Jul;330:138721. doi: 10.1016/j.chemosphere.2023.138721. Epub 2023 Apr 18.	Per- and polyfluoroalkyl substances (PFAS) have been extensively produced and used as surfactants and repellents for decades. To date, the global contamination pattern of PFAS in marine biota has seldomly been reviewed. Seabirds are ideal biomonitoring tools to study environmental contaminants and their effects. Here, we compiled and synthesized reported PFAS concentrations in various seabird species to reflect spatiotemporal patterns and exposure risks of major PFAS on a global ocean scale. Perfluorooctane sulfonic acid (PFOS) was the most studied PFAS in seabirds, which showed the highest level in eggs of common guillemots (U. aalge) from the Baltic Sea, followed by great cormorants (P. carbo) from the North Sea and double-crested cormorants (P.auritus) from the San Francisco Bay, whereas the lowest were those reported for Antarctic seabirds. The temporal pattern showed an overall higher level of PFOS in the late 1990s and early 2000s, consistent with the phase-out of perfluorooctane sulfonyl fluoride-based products. Maximum liver PFOS concentrations in several species such as cormorants and fulmars from Europe and North America exceeded the estimated toxicity reference values. Systematic evaluations using representative species and long time-series are necessary to understand contamination patterns in seabirds in South America, Africa, and Asia where information is lacking. In addition, limited research has been conducted on the identification and toxic effects of novel substitutes such as fluorotelomers and ether PFAS (F-53B, Gen-X etc.) in seabirds. Further research, including multi-omics analysis, is needed to comprehensively characterize the exposure and toxicological profiles of PFAS in seabirds and other wildlife.								B	-	総説	
D895	蓄積性	Wang Q, Ruan Y, Jin L, Tao LSR, Lai H, Li G, Yeung LWY, Leung KMY, Lam PKS.	Legacy and Emerging Per- and Polyfluoroalkyl Substances in a Subtropical Marine Food Web: Suspect Screening, Isomer Profile, and Identification of Analytical Interference	2023	Environ Sci Technol. 2023 Jun 6;57(22):8355-8364. doi: 10.1021/acs.est.3c00374. Epub 2023 May 23.	The ban/elimination of legacy per- and polyfluoroalkyl substances (PFASs) has led to a dramatic increase in the production and use of various emerging PFASs over the past decade. However, trophodynamics of many emerging PFASs in aquatic food webs remain poorly understood. In this study, samples of seawaters and marine organisms including 15 fish species, 21 crustacean species, and two cetacean species were collected from the northern South China Sea (SCS) to investigate the trophic biomagnification potential of legacy and emerging PFASs. Bis(trifluoromethylsulfonyl)imide was found in seawater via suspect screening (concentration up to 1.50 ng/L) but not in the biota, indicating its negligible bioaccumulation potential. A chlorinated perfluorooctane sulfonate (PFOS) analytical interfering compound was identified with a predicted formula of C14H23O5SCl6- (most abundant at m/z = 514.9373). Significant trophic magnification was observed for 22 PFASs, and the trophic magnification factors of cis- and trans-perfluoroethylcyclohexane sulfonate isomers (1.92 and 2.25, respectively) were reported for the first time. Perfluorohexanoic acid was trophic-magnified, possibly attributed to the PFAS precursor degradation. The hazard index of PFOS was close to 1, implying a potential human health risk via dietary exposure to PFASs in seafood on the premise of continuous PFAS discharge to the SCS.		1						B	-		
D896	環境中運命	Jing Chen, Pengyi Zhang, Li Zhang	Photocatalytic Decomposition of Environmentally Persistent Perfluorooctanoic Acid	2006	Chemistry Letters, 2006年 35 巻 2 号 230-231. doi: 10.1246/cl.2006.230	Perfluorooctanoic acid was photocatalytically decomposed by using TiO2/Ni–Cu, and a small bias potential (−0.1 V) applied on TiO2/Ni–Cu electrode greatly enhanced its decomposition.								C	-		
D897	環境中運命	鈴木 裕識, 田中 周平, 北尾 亮太, 雪岡 聖, 中田 典秀, 藤井 滋穂, 齋藤 憲光	都市河川流下過程におけるPFCAs生成ポテンシャルの底質への移行とその変化体の蓄積	2016	土木学会論文集G（環境）, 2016年 72 巻 7 号 III_45-III_53. doi: 10.2208/jscejer.72.III_45	本研究グループでは，前駆体から生成するPFCAs量をPFCAs生成ポテンシャル（PFCA-FPs）と定義してその評価手法を検討し，適用を進めてきた．本研究では，下水処理水が水源のほぼ100%を占める都市河川を対象に，流下過程におけるPFCAsとPFCA-FPsの挙動の把握を主目的とし調査を行った．その結果，1) 生成ポテンシャルとして評価された前駆体が下水処理放流水中に残留し，2) 河川流下過程でPFOAとPFHxAの負荷量が増加していた．3) また，PFPeA-FPやPFHxA-FP等の生成ポテンシャルとして評価された前駆体が底質に移行しやすい傾向が確認され，4) さらに，LC-MS/MSによるMRM測定を用いて未知物質の探索を試みた結果，河川試料から5:3FTCAや5:2ketonとみられるピークが検出され，5:3FTCAとみられる化合物の底質中の蓄積が示唆された．		1						B	-		
D898	環境中運命	雪岡 聖, 田中 周平, 鈴木 裕識, 藤井 滋穂	化粧品中のポリフルオロアルキルリン酸エステル類の好気条件下における生分解生成物の挙動	2017	土木学会論文集G（環境）, 2017年 73 巻 7 号 III_149-III_156. doi: 10.2208/jscejer.73.III_149	本研究では，化粧品中のポリフルオロアルキルリン酸エステル類（PAPs）の好気条件下における生分解生成物の挙動の検討を主目的とした．PAPsは難分解性や生殖毒性が疑われているペルフルオロカルボン酸類（PFCAs）の前駆体として注目されている．下水処理場の生物処理工程を模擬した生分解試験より，化粧品中のPAPsからの類縁化合物類を含めた生分解生成物の挙動を定量的に評価した．化粧品中の10種のdiPAPsの濃度減少を一次反応式で近似した場合，その半減期は6～111時間であり，分子量が大きくなるにつれて，半減期が長くなる傾向が示された．8:2diPAPからのペルフルオロオクタン酸（PFOA）のモル生成率は4.0±0.4%であった．中間生成体と予想されるフッ素テロマーアルコール類（FTOHs），フッ素テロマーカルボン酸類（FTCAs）が生分解生成物として検出された．さらに，低分子量のFTOHs（5:2sFTOH, 6:2FTOH, 7:2sFTOH）は，曝気により気相へ移行する可能性が示唆された．								C	-		
D899	環境中運命	雪岡 聖, 田中 周平, 鍋谷 佳希, 鈴木 裕識, 藤井 滋穂, 高田 秀重	水環境中におけるマイクロプラスチックの粒径に着目した微量有機汚染物質の吸着特性	2018	土木学会論文集G（環境）, 2018年 74 巻 7 号 III_527-III_535. doi: 10.2208/jscejer.74.III_527	近年，水環境中のマイクロプラスチック（MPs）を輸送媒体とした微量有機汚染物質の水生生物への悪影響が問題視されている．本研究では水環境中におけるペルフルオロアルキル酸類（PFAAs）および多環芳香族炭化水素類（PAHs）とそのハロゲン化体類（X-PAHs）のMPsへの吸着特性の検討を主目的とした．特にMPsの粒径に着目し，1）MPs標準品を用いた吸着試験，2）2017年10~11月に琵琶湖・大阪湾における表層水中のMPsへの微量有機汚染物質の吸着量の存在実態の調査を行った．MPsの粒径が小さくなるにつれて，単位重量あたりのPFAAs, PAHs, X-PAHsの吸着量が多くなる傾向が示され，粒径数十μmのMPsでは浮遊物質より吸着量が多くなる可能性が示唆された．また，環境中の作用によりMPsが劣化し表面積が大きくなると，PFAAs, PAHsの吸着量がさらに増加することが予想された．								B	-		
D900	環境中運命	鍋谷 佳希, 田中 周平, 鈴木 裕識, 雪岡 聖, 藤井 滋穂, 高田 秀重	琵琶湖・大阪湾におけるマイクロプラスチックへのペルフルオロ化合物類および多環芳香族炭化水素類の吸着特性	2017	土木学会論文集G（環境）, 2017年 73 巻 7 号 III_1-III_8. doi: 10.2208/jscejer.73.III_1	本研究では，琵琶湖・大阪湾におけるマイクロプラスチックへのペルフルオロ化合物類（PFCs）および多環芳香族炭化水素類（PAHs）の吸着特性を検討することを主目的とした．表層水中の粒径315 μm～5 mmのマイクロプラスチックを対象としてPFCs 15種，PAHs 16種および塩素化PAHs 4種の同時分析を行った．マイクロプラスチック中の含有量は，Σ15 PFCsが49～218 ng/g-dry，Σ16 PAHsが 1,730～27,100 ng/g-dry，Σ4塩素化PAHsが29～799 ng/g-dryであった．PFCsおよびPAHsの各物質におけるマイクロプラスチックと溶存態の濃度比は，オクタノール/水分配係数（Log Kow）が大きくなるにつれて，増加傾向であり，疎水性吸着である可能性が示唆された．さらに，マイクロプラスチックの単位重量あたりのPAHs含有量は，粒径が小さくなるにつれて，増加する傾向が推察された．								B	-		
D901	蓄積性	津田 泰三, 居川 俊弘	世界河川および湖沼の水質および魚類中の有機フッ素化合物	2012	環境化学, 2012年 22 巻 4 号 149-173. doi: 10.5985/jec.22.149 詳細	Concentrations of 10 perfluorinated compounds in water and fish from rivers and lakes in the world were reviewed from the surveys in the years of 1998-2011. A yearly decreasing tendency was recognized in the concentrations of Perfluorooctane sulfonate (PFOS) and Perfluorooctanoic acid (PFOA) in water from several rivers in Japan. The concentrations of PFOA in water from rivers and lakes in Japan had a tendency to be higher than those of PFOS but the concentration levels of both compounds were equal in Europe. Further, the concentrations of PFOS in water from rivers in Europe and North America were higher than those in Japan and Asia. Composition of the perfluorinated compounds was PFOA >> Perfluorononanoic acid (PFNA) ≧ Perfluorohexanoic acid (PFHxA) in water from rivers and lakes in Japan and PFOS ≧ PFOA in Asia, Europe and North America. Perfluorinated compounds with more carbon atoms were more highly accumulated in fish, and bioconcentration factor (BCF) of PFOS was lower than that of Perfluorododecanoic acid (PFDDA) and nearly equal to that of Perfluoroundecanoic acid (PFUA) or Perflurorodecanoic acid (PFDA). Each of the BCF data of the perfluorinated compounds by field survey data (Field BCF) was nearly in the same order as each of the BCF data by laboratory experimental data (Laboratory BCF). However, absolute values of the Field BCF had a tendency to be higher than those of the Laboratory BCF. To verify this tendency, it is necessary to accumulate additional data on Laboratory and Field BCF and to advance the research development in future on adding the uptake of the compounds via food for the uptake of the compounds via gill in the Field BCF values or on the differences of the environmental conditions.		1	1					B	-		
D902	環境中運命	Xiaming CHEN, Hiroaki OZAKI, Rabindra Raj GIRI, Shogo TANIGUCHI, Ryohei TAKANAMI	Distribution and Diffusion Behaviors of Perfluorinated Compounds with Low Pressure Reverse Osmosis Membranes	2012	Journal of Water and Environment Technology, 2012年 10 巻 4 号 449-461. doi: 10.2965/JWET.2012.449	Low pressure reverse osmosis (LPRO) membrane filtration has emerged as the best alternative to ordinary reverse osmosis (RO) membrane filtration due to very low operating pressure involved with the former resulting in low cost. However, behaviors of perfluorinated compounds (PFCs) with LPRO membrane filtration are not known since the compounds as water/wastewater contaminants have only a very short history. Therefore, adsorption and diffusion behaviors of selected perfluoroalkyl carboxylate (PFAC) and perfluoroalkyl sulfonate (PFAS) compounds with a tight and a loose LPRO membranes were tested in laboratory experiments. Distribution coefficient (logKmw) and diffusion coefficient (Dp) values for the compounds were experimentally determined for the first time. The Dp values were about three orders of magnitude larger than those for pharmaceutical and endocrine disrupting compounds. The compounds exhibited similar behaviors to those of pharmaceutical and endocrine disrupting chemicals reported earlier. Adsorption of PFCs to membranes was directly correlated to molecular weight (MW) and carbon-chain length, while their diffusion through membrane pores showed inverse correlations with the parameters. Similarly, their rejections were directly correlated to their logKmw values and MW. However, significance of carbon-chain length on diffusion was not well understood, and hence further investigations should be devoted to elucidate on the point.								B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D903	蓄積性	Katsumi Iwabuchi, Norimasa Senzaki, Shuji Tsuda, Haruna Watanabe, Ikumi Tamura, Hitomi Takanobu, Norihisa Tatarazako	Bioconcentration of perfluorinated compounds in wild medaka is related to octanol/water partition coefficient	2015	Fundamental Toxicological Sciences, 2015年 2 巻 5 号 201-208. doi: 10.2131/fts.2.201	Perfluorinated compounds (PFCs) have been used widely, detected worldwide in the environment, and have accumulated highly in animals. As far as we know, there have been no reports which relate the PFC concentration in wild animals to the physicochemical properties. Therefore, we measured the concentrations of 15 currently available PFCs (perfluorocarboxylic acids with x carbons: Cx, perfluorosulfonic acids with x carbons: CxS) in medaka and the environmental water where medaka live. Samples were obtained from 7 points in Japan (Iwate, Ibaraki, Niigata, Hyogo, Yamaguchi, Ehime, and Nagasaki) from July to September in 2013. Twenty to forty medaka were collected from each point, as well as 2 L of water in a clean PET bottle. PFCs were extracted and concentrated using a solid-phase cartridge, and were measured by LC/MS/MS. The medaka samples were treated individually. C5-C9 and C8S were detected mainly in the water, C11-C13 and C8S were detected mainly in medaka. C8S was always detected in high concentrations in the water and medaka. The bioconcentration factors (BCFs) of PFCs were calculated from PFC concentrations of the water and the medaka. The BCFs of C8-C11 were increased exponentially with the length of carbon chain. The BCF of C8S (approx. 5,500) was far greater than C8 (approx. 330) or C9 (approx. 480). However, the BCFs of C8-C11 and C8S tended to increase in proportion with octanol/water partition coefficient (log Kow).								B	-		
D904	蓄積性	白坂 華子, 門上 希和夫	日本の淡水域に生息するギンブナ（Carassius auratus (gibelio) langsdorfii）中の有機フッ素化合物蓄積量調査	2014	環境化学, 2014年 24 巻 3 号 67-76. doi: 10.5985/jec.24.67	Perfluorinated compounds (PFCs) that are widely used as surfactants and coatings were determined in muscles of crucian carp (Carassius auratus (gibelio) langsdorfii) taken from 14 freshwater areas throughout Japan during 2003-2005.The sampling sites comprised 10 rivers and 4 ponds and were categorized into 4 groups based on local circumstances: large cities, small cities, agricultural areas and remote areas. PFCs were detected in all samples analyzed, and total PFCs concentrations ranged from 1.60 to 30.1 (average: 9.54, median: 8.80) ng/g wet wt. and 167 to 3496 (average: 914, median:645) ng/g lipid wt. The highest concentrations of PFCs were found in fish caught at sites in large cities. Fish in the remote area's had low PFCs concentrations. Branched chain PFC isomers were also detected, although the relative ratios of the straight chains to the branch isomers were different between sampling sites. To obtain maternal transfer rates for the PFCs, female fish were collected from the Murasaki River during the spawning season and their muscles and eggs were analyzed. The maternal transfer rate of PFCs was 9.1%, which is lower than those of hydrophobic substances such as dioxins, organochlorine pesticides and hexabromocyclododecanes. As a result, sexual differences between male and female fish were not found.								B	-		
D905	環境中運命	鈴木 裕識, 田中 周平, 藤井 滋穂, Chinagarn Kunacheva, 林 益啓, 齋藤 憲光	下水処理場生物処理工程におけるペルフルオロオクタン酸の活性汚泥への吸着挙動および生成ポテンシャルの検討	2012	土木学会論文集G（環境）, 2012年 68 巻 7 号 III_333-III_340. doi: 10.2208/jscejer.68.III_333	本研究では，下水処理場生物処理工程におけるペルフルオロオクタン酸（PFOA）の挙動の把握を主目的とし，処理場から採取後すぐの活性汚泥と馴養した活性汚泥を用いて，室内実験を行った．主な結果として，(1)PFOAを添加した合成下水の半回分式生物処理実験では，生物反応槽内のPFOAの懸濁態比と存在量が増加し，(2)実下水が処理槽に流入する実験系では，PFOAの総排出量が総投入量に比べ2.0倍となった．(3)8日間の活性汚泥上澄み液存在下における1H, 1H, 2H, 2H-Perfluoro-1-decanolの分解実験では，添加モル量に対して2.9%のPFOAが生成した．このことから，生物反応槽におけるPFOAの存在量増加には，活性汚泥への吸着による循環と実下水中に存在する前駆体からのPFOAの生成が影響していることが示唆された．								C	-		
D906	環境中運命	鈴木 裕識, 田中 周平, 藤井 滋穂, 中田 典秀, 石川 一真, Jira KONGPRAN, 齋藤 憲光	下水処理過程における前駆体からの生成を考慮したペルフルオロカルボン酸類の挙動の検討	2014	土木学会論文集G（環境）, 2014年 70 巻 7 号 III_55-III_64. doi: 10.2208/jscejer.70.III_55	本研究では，下水処理過程におけるペルフルオロカルボン酸類（PFCAs）の挙動をその前駆体を考慮して検討することを主目的とし，実処理場の調査結果を元に，1)各処理過程中のPFCAs存在状況の把握，2)包括的なPFCAs生成能の評価手法の検討，3)生成能を考慮した各処理過程中のPFCAsの存在量収支の検討を行った．その結果，1) PFOAやPFNAは処理過程を経て濃度が増加し，返送汚泥とともに生物処理系を循環している傾向が示唆された．2) 塩基性条件下でペルオキソ二硫酸カリウムによる酸化分解を行うことで，返送汚泥中では317ng/LのPFOA生成能（初期濃度の4.5倍）と929ng/LのPFNA生成能（初期濃度の5.0倍）を検出した．3) 生物処理および最終沈殿処理では収支が合わなかったΣ6種PFCAsの存在量が，生成能を考慮することで収支がほぼ一致した．			1					B	-		
D907	環境中運命	三島 聡子, 小澤 憲司, 中山 駿一, 菊池 宏海	相模湾漂着マイクロプラスチックの有機フッ素化合物の吸着実態と流入河川の影響	2020	環境化学, 2020年 30 巻 66-81. doi: 10.5985/jec.30.66	Microplastics (MP) can cause damage to ocean ecosystem. The environmental problems due to MP contamination is attracting worldwide attention. In this study, the survey was conducted to clarify the origin of MP obtained on various beaches of Sagami Bay from the viewpoint of chemical adsorption. There was no clear difference in the amount of Perfluorinated Compounds (PFCs) adsorbed on various MP materials. PS foam with a large surface area adsorbed more PFCs per unit weight than resin. The amount of PFOS adsorbed on the MP collected on Kugenuma beach downstream Hikiji river, where PFOS concentration in the water sample was relatively high, was higher than that adsorbed on the MP collected from the other two beaches. The total rainfall for one month before sampling in autumn was higher than the annual average, and the amount of PFCs adsorbed on the MP in autumn was lower than that in other seasons. The amount of PFOS adsorbed on the MP was high in the river downstream from the middle of the Hikiji River. Partition coefficient (Kd) of PFOS that obtained from the elution test used the collected MP was higher than the valve by adsorption test for unused MP. Apparent Kd of PFOS by the MP on Kugenuma beach and the river water at Hujimi bridge of Hikiji river was the same order as the valve that obtained from the elution test used the collected MP. It has been clarified that the MP fragments flowed into the Hikiji river were adsorbed with PFOS and flowed down, and they were drifted to the Kugenuma beach.								B	-		
D908	環境中運命	Shintaro Kawano, Toshiyuki Kida, Shusuke Takemine, Chisato Matsumura, Takeshi Nakano, Masaki Kuramitsu, Kenji Adachi, Mitsuru Akashi	Efficient Removal and Recovery of Perfluorinated Compounds from Water by Surface-tethered β-Cyclodextrins on Polystyrene Particles	2013	Chemistry Letters, 2013年 42 巻 4 号 392-394. doi: 10.1246/cl.121239	-To efficiently remove and recover perfluorinated compounds (PFCs) such as perfluorooctanoic acid (PFOA) and perfluorooctanesulfonate (PFOS) from water, surface-tethered β-cyclodextrins (CDs) on the surface of polystyrene (PS) particles (PS-β-CDs) were prepared. The PS-β-CDs with a 36% β-CD content showed high adsorption capability against these PFCs from water via inclusion complex formation. The perfluorocarboxylic acids (PFCAs) adsorbed onto PS-β-CDs were easily and quantitatively recovered by washing with acetone.								B	-		
D909	環境中運命	Jira KONGPRAN, Shuhei TANAKA, Shigeo FUJII, Yuji SUZUKI, Norihiro SAKUI, Norimitsu SAITO	Wet Deposition and Photodegradation of Perfluoroalkyl Carboxylates and Fluorotelomer Alcohols: Distribution Pathways from Air to Water Environment	2014	Journal of Water and Environment Technology, 2014年 12 巻 6 号 481-499. doi: 10.2965/jwet.2014.481	This study aims to investigate the distribution of perfluoroalkyl carboxylates (PFCAs) and fluorotelomer alcohols (FTOHs) from air to water environment. Air and rainwater samples were collected in Kyoto, Japan. Eight PFCAs (C5 - C12) and three FTOHs in the samples were quantified by HPLC-MS/MS and GC-MS, respectively. All PFCAs were detected in the air (140 pg/m3) and rainwater (16.4 ng/L) samples, indicating their wet deposition from air in the study area. Flux of PFCAs via wet deposition ranged between 120 - 670 ng/m2 in each rainfall event. All FTOHs were detected in the air (1,800 pg/m3) but they were below the detection limits in rainwater (< 6.9 - 8.7 ng/L). The results indicated that FTOHs were difficult to be wet deposited from the air. Most of PFCAs in rainwater increased after a few weeks of sunlight exposure, which suggests degradation of their precursor compounds. Photodegradation of 8:2 FTOH was confirmed by a UV (254 nm) irradiation experiment. Five PFCAs (C5 - C9) were identified as degradation products of 8:2 FTOH, with the production rate of 1.79% at molar basis. This study demonstrated distribution pathways of PFCAs and their precursors in environment via wet deposition and photodegradation, and confirmed that atmosphere is an important compartment for the distribution of these compounds to water environment.								B	-		
D910	環境中運命	雪岡 聖, 田中 周平, 鈴木 裕識, Zeng Chenghui, 北尾 亮太, 仲田 雅俊, 藤井 滋穂	化粧品由来のポリフルオロアルキルリン酸エステル類の下水処理場における挙動および流入負荷量の推定	2018	水環境学会誌, 2018年 41 巻 2 号 27-34. doi: 10.2965/jswe.41.27	本研究では1) 化粧品におけるポリフルオロアルキルリン酸エステル類 (PAPs) の存在実態の把握, 2) 下水処理場におけるPAPsの挙動の検討, 3) 化粧品由来のPAPsの流入負荷量の推定を目的とした。国内外の化粧品を23製品購入し, 2016年8月に5ヶ所の下水処理場を調査した。化粧品中のΣ3 diPAPs (6:2diPAP, 6:2/8:2diPAP, 8:2diPAP) は1,030～58,500,000 ng g-wet-1であった。下水処理場におけるΣ3 diPAPsの濃度は最初沈殿汚泥で479 ng L-1, 返送汚泥で269 ng L-1であり, その負荷量は生物反応槽前後で減少する傾向が示された。化粧品由来のΣ3 diPAPsの流入負荷量は67～1,180 mg day-1であり, その流入負荷率は14±2%を占め, 化粧品由来のPAPsの負荷割合が明らかになった。								C	-		
D911	環境中運命	西野　貴裕, 加藤　みか, 下間 志正, 北野　大	東京都内地下水における有機フッ素化合物の汚染実態と土壌浸透実験における挙動の考察	2015	環境化学, 2015年 25 巻 3 号 149-160. doi: 10.5985/jec.25.149	We measured 13 perfluorinated compounds (PFCs) in the groundwater in Tokyo. PFCs with nine carbons or fewer were frequently detected. PFOS and PFOA were detected at high concentrations, despite discharge reduction measures taken since 2010. Chromatograms of PFOS showed variations in the peak area ratio between linear-PFOS and branched-PFOS with the sampling points. To investigate the cause, leaching experiments were conducted for the 13 PFCs and branched-PFOS isomers. The results show that branched-PFOS penetrated the soil faster than linear-PFOS, and shorter chain PFCs faster than longer-chain PFCs. Long chain PFCs with more than 10 carbons were expected to remain in soil.								B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D912	バイオモニタリング	Bil, W; Zeilmaker, MJ; Bokkers, BGH	Internal Relative Potency Factors for the Risk Assessment of Mixtures of Per- and Polyfluoroalkyl Substances (PFAS) in Human Biomonitoring	2022	Environ. Health Perspect. 2022 Jul;130(7):77005. doi: 10.1289/EHP10009.	BACKGROUND: In human biomonitoring, blood is often used as a matrix to measure exposure to per-and polyfluoroalkyl substances (PFAS). Because the toxicokinetics of a substance (determining the steady-state blood concentration) may affect the toxic potency, the difference in toxicokinetics among PFAS has to be accounted for when blood concentrations are used in mixture risk assessment. OBJECTIVES: This research focuses on deriving relative potency factors (RPFs) at the blood serum level. These RPFs can be applied to PFAS concen-trations in human blood, thereby facilitating mixture risk assessment with primary input from human biomonitoring studies.METHODS: Toxicokinetic models are generated for 10 PFAS to estimate the internal exposure in the male rat at the blood serum level over time. By applying dose-response modeling, these internal exposures are used to derive quantitative internal RPFs based on liver effects.RESULTS: Internal RPFs were successfully obtained for nine PFAS. Perfluorobutanoic acid (PFBA), perfluorohexanoic acid (PFHxA), perfluorononа-noic acid (PFNA), perfluorododecanoic acid (PFDoDA), perfluorooctane sulfonic acid (PFOS), and hexafluoropropylene oxide-dimer acid (HFPO-DA, or GenX) were found to be more potent than perfluorooctanoic acid (PFOA) at the blood serum level in terms of relative liver weight increase, whereas perfluorobutane sulfonic acid (PFBS) and perfluorohexane sulfonic acid (PFHxS) were found to be less potent. The practical implementation of these internal RPFs is illustrated using the National Health and Nutrition Examination Survey (NHANES) biomonitoring data of 2017-2018.DISCUSSION: It is recommended to assess the health risk resulting from exposure to PFAS as combined, aggregate exposure to the extent feasible.	1	1	1	1	1		1	A	A	RPF	10種類のPFASのTKモデルに基づいた係数を求め、混合物評価の手法として提案
D913	バイオモニタリング	Garcia-Barrios, J; Drysdale, M; Ratelle, M; Gaudreau, E; LeBlanc, A; Gamberg, M; Laird, BD	Biomarkers of poly- and perfluoroalkyl substances (PFAS) in Sub-Arctic and Arctic communities in Canada	2021	Int. J. Hyg. Environ. Health. 2021 Jun:235:113754. doi: 10.1016/j.ijheh.2021.113754.	Polyfluoroalkyl substances and perfluoroalkyl substances (PFAS) are a family of anthropogenic chemicals that are used in food packaging, waterproof clothing, and firefighting foams for their water and oil resistant properties. Though levels of some PFAS appear to be decreasing in Canada's south, environmental levels have been increasing in the Arctic due to long-range transport. However, the implications of this on human exposures in sub-Arctic and Arctic populations in Canada have yet to be established. To address this data gap, human biomonitoring research was completed in Old Crow, Yukon, and the Dehcho region, Northwest Territories. Blood samples were collected from adults residing in seven northern First Nations and were analyzed by liquid chromatography mass spectrometry. A total of nine PFAS were quantified: perfluorooctanoic acid (PFOA), perfluorooctane sulphonic acid (PFOS), perfluorohexane sulphonic acid (PFHxS), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUdA), perfluorobutanoic acid (PFBA), perfluorohexanoic acid (PFHxA), and perfluorobutane sulphonic acid (PFBS). In the Dehcho (n = 124), five PFAS had a detection rate greater than 50% including PFOS, PFOA, PFHxS, PFNA, and PFDA. In addition to these PFAS, PFUdA was also detected in at least half of the samples collected in Old Crow (n = 54). Generally, male participants had higher concentrations of PFAS compared to female participants, and PFAS concentrations tended to increase with age. For most PFAS, Old Crow and Dehcho levels were similar or lower to those measured in the general Canadian population (as measured through the Canadian Health Measures Survey or CHMS) and other First Nations populations in Canada (as measured through the First Nations Biomonitoring Initiative or FNBI). The key exception to this was for PFNA which, relative to the CHMS (0.51 mu g/L), was approximately 1.8 times higher in Old Crow (0.94 mu g/L) and 2.8 times higher in Dehcho (1.42 mu g/L) than observed in the general Canadian population. This project provides baseline PFAS levels for participating communities, improving understanding of human exposures to PFAS in Canada. Future research should investigate site-specific PFNA exposure sources and monitor temporal trends in these regions.	1	1	1	1				B	B		カナダの極地に住む人の9種類のPFASを測定
D914	バイオモニタリング	Caron-Beaudoin, E; Ayotte, P; Blanchette, C; Muckle, G; Avard, E; Ricard, S; Lemire, M	Perfluoroalkyl acids in pregnant women from Nunavik (Quebec, Canada): Trends in exposure and associations with country foods consumption	2020	Environ. Int. 2020 Dec:145:106169. doi: 10.1016/j.envint.2020.106169.	Background: Perfluoroalkyl acids (PFAAs) are persistent and ubiquitous environmental contaminants that potentially disrupt endocrine system functions. While some PFAAs (perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA)) are regulated, currently used fluorotelomer alcohols (FTOHs) can be transported to the Arctic and are degraded in a number of PFAAs which biomagnify in Arctic wildlife (e.g. perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUdA)). Objectives: From 2004 to 2017, 279 pregnant Inuit women were recruited as part of biomonitoring projects in Nunavik. Our goal was to evaluate: (i) time-trends in plasma/serum PFAAs levels in pregnant Nunavimmiut women between 2004 and 2017; (ii) compare plasma/serum PFAAs levels in Nunavimmiut women in 2016-2017 to those measured in women of childbearing age in the Canadian Health Measure Survey (CHMS); and (iii) evaluate the associations of PFAAs levels with the consumption of country foods and pregnancy and maternal characteristics during pregnancy in the 97 participants recruited in 2016-2017. Methods: Individual blood sample were collected for serum or plasma PFAAs (PFOS, PFOA, pentafluorobenzoic acid (PFBA), perfluorohexanoic acid (PFHxA), perfluorobutanesulfonic acid (PFBS), perfluorohexane-1-sulfonic acid (PFHxS), PFNA, PFDA, PFUdA) analyses. Socio-demographic data, pregnancy and maternal characteristics and country foods consumption were documented using a questionnaire. Omega-3 and -6 polyunsaturated fatty acids (PUFA) were measured in red blood cell membranes and their ratio used as a biomarker of marine country foods consumption. Time-trends in PFAAs levels were evaluated using ANCOVA models adjusted for relevant covariables. Serum/plasma levels of PFAAs in the 97 pregnant women aged 16 to 40 years old and recruited in 2016-2017 were compared to those measured in women aged 18 to 40 years old from the CHMS cycle 5 (2016-2017) using the geometric means (GM) and 95% confidence intervals (95% CI). Multivariate regression analyses were performed to examine associations between concentrations of PFAAs and country foods consumption data. Results: Statistically-significant downward time trends were noted for concentrations of PFOS, PFOA and PFHxS in pregnant Nunavik women between 2004 and 2017. Conversely, between 2011 and 2016-2017, PFNA, PFDA and PFUdA maternal serum levels increased by 19, 13 and 21% respectively. Among participants in 2016-2017, mean concentrations for PFNA (GM: 2.4 mu g/L), PFDA (0.53 mu g/L) and PFUdA (0.61 mu g/L) were higher than those measured in women aged 18-40 years old in the Cycle 5 (2016-2017) of the CHMS. PFOA (0.53 mu g/L) and PFHxS (0.26 mu g/L) were lower than in CHMS, whereas PFBA, PFHxA and PFBS were not detected in 2016-2017. Ratios of serum/plasma levels of PFNA/PFOA, PFNA/PFOS, PFNA/PFHxS and PFUdA/PFDA were significantly higher in the 97 pregnant women from Nunavik recruited in 2016-2017 compared to CHMS, highlighting their distinct exposure profile. In multivariate models, PFHxS, PFOS, PFNA, PFDA and PFUdA levels in	1	1	1	1				B	B		イヌイットの9種類のPFASを測定
D915	バイオモニタリング	Gockener, B; Weber, T; Rudel, H; Bucking, M; Kolossa-Gehring, M	Human biomonitoring of per- and polyfluoroalkyl substances in German blood plasma samples from 1982 to 2019	2020	Environ. Int. 2020 Dec:145:106123. doi: 10.1016/j.envint.2020.106123.	The findings of per- and polyfluoroalkyl substances (PFAS) in humans and the environment all over the world have raised concerns and public awareness for this group of man-made chemicals. In the last three decades, this led to different regulatory restrictions for specific PFAS as well as shifts in the production and usage of these substances. In this study, we analyzed the PFAS levels of 100 human blood plasma samples collected from 2009 to 2019 for the German Environmental Specimen Bank (ESB) to further elucidate the time course of exposure towards this substance group as shown by Schröter-Kermani et al., (2013) with samples from 1982 to 2010. A spectrum of 37 PFAS, including perfluorocarboxylic (PFCA) and -sulfonic acids (PFSA) as well as potential precursors and substitutes like ADONA, GenX or F-53B was analyzed by UHPLC coupled with high-resolution mass spectrometry. Validation was successful for 33 of the substances. The two legacy substances perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) were detected in every sample of the 2009-2019 dataset and showed the highest concentrations with ranges of 0.27-14.0 ng/mL and 1.21-14.1 ng/mL, respectively. A significant portion of total PFOS analytes was present as branched isomers (mean: 34 ± 7%). High detection frequencies of 95% and 82% were also found for perfluorohexane sulfonic acid (PFHxS) and perfluorononanoic acid (PFNA), respectively, but in lower concentrations (PFHxS: <LOQ - 4.62 ng/mL; PFNA: <LOQ - 3.66 ng/mL) than PFOA and PFOS. Besides other PFCA and PFSA only 8:2 fluorotelomer sulfonic acid (8:2 FtS) and N-methyl perfluorooctane sulfonamidoacetic acid were detected in very few samples. In combination with the previous results from 1982 to 2010, declining temporal trends were observed for all PFAS (PFOA, PFNA, PFHxS, and PFOS) frequently detected in the ESB samples. The results of this study indicate a decrease in human exposure to known PFAS in Germany over the last three decades and emphasize the importance of long-term human biomonitoring studies for investigating the effects of chemical regulation.			1		1			B	A		1982-2019年までのドイツの保存血を用いて37種類のPFAS濃度を測定
D916	バイオモニタリング	Yeung, LWY; So, MK; Jiang, GB; Taniyasu, S; Yamashita, N; Song, MY; Wu, YN; Li, JG; Giesy, JP; Guruge, KS; Lam, PKS	Perfluorooctanesulfonate and related fluorochemicals in human blood samples from China	2006	Environ. Sci. Technol. 2006 Feb:40(3):715-720. doi: 10.1021/es052067y.	Perfluorooctanesulfonylfluoride (POSF)-based compounds have been manufactured and used in a variety of industrial applications. These compounds degrade to perfluorooctanesulfonate (PFOS) which is regarded as a persistent end-stage metabolite and is found to accumulate in tissues of humans and wildlife. PFOS, perfluorohexanesulfonate (PFHxS), perfluorooctanoate (PFOA), and perfluorooctanesulfonamide (PFOSA) have been found in human sera from the United States. In this study, concentrations of PFHxS, perfluorobutanesulfonate (PFBS), PFOS, Perfluoro-hexanoic acid (PFHxA), PFOA, perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA), perfluorododecanoic acid (PFDoDA), and PFOSA were measured in 85 samples of whole human blood collected from nine cities (eight provinces) in China, including Shenyang (Liaoning), Beijing (Hebei), Zhengzhou (Henan), Jintan (Jiangsu), Wuhan (Hubei), Zhoushan (Zhejiang), Guiyang (Guizhou), Xiamen (Fujian), and Fuzhou (Fujian). Among the 10 perfluorinated compounds (PFCs) measured, PFOS was the predominant compound. The mean concentration of PFOS was greatest in samples collected from Shenyang (79.2 ng/mL) and least in samples from Jintan (3.72 ng/mL). PFHxS was the next most abundant perfluorochemical in the samples. No age-related differences in the concentrations of PFOA, PFOS, PFOSA, and PFHxS were observed. Gender-related differences were found, with males higher for PFOS and PFHxS, and females higher in PFUnDA. Concentrations of PFHxS were positively correlated with those of PFOS, while concentrations of PFNA, PFDA, and PFUnDA were positively correlated with those of PFOA. There were differences in the concentration profiles (percentage composition) of various PFCs in the samples among the nine cities.		1	1	1				B	B		中国各地の住民の10種類のPFAS濃度を測定

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D917	バイオモニタリング	Colles, A; Bruckers, L; Den Hond, E; Govarts, E; Morrens, B; Schettgen, T; Buekers, J; Coertjens, D; Nawrot, T; Loots, I; Nelen, V; De Henauw, S; Schoeters, G; Baeyens, W; van Larebeke, N	Perfluorinated substances in the Flemish population (Belgium): Levels and determinants of variability in exposure	2020	Chemosphere. 2020 Mar:242:125250. doi: 10.1016/j.chemosphere.2019.125250.	Because of their dirt-, water- and oil-repelling properties, per- and polyfluoroalkyl substances (PFASs) are frequently used in a broad variety of consumer products. They have been detected in human samples worldwide. In Flanders, Belgium, the Flemish Environment and Health Studies (FLEHS) measured the levels of five PFAS biomarkers in four different age groups of the Flemish population and identified determinants of variability in exposure. Cord plasma or peripheric serum samples and questionnaire data were available for 220 mother-newborn pairs (2008-2009), 269 mother-newborn pairs (2013-2014), 199 adolescents (14-15 years old, 2010), 201 adults (20-40 years old, 2008-2009) and 205 adults (50-65 years old, 2014). Measured levels of perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulfonic acid (PFHxS) and perfluorononanoic acid (PFNA) in Flanders are in the middle or low range compared to concentrations reported in other Western countries. Levels of perfluorobutanesulfonic acid (PFBS) were below the quantification limit in 98%-100% of the samples. Despite decreasing levels in time for PFOS and PFOA, 77% of the adults (2014) had serum levels exceeding HBM-I values of 5 mu/L for PFOS and 2 mu g/L for PFOA. Beside age, sex, fish consumption, parity and breastfeeding, the multiple regression models identified additionally consumption of offal and locally grown food, and use of cosmetics as possible exposures and menstruation as a possible route of elimination. Better knowledge on determinants of exposure is essential to lower PFASs exposure.			1	1				B	B		ベルギーのフレミッシュの母子の数種類のPFAS濃度を測定
D918	バイオモニタリング	Petriello, MC; Mottaleb, MA; Serio, TC; Balyan, B; Cave, MC; Pavuk, M; Birnbaum, LS; Morris, AJ	Serum concentrations of legacy and emerging per- and polyfluoroalkyl substances in the Anniston Community Health Surveys (ACHS I and ACHS II)	2022	Environ. Int. 2022 Jan:158:106907. doi: 10.1016/j.envint.2021.106907.	Background: Residents of Anniston Alabama were highly exposed to polychlorinated biphenyls (PCBs) due to longstanding manufacturing in the area. The Anniston Community Health Surveys (ACHS I-2005-2007 and II, 2014) have linked these exposures with a variety of deletereous health outcomes. In addition to PCBs, these individuals were likely simultaneously exposed to other persistent organic pollutants including per and polyfluoroalkyl substances (PFAS), which are an emerging class of ubiquitous industrial chemicals that are measurable in the blood of most individuals and have themselves been linked increased risk of some non communicable diseases. Methods: To characterize PFAS exposures in ACHS I and ACHS II, we measured eight environmentally significant PFAS in serum by UPLC coupled electrospray ionization tandem mass spectrometry. Perfluorooctane sulfonate (PFOS), Perfluorooctanoic acid (PFOA), Perfluorononanoate (PFNA), Perfluorohexane sulfonate (PFHxS), Perfluoroheptanoic acid (PFHpA), Perfluorobutanesulfonic acid (PFBS), Hexafluoropropylene oxide dimer acid (HFPO-DA), and 4:2 Fluorotelomer sulfonic acid (4.2 FTS) were extracted from matched serum samples of individuals who participated in the original ACHS I (2005-2007; n = 297) and the follow up ACHS II (2014; n = 336). Data were collected in negative multiple reaction monitoring (MRM) mode with monitoring of quantitation and qualifier ions for all target PFAS analytes, surrogates and internal standards. VARCLUS procedure was used to create hierarchical clusters between PFAS and other legacy persistent organic pollutants which may share similar exposure routes. Results: Overall, circulating PFAS levels decreased approximately 50% from ACHS I (2005-2007) to ACHS II (2014), but these changes varied by compound. Mean levels of PFOS were >3 times higher in ACHS I subjects than in conpemporaneous NHANES subjects (2005-2006; ACHS I mean: 71.1 ng/ml; NHANES mean: 20.2 ng/ mL), and this relationship persisted in ACHS II subjects (2014: ACHS II mean: 34.7 ng/ml; NHANES mean: 5.92 ng/mL). PFNA was also higher in both ACHS I and ACHS II subjects in comparision to NHANES whereas levels of PFOA and PFHxS were lower than in NHANES. Finally, cluster analysis revealed that in ACHS II, most PFAS tracked with polybrominated diphenyl ethers, except PFNA and PFHpA which clustered with industrial PCBs. In ACHS I, PFAS analytes correlated more closely with industrial PCBs and chlorinated pesticides. Conclusions: Participants in the Anniston Community Health Surveys have higher levels of PFOS and PFNA than the general population with average PFOS levels >3 times contemporaneous NHANES levels. Since PFAS were not known to be manufactured in the area, more work needs to be completed to determine if population demographics, proximity to a military base, or regional manufacturing can explain the elevated levels.			1	1	1			B	B		アラバマ州のPCB汚染があった地域で10種類のPFAS濃度を測定
D919	バイオモニタリング	Olsen, GW; Ellefson, ME; Mair, DC; Church, TR; Goldberg, CL; Herron, RM; Medhdizadehkashi, Z; Nobiletti, JB; Rios, JA; Reagen, WK; Zobel, LR	Analysis of a Homologous Series of Perfluorocarboxylates from American Red Cross Adult Blood Donors, 2000-2001 and 2006	2011	Environ. Sci. Technol. 2011 Oct:45(19):8022-8029. doi: 10.1021/es1043535.	The purpose of this study was to determine the concentration trends of a nine-target-analyte homologous series of perfluorocarboxylates from six American Red Cross adult blood donor centers. A total of 645 serum and 600 plasma samples were obtained in 2000-2001 and 2006, respectively, with samples stratified for each 10-year (20-69) age- and sex-group per each location. Samples were extracted by protein precipitation and quantified by using tandem mass spectrometry. The nine perfluorocarboxylates were perfluorobutanoate (PFBA, C3F7CO2-), perfluoropentanoate (PFPeA, C4F9CO2-), perfluorohexanoate (PFHxA, C5F11CO2-), perfluoroheptanoate (PFHpA, C6F13CO2-), perfluorooctanoate (PFOA, C7F15CO2-), perfluorononanoate (PFNA, C8F17CO2-), perfluorodecanoate (PFDA, C9F19CO2-), perfluoroundecanoate (PFUnA,C10F21CO2-), and perfluorododecanoate (PFDoA, C11F23CO2-). The majority of measurements were less than the lower limit of quantitation for PFPeA, PFHxA, and PFDoA. For the remaining targeted analytes, the geometric mean serum and plasma concentrations (ng/mL) for 2000-2001 and 2006 were, respectively, as follows: PFBA 2.61 vs 0.33, PFHpA 0.13 vs 0.09, PFOA 4.70 vs 3.44, PFNA 0.57 vs 0.97, PFDA 0.16 vs 0.34, and PFUnA 0.10 vs 0.18. Estimates of the 95th percent tolerance limits (ng/mL) were as follows: PFBA 5.3 vs 1.4, PFHpA 0.4 vs 0.4, PFOA 12.3 vs 7.7, PFNA 1.4 vs 2.2, PFDA 0.4 vs 0.8, and PFUnA 0.3 vs 0.5. Important observations were the decline in PFBA and increase in PFNA, PFDA, and PFUnA concentrations between 2000-2001 and 2006. The longer chain length perfluorocarboxylates were also highly correlated with each other.	1	1	1					B	B		米国の献血試料を用いて9種類のPFAS濃度の経時変化を調べた
D920	バイオモニタリング	Gyllenhammar, I; Benskin, JP; Sandblom, O; Berger, U; Ahrens, L; Lignell, S; Wiberg, K; Glynn, A	Perfluoroalkyl Acids (PFAAs) in Children's Serum and Contribution from PFAA-Contaminated Drinking Water	2019	Environ. Sci. Technol. 2019 Oct:53(19):11447-11457. doi: 10.1021/acs.est.9b01746.	We investigated associations between serum perfluoroalkyl acid (PFAA) concentrations in children aged 4, 8, and 12 years (sampled in 2008-2015; n = 57, 55, and 119, respectively) and exposure via placental transfer, breastfeeding, and ingestion of PFAA-contaminated drinking water. Sampling took place in Uppsala County, Sweden, where the drinking water has been historically contaminated with perfluorobutanesulfonate (PFBS), perfluorohexanesulfonate (PFHxS), perfluorooctanesulfonate (PFOS), perfluoroheptanoate (PFHpA), and perfluorooctanoate (PFOA). PFOS showed the highest median concentrations in serum (3.8-5.3 ng g(-1) serum), followed by PFHxS (1.6-5.0 ng g(-1) serum), PFOA (2.0-2.5 ng g(-1) serum), and perfluorononanoate (PFNA) (0.59-0.69 ng g(-1) serum) in children. Including all children, serum PFOA, PFHxS, and PFOS concentrations (adjusted mean), respectively, per unit (ng g(-1) serum) of increase in the maternal serum level (at delivery), the associations being strongest for 4 year-old children. PFHxS and PFOS significantly increased 3.9 and 3.8%, respectively, per month of nursing, with the highest increase for 4 year-olds. PFOA, PFBS, PFHxS, and PFOS increased 1.2, 207, 7.4, and 0.93%, respectively, per month of cumulative drinking water exposure. Early life exposure to PFOA, PFHxS, and PFOS is an important determinant of serum concentrations in children, with the strongest influence on younger ages. Drinking water with low to moderate PFBS, PFHxS, PFOS, and PFOA contamination is an important source of exposure for children with background exposure from other sources.			1	1				B	B		ウプサラの汚染があった地域の子供について5種類のPFAS濃度を測定
D921	バイオモニタリング	Gyllenhammar, I; Benskin, JP; Sandblom, O; Berger, U; Ahrens, L; Lignell, S; Wiberg, K; Glynn, A	Perfluoroalkyl Acids (PFAAs) in Serum from 2-4-Month-Old Infants: Influence of Maternal Serum Concentration, Gestational Age, Breast-Feeding, and Contaminated Drinking Water	2018	Environ. Sci. Technol. 2018 Jun:52(12):7101-7110. doi: 10.1021/acs.est.8b00770.	Little is known about factors influencing infant perfluorinated alkyl acid (PFAA) concentrations. Associations between serum PFAA concentrations in 2-4-month-old infants (n = 101) and determinants were investigated by multiple linear regression and general linear model analysis. In exclusively breastfed infants, maternal serum PFAA concentrations 3 weeks after delivery explained 13% (perfluoroundecanoic acid, PFUnDA) to 73% (perfluorohexanesulfonate, PFHxS) of infant PFAA concentration variation. Median infant/maternal ratios decreased with increasing PFAA carbon chain length from 2.8 for perfluoroheptanoic acid and perfluorooctanoic acid (PFOA) to 0.53 for PFUnDA and from 1.2 to 0.69 for PFHxS and perfluorooctanesulfonate (PFOS). Infant PFOA, perfluorononanoic acid (PFNA), and PFOS levels increased 0.7-1.2% per day of gestational age. Bottle-fed infants had mean concentrations of PFAAs 2 times lower than and a mean percentage of branched (%br) PFOS isomers 1.3 times higher than those of exclusively breast-fed infants. PFOA, PFNA, and PFHxS levels increased 8-11% per week of exclusive breast-feeding. Infants living in an area receiving PFAA-contaminated drinking water had 3-fold higher mean perfluorobutanesulfonate (PFBS) and PFHxS concentrations and higher mean %br PFHxS. Prenatal PFAA exposure and postnatal PFAA exposure significantly contribute to infant PFAA serum concentrations, depending on PFAA carbon chain length. Moderately PFBS- and PFHxS-contaminated drinking water is an important indirect exposure source.			1	1				B	B		2-4ヶ月児と母親の数種類のPFAS濃度を比較

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D922	バイオモニタリング	Johanson, G; Gyllenhammar, I; Ekstrand, C; Pyko, A; Xu, YY; Li, Y; Norstrom, K; Lilja, K; Lindh, C; Benskin, JP; Georgelis, A; Forsell, K; Jakobsson, K; Glynn, A; Vogs, C	Quantitative relationships of perfluoroalkyl acids in drinking water associated with serum concentrations above background in adults living near contamination hotspots in Sweden	2023	Environ. Res. 2023 Feb:219:115024. doi: 10.1016/j.envres.2022.115024.	Contaminated drinking water (DW) is a major source of exposure to per-and polyfluoroalkyl substances (PFAS) at locations around PFAS production/use facilities and military airports. This study aimed to investigate quan-titative relationships between concentrations in DW and serum of nine perfluoroalkyl acids (PFAAs) in Swedish adult populations living near contamination hotspots. Short-chained (PFPeA, PFHxA, PFHpA, and PFBS) and long-chained PFAAs (PFOA, PFNA, PFDA, PFHxS and PFOS) were measured in DW and serum. We matched DW and serum concentrations for a total of 398 subjects living or working in areas receiving contaminated DW and in one non-contaminated area. Thereafter, linear regression analysis with and without adjustments for co-variates was conducted. This enabled to derive (i) serum concentrations at background exposure (CB) from sources other than local DW exposure (i.e. food, dust and textiles) at 0 ng/L DW concentration, (ii) population-mean PFAA serum:water ratios (SWR) and (iii) PFAA concentrations in DW causing observable elevated serum PFAA con-centrations above background variability. Median concentrations of the sum of nine PFAAs ranged between 2.8 and 1790 ng/L in DW and between 7.6 and 96.9 ng/mL in serum. DW concentration was the strongest predictor, resulting in similar unadjusted and adjusted regression coefficients. Mean CB ranged from <0.1 (PFPeA, PFHpA, PFBS) to 5.1 ng/mL (PFOS). Serum concentrations increased significantly with increasing DW concentrations for all PFAAs except for PFPeA with SWRs ranging from <10 (PFHxA, PFHpA and PFBS) to 111 (PFHxS). Observed elevated serum concentrations above background variability were reached at DW concentrations between 24 (PFOA) and 357 ng/L (PFHxA). The unadjusted linear regression predictions agreed well with serum concen-trations previously reported in various populations exposed to low and high DW levels of PFOA, PFHxS and PFOS. The quantitative relationships derived herein should be helpful to translate PFAA concentrations in DW to concentrations in serum at the population level.		1	1	1				B	A		スウェーデンのホットスポット汚染があった地域で9種類のPFASの飲水中、血清中濃度を比較
D923	バイオモニタリング	Li, N; Ying, GG; Hong, HC; Deng, WJ	Perfluoroalkyl substances in the urine and hair of preschool children, airborne particles in kindergartens, and drinking water in Hong	2021	Environ. Pollut. 2021 Feb:270:116219. doi: 10.1016/j.envpol.2020.116219.	Seven perfluorinated and polyfluorinated substances (PFASs), namely perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluoroheptanoic acid (PFHpA), perfluorohexanoic acid (PFHxA), and perfluoro-1,10decanedicarboxylic acid (PFDDA), were evaluated in urine and hair samples from children (age: 4-6 years, N = 53), airborne particles sampled at 17 kindergartens, and tap water and bottled water samples. All samples were collected in Hong Kong. The analytical results suggested widespread PFAS contamination. All target PFASs were detected in at least 32% of urine samples, with geometric mean (GM) concentrations ranging from 0.18 to 2.97 ng/L, and in 100% of drinking water samples at GM concentrations of 0.18-21.1 ng/L. Although PFOS and PFDDA were not detected in hair or air samples, the other target PFASs were detected in 48-70% of hair samples (GM concentrations: 2.40-233 pg/g) and 100% of air samples (GM concentrations: 14.8-536.7 pg/m(3)). In summary, the highest PFAS concentrations were detected in airborne particles measured in kindergartens. PFOA was the major PFAS detected in hair, urine, and drinking water samples, while PFOA, PFDA, and PFHpA were dominant in airborne particles. Although a significant difference in PFAS concentrations in hair samples was observed between boys and girls (p <.05), no significant sex-related difference in urinary PFAS or paired PFAS (hair/urine) concentrations was observed.		1	1					C	A		香港で7種類のPFASの幼児の尿、毛髪、幼稚園のハウスダスト、飲水の濃度を測定して比較。
D924	バイオモニタリング	Runkel, AA; Stajnko, A; Tratnik, JS; Mazej, D; Horvat, M; Pribylova, P; Kosjek, T	Exposure of children and adolescents from Northeastern Slovenia to per- and polyfluoroalkyl substances	2023	Chemosphere. 2023 Apr:321:138096. doi: 10.1016/j.chemosphere.2023.138096.	Per-and polyfluoroalkyl substances (PFAS) are of high concern for the environment, wildlife, and human health due to their persistence and potential to cause adverse health effects. Despite political measures to restrict the production and distribution of PFAS and to limit the exposure of populations, PFAS can be measured at commonly high detection frequencies in human samples.Thus, this pilot study aimed to determine the serum concentrations of PFPA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFHxS, PFHpS, PFOS, PFHxA, PFDoDA, and PFBS in 113 girls and 112 boys (age 7-10 and 12-15) from Northeastern Slovenia -a rural area characterized by agricultural activities -and to identify potential sources of exposure using questionnaire data. PFAS were analysed by liquid chromatography coupled to mass spectrometry after phospholipid removal.9 out of 12 analytes were detected at detection frequencies above 30%, with the highest geometric means (GM) being observed for PFOS (GM 1.9 ng/mL) > PFOA (GM 1.0 ng/mL) > PFHxS (GM 0.3 ng/mL) symbolscript PFNA (GM 0.3 ng/mL). We identified the participants' socio-economic status, age, sex, sampling region, public water supply, and the consumption of fish and seafood, cereals, and locally produced fruits, vegetables, and mushrooms as the predominant determinants of exposure. Furthermore, we compared our results with the serum and plasma concentrations reported for similar age groups in other studies and concluded that PFAS exposure in this highly agricultural area in Slovenia is notably low. This is the first study systematic HBM study of PFAS exposure in Slovenia, although it was conducted on a limited number of participants representative of rural and agricultural areas, it represents a good basis for upgrading the approach to a nationwide HBM study.		1	1	1				B	B		スロベニアの農村地帯で12種類のPFAS濃度を測定
D925	バイオモニタリング	Zhou, W; Zhao, SS; Tong, CL; Chen, L; Yu, XD; Yuan, T; Aimuzi, R; Luo, F; Tian, Y; Zhang, J	Dietary intake, drinking water ingestion and plasma perfluoroalkyl substances concentration in reproductive aged Chinese women	2019	Environ. Int. 2019 Jun:127:487-494. doi: 10.1016/j.envint.2019.03.075	Background: Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals that are widely used in industrial and consumer products. A growing body of literature suggests that exposure to these chemicals are associated with adverse reproductive outcomes in women. However, the sources of PFAS exposure are often poorly characterized in women of child-bearing age. Objectives: To examine the association of plasma PFAS concentrations with dietary intake and drinking water sources in reproductive aged women in Shanghai, one of the high PFAS polluted regions in China. Methods: Concentrations of ten PFAS in plasma samples were measured in 933 women. Information on dietary intake and type of drinking water was collected by questionnaire. We used multivariable linear regression models to assess the association of PFAS concentrations with dietary intake and drinking water. Results: After controlling for potential confounders, a higher frequency of intake of aquatic products (freshwater fish, marine fish, shellfish, shrimp and crab) was positively and significantly associated with concentrations of PFOS, PFOA, PFNA, PFDA, PFUA and PFDoA in 900 reproductive aged women. Intake of freshwater fish showed the strongest association with PFAS. Compared with the lowest intake group of freshwater fish, the intermediate intake group had 8-32% increase in the concentrations of these pollutants; and the highest group had 11-57% increase. Conversely, intake of soy products was associated with lower levels of PFDA, PFUA, PFNA, PFOS, and PFDoA. In addition, compared with women drinking tap water, drinking bottled water was associated with significantly decreases in PFHpA, PFDA, PFOA, PFUA and PFBS blood levels by 9-13% in 905 reproductive aged women. Conclusions: Intake of freshwater fish, marine fish, shrimp and crab was positively associated with plasma PFAS concentrations, while intake of soy products and bottled water was associated with lower PFAS concentrations in the Chinese women of reproductive age.			1	1				B	B		上海で10種類のPFAS濃度と食事からの摂取（FFQで調査）との関係を調べた
D926	バイオモニタリング	Peng, L; Xu, W; Zeng, QH; Cheng, Y; Zhang, YJ; Guo, Y; Chen, D; Jiang, C; Wang, F	Distribution characteristics of per- and polyfluoroalkyl substances (PFASs) in human urines of acrylic fiber plant and chemical plant	2021	Environ. Sci. Pollut. Res. 2021 Dec:28(48):69181-69189. doi: 10.1007/s11356-021-15355-7.	Per- and polyfluoroalkyl substances (PFASs) are persistent and bioaccumulative substances that have many adverse effects on human bodies. This study investigated the PFASs distribution characteristics in urine samples of workers from an acrylic fiber plant and a chemical plant. It was found that perfluorobutanoic acid (PFBA) was the predominant PFASs both in urine samples from the chemical plant (detection frequency: 86.52%; median value: 39.01 ng/mL) and the acrylic fiber plant (detection frequency: 88.16%; median value: 44.36 ng/mL). Meanwhile, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) were detected with very low frequencies and low concentrations. Furthermore, the results showed that PFASs levels in urine samples of workers from different units of the plants were quite different. PFASs concentrations of urine samples in males were higher than those in females, especially for PFBA, PFHxA, and PFDoA. The age had limited effects on the PFASs distribution in urine samples in this study, as short-chain PFASs were the dominant compounds. The correlations between PFASs concentrations in urine and gender/ages of workers were finally analyzed by Pearson correlation. The overall results may indicate that short-chain PFASs (such as: PFBA and PFBS) were becoming dominant for human exposure, especially occupational workers.	1	1		1			C	B		中国の化学工場労働者の尿中PFAS濃度で短鎖の化合物が増えている
D927	バイオモニタリング	Piva, E; Fais, P; Cecchetto, G; Montisci, M; Viel, G; Pascali, JP	Determination of perfluoroalkyl substances (PFAS) in human hair by liquid chromatography-high accurate mass spectrometry (LC-QTOF)	2021	J. Chromatogr. B. 2021 May:1172:122651. doi: 10.1016/j.jchromb.2021.122651.	Biomonitoring of perfluoroalkyl substances (PFASs) in hair is conventionally achieved by SPE extraction and liquid chromatography-triple quadrupole analysis, with sensitivities in the range of ng/g. The aim of this study was to develop and validate a rapid method to detect 20 perfluoroalkyl substances (PFASs) in human hair from general populations by SPE purification and liquid-chromatography coupled to accurate mass measurement (LC-QTOF). The obtained sensitivities (LOQ), linearity and RSD accuracies were respectively in the range of 0.07-0.5 ng/g, 0.1 (or 0.2 or 0.5)-10 ng/g, 1-16%. To verify the applicability of the method, 11 hair samples from volunteers were tested. The detected PFAS were PFBA (range 0.24-14.6 ng/g), PFBS (0.496 ng/g), PFOA (range 0.08-0.178 ng/g) and PFOS (<LOQ-0.239 ng/g). The results were compared in terms of detection frequency and abundance with previously published studies. The method proved useful for the determination of the tested PFAS in the hair matrix.	1			1			C	B		毛髪から20種類のPFASを分析

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D928	バイオモニタリング	Piva, E; Giorgetti, A; Ioime, P; Morini, L; Freni, F; Lo Faro, F; Pirani, F; Montisci, M; Fais, P; Pascali, JP	Hair determination of per- and polyfluoroalkyl substances (PFAS) in the Italian population	2021	Toxicology. 2021 Jun:458:152849. doi: 10.1016/j.tox.2021.152849.	Per- and polyfluoroalkyl substances (PFAS) are anthropogenic chemicals present in the environment and defined as persistent organic pollutants (POPs). The interest in these forms of contaminants is related to the toxic consequences for health derived from exposures and bioaccumulation processes. The present research aims at assessing differences in the exposure of PFAS in the Italian population by hair analyses. To this aim, 20 compounds of the PFAS family were investigated in hair of 86 Italian subjects distributed across the regions of Veneto, Emilia-Romagna, Lombardy and Marche. The applied method was ad hoc developed in a previous research and included SPE extraction and LC-QTOF analysis. In the analyzed population, 66.4 % had quantifiable amounts of one or more PFAS molecules (up to 4 compounds); mean PFAS content, expressed as sum of PFAS, was 0.1457 ng/g, ranging from not detected to 0.85 ng/g (SD 0.1867). PFOA and PFOS were the chemicals most frequently detected, with mean concentrations of 0.1402 ng/g and 0.1155 ng/g, respectively. PFBA was detected in 9.3 % of subjects with a mean concentration of 0.3760 ng/g; PFNA in 3.5 % of subjects with mean concentration 0.12 ng/g; PFDA was found in one subject at the concentration of 0.541 ng/g. PFUnA and PFHxS were detected below the limit of quantification. The overall results displayed differences in the presence and prevalence of PFAS in hair of the Italian population on a geographical base. On the contrary, no significatively differences in the amount of PFAS were observed when considering gender or age classes. On this base, hair can be considered a good diagnostic tool to assess PFAS exposure on a regional-scaled base. Of course, more studies are required to infer PFAS internal dose from hair results due to its peculiar detection window and to interpretative issues derived from external contamination.	1		1					C	D		イタリアのベネト地区で毛髪から20種類のPFASを分析 ※先生未記入セル。先生曰く「A以外の評価」のため、CERI事務局により文献ランク「D」を入力した。
D929	バイオモニタリング	Li, J; Li, JF; Ma, YN; Chen, B; Wang, XR; Jiao, XT; Jin, YH; Shen, ZM; Yuan, T; Yu, XD	Urine concentrations of perfluoroalkyl acids in children and contributions of dietary factors: a cross-sectional study from Shanghai, China	2021	Environ. Sci. Pollut. Res. 2021 Apr:28(16):20440-20450. doi: 10.1007/s11356-020-12293-8.	The production and emission of short-chain perfluoroalkyl acids (PFAAs) has increased over the years to replace long-chain PFAAs, leading to frequent detection in the environment and raising global concerns about the potential impacts on human health. In this study, the specific urine levels of 10 PFAAs were obtained from 189 children (age 8-12 years) from two primary schools located in urban and suburban areas of Shanghai in 2019, and the contributions of dietary factors were investigated. Perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), and perfluorobutane sulfonate (PFBS) were detected in 100%, 99.5%, and 87.3% of the samples, with median concentrations of 20.20 ng/L, 46.50 ng/L, and 20.95 ng/L, respectively. The most abundant PFAA was perfluorooctanoic acid (PFOA), with a median concentration of 78.90 ng/L. The concentration of n-ary sumation PFAAs ranged from 61.10 to 4108.93 ng/L, with a median concentration of 253.12 ng/L. Children aged 8-9 years had higher median levels of PFBS, perfluorohexane sulfonate (PFHxS), and perfluorooctane sulfonate (PFOS) than children aged 10-12 years. Obese/overweight children had lower levels of PFHpA, PFBS, and PFOS. The intake of red meats, tubers, sugared beverages, fish and seafood, and eggs contributed to higher concentrations of PFAAs, while frequent intake of poultry and soy milk was associated with lower PFAA concentrations.		1		1				C	B		上海の8-12歳の子供の尿で10種類のPFASを測定
D930	バイオモニタリング	Oh, J; Bennett, DH; Tancredi, DJ; Calafat, AM; Schmidt, RJ; Hertz-Picciotto, I; Shin, HM	Longitudinal Changes in Maternal Serum Concentrations of Per- and Polyfluoroalkyl Substances from Pregnancy to Two Years Postpartum	2022	Environ. Sci. Technol. 2022 Aug:56(16):11449-11459. doi: 10.1021/acs.est.1c07970.	Exposure to per- and polyfluoroalkyl substances (PFAS) during pregnancy and lactation is of increasing public health concern, but little is known about longitudinal changes in maternal PFAS concentrations from pregnancy to a few years postpartum. We quantified 11 PFAS in 251 serum samples prospectively collected from 42 Northern California mothers during the first, second, and third trimesters of pregnancy and at 3, 6, and 24 months after delivery over 2009-2017. We fit separate linear mixed models during pregnancy, early postpartum, and late postpartum to estimate percent changes of PFAS for each subperiod. Among five PFAS detected in more than 99% of samples, linear and branched perfluorooctanesulfonate (n- and Sm-PFOS), linear perfluorooctanoate (n-PFOA), and perfluorononanoate (PFNA) concentrations changed -4% to -3% per month during pregnancy. During early postpartum, perfluorohexanesulfonate (PFHxS) and n-PFOA concentrations changed -6% and -5%, respectively, per month, and Sm-PFOS and PFNA concentrations changed -1% per month. During late postpartum, n-PFOS, Sm-PFOS, and PFNA concentrations changed -1% per month. Breastfeeding duration was the primary determinant of n-PFOA and PFNA concentrations during late postpartum, showing negative associations. Our findings might be useful for reconstructing reliable prenatal or early life PFAS exposures for offspring.			1					B	A		北カルフォルニアの妊婦の血清中の11種類のPFAS濃度を出産後6か月まで追跡調査
D931	バイオモニタリング	Manzano-Salgado, CB; Casas, M; Lopez-Espinosa, MJ; Ballester, F; Martinez, D; Ibarluzea, J; Santa-Marina, L; Schettgen, T; Vioque, J; Sunyer, J; Vrijheid, M	Variability of perfluoroalkyl substance concentrations in pregnant women by socio-demographic and dietary factors in a Spanish birth cohort	2016	Environ. Int. 2016 Jul:92-93:357-365. doi: 10.1016/j.envint.2016.04.004	Background: Prenatal exposure to perfluoroalkyl substances (PFAS) might affect child health; but maternal determinants of PFAS exposure are unclear. We evaluated the socio-demographic and dietary factors of prenatal PFAS concentrations in a Spanish birth cohort Methods: We analyzed perfluorohexanesulfonic acid (PFHxS), perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA) in 1216 plasma samples collected during the 1ST trimester of pregnancy (2003-2008). We used multivariable linear regressions to assess the geometric mean (GM) ratios of PFAS concentrations by socio-demographic and dietary factors. We used analysis of variance (ANOVA) to assess the variability of PFAS concentrations by maternal factors. Results: GM PFAS concentrations ranged from 0.55 ng/mL for PFHxS to 5.77 ng/mL for PFOS. Women born outside of Spain had lower PFAS concentrations (e.g. GM ratio for PFHxS 0.53[95%CI: 0.46, 0.60] than Spanish women. PFHxS and PFOA concentrations were higher in mothers from the regions of Sabadell (2.13[1.93, 2.35] and 1.73[1.60,1.88], respectively) and Valencia (1.40[1.28,1.54] and 1.42[1.31,1.53], respectively) than Gipuzkoa. PFOA and PFNA concentrations decreased with parity (>= 2 children: 0.79[0.67, 0.94] and 0.82[0.68, 0.99], respectively). Younger women (i.e. <25 years) had lower PFHxS (0.73[0.62, 0.861) and PFOS (0.85[0.75, 0.96]) concentrations than older women. PFHxS and PFOA concentrations were lower in women who previously breastfed for >6 months compared to those who never breastfed (0.79[0.67, 0.94] and 0.82[0.71, 0.95], respectively). High intake of fish and shellfish during pregnancy (i.e. >= 5.6 servings/week) was associated with 11% (1.11[1.04,1.18]) higher PFOS concentrations than the lowest intake group. Our. ANOVA models explained 26% to 40% of PFAS concentrations variability. Conclusions: Prenatal PFAS concentrations were mainly determined by maternal country of birth, region of residence, previous breastfeeding and age. Fish and shellfish intake also contributed to PFOS and PFOA concentrations.			1					B	B		妊婦の血清中の4種類のPFASを測定
D932	バイオモニタリング	Claessens, J; Pirard, C; Charlier, C	Determination of contamination levels for multiple endocrine disruptors in hair froma non-occupationally exposed population living in Liege (Belgium)	2022	Sci. Total Environ. 2022 Apr:815:152734. doi: 10.1016/j.scitotenv.2021.152734.	Today, the interest in hair as alternative matrix for human biomonitoring of environmental pollutants has increased, but available data on chemical levels in hair remain scarce. In this study, the measurement of 2 bisphenols (A and S), 3 parabens (methyl-, ethyl- and propylparabens) and 8 perfluoralkyl compounds (PFCs) namely perfluorooctanesulfonate (PFOS), perfluorohexanesulfonate (PFHxS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroheptanoic acid (PFHpA), perfluoropentanoic acid (PFPeA) and perfluorohexanoic acid (PFHxA) was carried out, using a thoroughly validated UPLC-MS/MS method, in the hair from 114 adults living in Liege (Belgium) and surrounding areas. Themost frequently quantified compounds in the population were: bisphenol S (97.4%, median = 31.9 pg.mg(-1)), methylparaben (94.7%, median = 28.9 pg.mg(-1)), bisphenol A (93.9%, median = 46.6 pg.mg(-1)), ethylparaben (66.7%, median = 5.2 pg.mg(-1)), propylparaben (54.8%, median = 16.4 pg.mg(-1)) and PFOA (46.4%, median < 0.2 pg.mg(-1)). The other PFCs were detected only in few samples although current exposure of the Belgian population to PFCs was previously demonstrated using blood analyses. Nonparametric statistical analyses were performed to evaluate the influence of gender, hair treatments and hair length, but no significant difference was observed. Only age was positively correlated with the propylparaben contamination. Although blood seems to remain more suitable for PFCs exposure assessment, the results of this study suggest that hair can be an appropriate matrix for biomonitoring of organic pollutants such as parabens or bisphenols.		1	1					C	B		ベルギーで8種類のPFASの濃度を毛髪で測定したが、血清中濃度より感度が悪い
D933	バイオモニタリング	Liu, JY; Gao, XY; Wang, YX; Leng, JH; Li, JG; Zhao, YF; Wu, YN	Profiling of emerging and legacy per-/polyfluoroalkyl substances in serum among pregnant women in China	2021	Environ. Pollut. 2021 Feb:271:116376. doi: 10.1016/j.envpol.2020.116376.	Emerging per-/polyfluoroalkyl substances (PFASs), such as chlorinated polyfluorinated ether sulfonates (Cl-PFESAs), have been detected in human samples, yet investigation on their occurrence in pregnant women remains limited. Herein, ten legacy PFASs, branched perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA), two Cl-PFESAs, perfluoro-2-propoxypropanoic acid (HFPO-DA), and ammonium 4,8-dioxa-3H-perfluorononanoate (ADONA) were detected in serum samples from 480 pregnant women in Tianjin, China. The influencing effects of age, body mass index, gravidity, and parity were also evaluated. PFOS [geographic mean (GM): 7.05 ng/mL], 6:2Cl-PFESA (GM: 5.31 ng/mL), and PFOA (GM: 2.82 ng/mL) were the dominant PFASs in the serum of pregnant women, while neither HFPO-DA nor ADONA was detectable in any serum. The serum concentration of Cl-PFESAs and 6:2Cl-PFESA/PFOS ratio in the present study were 2-5 times higher than that in previous studies of pregnant women in China. Serum concentrations of Cl-PFESAs were significantly correlated with all detected PFAAs (Spearman's Rho: 0.15-0.69, $p < 0.01$) excepting perfluoropentanesulfonate (PFPeS), indicating common exposure sources for Cl-PFESAs and PFAAs and some particular exposure source for PFPeS. Younger age and multiparity were associated with lower serum concentrations of PFOS and several perfluoroalkyl sulfonates but not associated with Cl-PFESAs or PFOA, suggesting an increasing exposure to Cl-PFESAs and PFOA which neutralized the impact of age and parity. Overall, this study indicated a relatively high exposure level and composition of 6:2Cl-PFESA in pregnant women in the north coast of China, which highlights the need to investigate the exposure sources in this area.			1		1			B	B		中国の妊婦の10種類の血清PFASを測定

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D934	バイオモニタリング	Cho, CR; Lam, NH; Cho, BM; Kannan, K; Cho, HS	Concentration and correlations of perfluoroalkyl substances in whole blood among subjects from three different geographical areas in Korea	2015	Sci. Total Environ. 2015 Apr:512:397-405. doi: 10.1016/j.scitotenv.2015.01.070	Toxicity and persistence of perfluorinated alkyl substances (PFASs) in human have raised considerable concern and several biomonitoring studies throughout the world reported the widespread occurrence of these compounds in human tissues. However, information regarding influence of geographic, lifestyle and demographic factor on PFAS levels in human blood tissues is limited. In this study, whole blood samples collected in 2006-2007 from 319 donors from suburban Seoul (Suwon and Yongin), Busan and Yeosu in Korea were analyzed for perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorohexane sulfonate (PFHxS) and perfluorooctane sulfonamide (PFOSA). Blood donors classified into seven age groups with ages ranging from 8 to 82 years, and different lifestyles and socio-economic status. PFOS (median = 4.15 ng/mL) was found at the highest concentration with a maximum concentration of 59.1 ng/mL. The concentrations of other PFASs were in the decreasing order of; PFOA (median = 130 ng/mL) > PFNA (median = 0.85 ng/mL) > PFHxS (median = 0.47 ng/mL) > PFOSA (median = 0.12 ng/mL). Geographical differences in the concentrations of five target PFASs were found. Significant positive relationships between PFAS concentrations and the age of the donors were found. Gender-related differences were found in the concentrations of PFOA, PFNA, PFHxS and PFOSA. No association was found between PFAS levels and several lifestyle factors and socioeconomic status which included drinking habit, furniture/carpet in an indoor environment and monthly income. Occupation was an important determinant for PFNA and PFHxS concentrations in the whole blood. Except for PFOSA, significant associations were noted between PFASs concentrations and smoking habit The results of this study provide information for further public health monitoring and safety management for PFASs in Korea.			1						B	B		韓国で5種類の全血中PFAS濃度を測定
D935	バイオモニタリング	Dzierlenga, MW; Keast, DR; Longnecker, MP	The concentration of several perfluoroalkyl acids in serum appears to be reduced by dietary fiber	2021	Environ. Int. 2021 Jan:146:106292. doi: 10.1016/j.envint.2020.106292.	Fiber-rich food intake has been associated with lower serum concentrations of perfluoroalkyl substances (PFAS) in some studies and dietary fiber was related to lower serum PFAS in a recent study. Given the previous epidemiologic data suggesting that fiber might decrease serum PFAS concentrations, we examined the relation of serum PFAS concentrations to intake of dietary fiber in National Health and Nutrition Examination Survey (NHANES) data. We examined the PFAS-fiber association among 6482 adults who participated in the NHANES, 2005-2016. Fiber intake was estimated based on two 24-hour diet recalls. We adjusted the models for determinants of PFAS and potentially confounding factors such as intake of foods reported to increase PFAS exposure. Results were expressed as the percent difference in PFAS concentration per interquartile range (IQR) increase in fiber (and 95 percent confidence interval), and the NHANES sampling parameters were used to make the results generalizable to the U.S. The adjusted percent difference in perfluorooctanoic acid (PFOA) per IQR increase in fiber was-3.64 (-6.15, -1.07); for perfluorooctane sulfonic acid (PFOS) was-6.69 (-9.57, -3.73), and for perfluorononanoic acid (PFNA) was-8.36 (-11.33, -5.29). These results suggest that dietary fiber increases the gastrointestinal excretion of PFOA, PFOS, and PFNA. Because fiber also lowers serum cholesterol, in some studies of the serum cholesterol-PFAS relationship confounding by fiber may be worth evaluating.			1						B	B		NHANESに基づき、食物繊維摂取と３つのPFASのIQR比較。PFASだけでなくコレステロールにも影響を与える食物繊維の役割に注目
D936	バイオモニタリング	Shu, H; Lindh, CH; Wikstrom, S; Bornehag, CG	Temporal trends and predictors of perfluoroalkyl substances serum levels in Swedish pregnant women in the SELMA study	2018	PLoS One. 2018 Dec;13(12):e0209255. doi: 10.1371/journal.pone.0209255.	Background Perfluoroalkyl substances (PFAS) are used in numerous consumer products. They are persistent, bioaccumulating, and suspected to be endocrine disrupting chemicals (EDCs). A growing body of research has reported the association between PFAS exposure and adverse health effects. Concerns have been raised with special focus in childhood development. Methods Perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA), perfluorododecanoic acid (PFDoDA), perfluorohexane sulfonate (PFHxS) and perfluorooctane sulfonate (PFOS) were analyzed by LC/MS/MS in serum from 1,616 pregnant women in the Swedish SELMA study. The serum samples were collected in the first trimester (median week 10). Least square geometric means (LSGM) of PFAS were estimated for each year period for, adjusted for potential determinants including parity, fish intake in the family, and mother's age. Results Six PFAS (PFNA, PFDA, PFUnDA, PFHxS, PFOA, and PFOS) were detected above levels of detection (LOD) in more than 99% of the SELMA women, while PFHpA, and PFDoDA were detected above LOD in 73.4% and 46.7% respectively. Parity, maternal age, maternal smoking, and fish intake during pregnancy were found to be significantly associated (p<0.05) with serum PFAS levels in the pregnant women. Finally, serum concentration of six PFAS (PFNA, PFDA, PFHxS, PFHpA, PFOA and PFOS) were significantly decreasing (range 14-31%) during the period of 30 months from 2007-2010. Conclusions Our analysis shows that six out of eight PFAS could be identified in serum of more than 99% of SELMA subjects with a significant slightly decreasing trend for five of these compounds. Furthermore, parity, higher fish intake and mothers age are determinants for serum levels of PFAS in pregnant women.			1						B	A		SELMA study（スウェーデン）の妊婦の9種類のPFASと食事、妊娠回数、年齢との関連を調査。魚が重要
D937	バイオモニタリング	Wise, LA; Wesselink, AK; Schildroth, S; Calafat, AM; Bethea, TN; Geller, RJ; Coleman, CM; Fruh, V; Henn, BC; Botelho, JC; Harmon, QE; Thirkill, M; Wegienka, GR; Baird, DD	Correlates of plasma concentrations of per- and poly-fluoroalkyl substances among reproductive-aged Black women	2022	Environ. Res. 2022 Jan:203:111860. doi: 10.1016/j.envres.2021.111860.	Background: Per- and polyfluoroalkyl substances (PFAS) are synthetic chemicals used in commercial and consumer goods. Black women are underrepresented in studies of PFAS exposure. Methods: We performed a cross-sectional analysis of correlates of plasma PFAS concentrations among 1499 Black women aged 23-35 participating in the Study of Environment, Lifestyle, and Fibroids (SELF), a Detroitbased cohort study. At baseline (2010-2012), participants provided questionnaire data on socio-demographics; behaviors; diet; and menstrual, contraceptive, and reproductive histories. Using mass spectrometry in nonfasting plasma samples collected at enrollment, we quantified several PFAS, including perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorodecanoate (PFDA), perfluoroundecanoate (PFUnDA), and 2-N-methyl-perfluorooctane sulfonamido acetate (MeFOSAA). We used linear regression to calculate percentage differences (%D) and 95 % confidence intervals (CIs) for associations between selected correlates and PFAS concentrations, adjusting for all other correlates. Results: PFHxS, PFOS, PFOA, and PFNA were detected in >97 % of women; PFDA in 86 %; MeFOSAA in 70 %; and PFUnDA in 52 %. Age, income, education, and intakes of water, alcohol, and seafood were positively associated with several PFAS. Current smoking was positively associated with MeFOSAA. Body mass index was inversely associated with most PFAS, except PFHxS. Strong inverse associations (%D; 95 % CI) were observed between parity (>3 vs. 0 births) and PFHxS (-34.7; -43.0, -25.1) and PFOA (-33.1; -39.2, -26.3); breastfeeding duration (>6 months vs. nulliparous) and PFOA (-31.1; -37.8, -23.7), PFHxS (-24.2; -34.5, -12.3), and PFOS (-18.4; -28.3, -7.1); recent birth (<2 years ago vs. nulliparous) and PFOA (-33.1; -39.6, -25.8), PFHxS (-29.3; -39.0, -18.1), PFNA (-25.2; -32.7, -16.8), and PFOS (-18.3; -28.3, -6.9); and intensity of menstrual bleed (heavy vs. light) and PFHxS (-18.8; -28.3, -8.2), PFOS (-16.4; -24.9, -7.1), PFNA (-10.5; -17.8, -2.6), and PFOA (-10.0; -17.2, -2.1). Current use of depot medroxyprogesterone acetate (DMPA) was positively associated with PFOS (20.2; 1.4, 42.5), PFOA (16.2; 1.5, 33.0), and PFNA (15.3; 0.4, 32.4). Conclusions: Reproductive factors that influence PFAS elimination showed strong associations with several PFAS (reduced concentrations with parity, recent birth, lactation, heavy menstrual bleeding; increased concentrations with DMPA use).			1						B	B	B-minor	デトロイトの黒人コホートの女性の７種類のPFAS測定
D938	バイオモニタリング	Sultan, H; Buckley, JP; Kalkwarf, HJ; Cecil, KM; Chen, AM; Lanphear, BP; Yolton, K; Braun, JM	Dietary per- and polyfluoroalkyl substance (PFAS) exposure in adolescents: The HOME study	2023	Environ. Res.2023 Aug;231(Pt 1):115953. doi: 10.1016/j.envres.2023.115953.	Background: Diet is the primary exposure pathway for per- and polyfluoroalkyl substances (PFAS) in nonoccupationally exposed populations. Few studies have examined associations of dietary quality and macronutrient intake with PFAS exposure among US adolescents. Objective: To assess relationships of self-reported dietary quality and macronutrient intake with serum PFAS concentrations in adolescents. Methods: We used cross-sectional data from 193 Cincinnati, Ohio area adolescents (median age 12.3 years) collected from 2016 to 2019. Using 24-h food recalls completed by adolescents on three separate days, we derived Healthy Eating Index (HEI) scores, HEI components, and macronutrient intake. We measured perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA) concentrations in fasting serum samples. Using linear regression, we estimated covariate-adjusted associations between dietary variables and serum PFAS concentrations. Results: The median HEI score was 44 and median serum PFOA, PFOS, PFHxS, and PFNA concentrations were 1.3, 2.4, 0.7, and 0.3 ng/mL respectively. In adjusted models, higher total HEI scores, whole fruit and total fruit HEI component scores, and total dietary fiber intake were associated with lower concentrations of all four PFAS. For example, serum PFOA concentrations were 7% lower (95% CI: -15, 2) per standard deviation increase in total HEI score and 9% lower (95% CI: -18, 1) per standard deviation increase in dietary fiber. Significance: Given adverse health effects associated with PFAS exposure, it is crucial to understand modifiable exposure pathways. Findings from this study may inform future policy decisions aiming to limit human exposure to PFAS.			1						B	B	exposure source	シンシナティの住民の食事摂取調査と４種類のPFAS濃度との関連

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D939	バイオモニタリング	Harada, KH; Hitomi, T; Niisoe, T; Takanaka, K; Kamiyama, S; Watanabe, T; Moon, CS; Yang, HR; Hung, NN; Koizumi, A	Odd-numbered perfluorocarboxylates predominate over perfluorooctanoic acid in serum samples from Japan, Korea and Vietnam	2011	Environ. Int. 2011 Oct:37(7):1183-1189. doi: 10.1016/j.envint.2011.04.011.	Perfluorooctanoic acid (PFOA) has recently attracted attention as a potential health risk following environmental contamination. However, information detailing exposure to perfluorinated carboxylic acids (PFCAs) other than PFOA is limited. We measured the concentrations of PFCAs (from perfluorohexanoic acid to perfluorotetradecanoic acid) in serum samples obtained from patients in Japan (Sendai, Takayama, Kyoto and Osaka) between 2002 and 2009, Korea (Busan and Seoul) between 1994 and 2008 and Vietnam (Hanoi) in 2007/2008. Total PFCA levels (geometric mean) were increased from 8.9 ng mL(-1) to 10.3 ng mL(-1) in Japan; from 7.0 ng mL(-1) to 9.2 ng mL(-1) in Korea; and were estimated at 4.7 ng mL(-1) in Vietnam. PFCAs of greater length than PFOA were significantly increased in Sendai, Takayama and Kyoto, Japan, and levels of long-chain PFCAs exceeded PFOA levels in serum. Among these PFCAs, perfluoroundecanoic acid (PFUnDA) was the predominant component (28.5%), followed by perfluorononanoic acid (PFNA 17.5%), perfluorodecanoic acid (PFDA 7.9%), perfluorotridecanoic acid (PFTrDA 6.1%) and perfluorododecanoic acid (PFDoDA 1.8%). Odd-numbered PFCAs (PFNA, PFUnDA and PFTrDA) were also observed in Korea and Vietnam and their presence increased significantly in Korea between 1994 and 2007/2008. The proportion of long-chain PFCAs in serum was relatively high compared to reports in Western countries. Further investigations into the sources and exposure routes are needed to predict the future trajectory of these serum PFCA levels.		1	1					B	A		日本、韓国、ベトナムのPCAA濃度を比較。PFOSを測っていない
D940	バイオモニタリング	Hartmann, C; Jamnik, T; Weiss, S; Goss, M; Fareed, Y; Satrapa, V; Braun, D; Flasch, M; Warth, B; Uhl, M	Results of the Austrian Children?s Biomonitoring Survey 2020 part A: Per-and polyfluorinated alkylated substances, bisphenols, parabens and other xenobiotics	2023	Int. J. Hyg. Environ. Health. 2023 Apr:249:114123. doi: 10.1016/j.ijheh.2023.114123.	In 85 Austrian school children aged 6-10 years, two multi-analyte LC-MS/MS methods were used to study the concentrations of 33 chemical substances in urine, including per-and polyfluorinated alkylated substances (PFAS), bisphenols, parabens, benzophenones, triclosan, polycyclic aromatic hydrocarbon metabolites, and co-tinine. Each of the children was exposed to 14-21 substances simultaneously. Correlations were found between compounds of the same and of divergent substance groups supporting the strong need to consider multiple ex-posures and mixture effects. Eight compounds, including perfluorohexanoic acid (PFHxA), perfluorononanoic acid (PFOA), methyl paraben (n-MeP), ethyl paraben (n-EtP), propyl paraben (n-PrP), benzophenone-1 (BP-1), 2 -naphthol, and 3-hydroxyphenanthrene were detected in all urine samples. In the PFAS group the medians of detectable substances ranged between <0.0005 mu g/l for perfluorononanoic acid (PFNA) and 0.004 mu g/l for PFHxA. For other environmental contaminants investigated, a maximum urinary level of 893 mu g/l was identified for n-MeP. The highest median value was 2.5 mu g/l for 2-naphthol.Daily intakes were calculated for bisphenol A (BPA), triclosan (TCS), and four parabens. These values did not exceed the tolerable or acceptable daily intakes currently in force. Based on a recently proposed TDI for BPA, daily intakes of all children exceeded this value. A cumulative risk assessment was conducted for four parabens not showing exceedances of acceptable exposures. The results demonstrate simultaneous exposure to several different chemicals, with the majority showing impact on the endocrine system being of particular concern with respect to mixture effects. Further assessments with a stronger focus on mixtures are warranted. The results also highlight the need of policy actions as foreseen in the EU Chemicals Strategy for Sustainability.		1	1					B	B		オーストリアの子供の14種類のPFASを測定
D941	バイオモニタリング	Rock, KD; Polera, ME; Guillette, TC; Starnes, HM; Dean, K; Watters, M; Stevens-Stewart, D; Belcher, SM	Domestic Dogs and Horses as Sentinels of Per- and Polyfluoroalkyl Substance Exposure and Associated Health Biomarkers in Gray's Creek North Carolina	2023	Environ. Sci. Technol. 2023 Jun:57(26):9567-9579. doi: 10.1021/acs.est.3c01146.	Domestic dogs and horses provideunique insight into sharedenvironmental exposures and One Health risks for humansand animals in the industrialized world. Central North Carolina (NC) is highly contaminated withper- andpolyfluoroalkyl substances (PFAS), in part due to local fluorochemicalproduction. Little is known about the exposure profiles and long-termhealth impacts for humans and animals that live in nearby communities.In this study, serum PFAS concentrations were determined using liquidchromatography high-resolution mass spectrometry and diagnostic clinicalchemistry endpoints were assessed for 31 dogs and 32 horses that residein Gray's Creek NC at households with documented PFAS contaminationin their drinking water. PFAS were detected in every sample, with12 of the 20 PFAS detected in & GE;50% of samples from each species.The average total PFAS concentrations in horses were lower comparedto dogs who had higher concentrations of PFOS (dogs 2.9 ng/mL; horses1.8 ng/mL), PFHxS (dogs 1.43 ng/mL, horses < LOD), and PFOA (dogs0.37 ng/mL; horses 0.10 ng/mL). Regression analysis highlighted alkalinephosphatase, glucose, and globulin proteins in dogs and gamma glutamyltransferase in horses as potential biomarkers associated with PFASexposure. Overall, the results of this study support the utility ofcompanion animal and livestock species as sentinels of PFAS exposuredifferences inside and outside of the home. As in humans, renal andhepatic health in domestic animals may be sensitive to long-term PFASexposures.								C	B		ノースカロライナ州の犬と馬のPFASを測定
D942	バイオモニタリング	Koponen, J; Winkens, K; Airaksinen, R; Berger, U; Vestergren, R; Cousins, IT; Karvonen, AM; Pekkanen, J; Kiviranta, H	Longitudinal trends of per- and polyfluoroalkyl substances in children's serum	2018	Environ. Int. 2018 Dec;121(Pt 1):591-599. doi: 10.1016/j.envint.2018.09.006.	Studies suggest negative health impacts from early life exposure to per- and polyfluoroalkyl substances (PFASs). However, information on longitudinal exposure to PFASs during childhood is scarce for background-exposed individuals. This study sought to fill this gap by investigating children's longitudinal exposure trends through measurement of PFAS serum concentrations and calculation of body burdens (mu g, total in body). Blood of 54 Finnish children was sampled 2005-2015 and analyzed for 20 PFASs at 1, 6 and 10.5 years of age. The body burden was calculated by multiplying the serum concentration by the volume of distribution and the bodyweight for each individual. Associations between serum concentrations or body burdens and parameters, such as sex, breastfeeding duration, body mass index as well as indoor dust and air PFAS concentrations, were evaluated. Serum concentrations of perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorohexane sulfonic acid (PFHxS) decreased significantly ($p < 0.001$) with age. In contrast to serum concentrations, body burdens stayed unchanged or even increased significantly ($p < 0.05$), except for PFOA in female children. Breastfeeding duration was positively correlated ($p < 0.001$) with serum concentrations of PFHxS, PFOS, PFOA and PFNA at 1 year of age. Some associations were found at 10.5 years with sex and indoor PFAS concentrations. Observations of longitudinal decreasing trends of serum concentrations can be misleading for understanding exposure levels from external media during childhood, as the serum concentration is influenced by parallel temporal changes and growth dilution. Body burdens account for growth dilution and thus better reflect differences in early-life to adolescence exposure than serum concentrations.			1					B	B		フィンランドの2005-2015年の子供の血清PFAS濃度の変化
D943	バイオモニタリング	Guruge, KS; Taniyasu, S; Yamashita, N; Wijeratna, S; Mohotti, KM; Seneviratne, HR; Kannan, K; Yamanaka, N; Miyazaki, S	Perfluorinated organic compounds in human blood serum and seminal plasma: a study of urban and rural tea worker populations in Sri Lanka	2005	J. Environ. Monit. 2005 Apr:7(4):371-377. doi: 10.1039/b412532k.	Concentrations and accumulation of 13 fluorinated organic compounds (FOCs) in human sera and seminal plasma were measured in an Asian developing country, Sri Lanka. Six of the FOCs, PFOS (perfluorooctanesulfonate), PFHS (perfluorohexanesulfonate), PFUnA (perfluoroundecanoic acid), PFDA (perfluorodecanoic acid), PFNA (perfluorononanoic acid) and PFOA (perfluorooctanoic acid), were detected in all of the sera samples. Measurable quantities of two main perfluorosulfonates, PFOS and PFHS, were found in all seminal plasma samples. The detection frequency of the predominant perfluoroalkylcarboxylate, PFOA, in seminal plasma was >70%. Accumulation of PFOS in sera was significantly positively correlated with PFOA, PFHS and PFNA. Positive linear regressions were also found between PFNA and PFUnA and PFNA and PFDA suggesting that these compounds may have a similar origin of exposure and accumulation. Significantly positive associations were observed for partitioning of both PFOS and PFNA between sera and seminal plasma. The accumulation of FOCs was not significantly different in sera from Colombo (urban population) and Talawakele (rural conventional tea workers). However, the Haldummulla population (rural organic tea workers) had relatively lower exposure to FOCs compared to the other two groups, urban and rural conventional tea workers. Concentrations of FOCs in Sri Lanka were similar to those reported for industrialized countries suggesting that human exposure to such chemicals is widespread even in developing countries. The novel finding of FOCs in human seminal plasma implies that further studies are needed to determine whether long-term exposure in humans can result in reproductive impairments.			1					B	B	B-minor	スリランカの男性の血清と精漿中の13種類のPFAS濃度の相関
D944	バイオモニタリング	LaKind, JS; Naiman, J; Verner, MA; Leveque, L; Fenton, S	Per- and polyfluoroalkyl substances (PFAS) in breast milk and infant formula: A global issue	2023	Environ. Res. 2023 Feb:219:115042. doi: 10.1016/j.envres.2022.115042.	Background: Per-and polyfluoroalkyl substances (PFAS) are transferred from mother to infants through breast-feeding, a time when children may be particularly vulnerable to PFAS-mediated adverse health effects. Infants can also be exposed to PFAS from infant formula consumption. Our recent literature-based scoping of breast milk levels reported that four PFAS often exceeded the United States Agency for Toxic Substances and Disease Registry (ATSDR) children's drinking water screening levels in both the general population and highly impacted com-munities in the U.S. and Canada. This work presents a comparison of global breast milk and infant formula PFAS measurements with the only reported health-based drinking water screening values specific to children. Methods: We focused on four PFAS for which ATSDR has developed children's drinking water screening values: PFOA (perfluorooctanoic acid), PFOS (perfluorooctanesulfonic acid), PFHxS (perfluorohexanesulfonic acid), and PFNA (perfluorononanoic acid). Published literature on PFAS levels in breast milk and infant formula were identified via PubMed searches. Data were compared to children's drinking water screening values. Discussion: Breast milk concentrations of PFOA and PFOS often exceed children's drinking water screening values, regardless of geographic location. The limited information on infant formula suggests its use does not necessarily result in lower PFAS exposures, especially for formulas reconstituted with drinking water containing PFAS. Unfortunately, individuals generally cannot know whether their infant's exposures exceed children's drinking water screening values. Thus, it is essential that pregnant and lactating women and others, especially those having lived in PFAS-contaminated communities, have data required to make informed decisions on infant nutrition. An international monitoring effort and access to affordable testing are needed for breast milk, drinking water and infant formula to fully understand infant PFAS exposures. Currently, our understanding of demon-strable methods for reducing exposures to emerging PFAS is limited, making this research and the communi-cations surrounding it even more important.			1					B	B	exposure source	米国の母乳と人工乳の4種類のPFAS濃度に関する文献調査

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D945	バイオモニタリング	Jain, RB	Co-variate adjusted associations between serum concentrations of selected perfluoroalkyl substances and urinary concentrations of selected arsenic species	2023	Environ. Sci. Pollut. Res. 2023 Mar:30(12):34750-34759. doi: 10.1007/s11356-022-24745-4.	Data from National Health and Nutrition Examination Survey for 2011-2012 were used to estimate associations of the serum concentrations of perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), perfluoroundecanoic acid (PFUnDA), and 2-(N-methyl-perfluorooctane sulfonamido) acetic acid (Me-PFOSA) with urinary concentrations of total arsenic (UAS), inorganic arsenic (IAS), arsenobetaine (UAB), and dimethyl arsinic acid (UDMA) among US adults aged > = 20 years. Concentrations of PFNA were positively associated with all four arsenic variables but statistical significance was observed for IAS only (beta = 0.33364, P = 0.04). Concentrations of PFDA were positively associated with UAS (beta = 0.20688, P = 0.01), IAS (beta = 0.23712, P = 0.02), and UAB (beta = 0.26049, P = 0.02). Concentrations of PFUnDA were positively associated with UAS (beta = 0.49946, P < 0.01), IAS (beta = 0.51782, P < 0.01), UAB (beta = 0.62924, P < 0.01), and UDMA (beta = 0.26375, P < 0.01). Concentrations of Me-PFOSA with PFAS were inversely associated with every PFAS but statistical significance was observed for UDMA only (beta = - 0.05613, P = 0.03). PFOA, PFHxS, and PFOS were, in general, negatively associated with concentrations of all four arsenic variables but without reaching statistical significance. Positive associations of PFDA, PFNA, and PFUnDA with arsenic necessitate investigation about impact of the co-exposure of these PFAS with arsenic and their impact on health. Fluorinated carbon chain length > 8 as opposed to <= 8 may have a role in defining associations of PFAS with arsenic.			1					C	B		米国のNHANESを活用して血清中7種類のPFAS濃度と尿中ヒ素濃度との関係を調べた
D946	バイオモニタリング	Lee, S; Kim, S; Park, J; Kim, HJ; Choi, G; Choi, S; Kim, S; Kim, SY; Kim, S; Choi, K; Moon, HB	Perfluoroalkyl substances (PFASs) in breast milk from Korea: Time-course trends, influencing factors, and infant exposure	2018	Sci. Total Environ. 2018 Jan:612:286-292. doi: 10.1016/j.scitotenv.2017.08.094	Breastfeeding is an important exposure pathway to perfluoroalkyl substances (PFASs) for newborn infants. Nevertheless, reports are limited on the occurrence and time-course of PFASs in breast milk, and most studies have focused on the analysis of perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). In this study, 16 PFASs were analyzed in breast milk samples (n= 293) collected from 128 mothers in Korea during various lactation periods to assess maternal exposure levels, contamination profiles, time-course variations, and infant health risks. The total concentrations of PFASs (Sigma PFAS) ranged from 31.7 to 1004 (median: 188) ng/L, which was within the ranges recently reported for Asian and European populations. After a month of nursing, the concentrations of PFOS, PFOA, perfluorononanoic acid (PFNA), and SPFAS significantly increased. This could be due to changes in the dietary and behavior patterns of the mothers after the first month of lactation. The concentrations of PFOS and PFOA were significantly correlated with maternal age, body mass index, and parity. Certain types of diet (e.g. consuming snacks and milk) and eating-out frequency were significantly associated with increasing levels of PFAS. Significant correlations and similar time-course trends were found between PFASs and PCBs/DDTs, implying similar exposure sources and biokinetics for these contaminants. The estimated daily intakes of PFOS and PFOA via the consumption of breast milk were below the tolerable daily intakes for infants suggested by the European Food Safety Authority (EFSA).			1					B	B	exposure source	韓国の母乳中の16種類のPFAS濃度を調べた
D947	バイオモニタリング	Papadopoulou, E; Haug, LS; Sabaredzovic, A; Eggesbo, M; Longnecker, MP	Reliability of perfluoroalkyl substances in plasma of 100 women in two consecutive pregnancies	2015	Environ. Res. 2015 Jul:140:421-429. doi: 10.1016/j.envres.2015.04.022	The potential toxicity of background exposure to perfluoroalkyl substances (PFASs) is currently under active investigation. Such investigations typically rely on a single measure of PFAS concentration, yet the longer-term reliability of a single measure has not been well characterized, especially among reproductive-aged women. Our aim was to investigate the association between PFAS plasma concentrations of 100 women in two consecutive pregnancies and explore changes in plasma concentration related to reproductive factors. The women in our study were enrolled in the Norwegian Mother and Child Cohort Study (MoBa) from 2003 to 2009. About half of them breastfed exclusively for 6 months and the rest of the participants did not breastfeed between the two consecutive pregnancies (median time between pregnancies: 18 months). Maternal blood was collected at mid-pregnancy and plasma was analyzed for 10 PFASs. Statistical analyses were restricted to 6 PFASs that were quantifiable in more than 80% of the samples. We estimated the correlation between repeated PFAS measurements, the percentage change between pregnancies and the effect of several reproductive factors in multivariate linear regression models of PFAS concentrations in the second pregnancy. The Pearson correlation coefficient between repeated PFAS measurements was, for perfluorooctane sulfonate (PFOS), 0.80; perfluorooctanoate (PFOA), 0.50; perfluorohexane sulfonate (PFHxS), 0.74; perfluorononanoate (PFNA), 0.39; perfluoroundecanoate (PFUnDA), 0.71; and perfluorodecanoate (PFDA), 0.60. Adjustment for maternal age, delivery year, and time and breastfeeding between pregnancies did not substantially affect the observed correlations. We found 44-47% median reductions in the concentrations of PFOS, PFOA and PFHxS between pregnancies, while the change in concentrations between pregnancies was smaller and more variable for PFNA, PFUnDA and PFDA. The variation in plasma concentrations in the second pregnancy was mainly accounted for by the concentration in the first pregnancy; for PFOS, PFOA, and PFNA, breastfeeding also accounted for a substantial proportion. In conclusion, we found the reliability of PFAS measurements in maternal plasma to be moderate to high, and in these data, several factors, especially breastfeeding, were related to plasma concentrations.			1					B	A	PK	妊婦のPFAS濃度の信頼性を調べるため2回連続妊娠時の10種類のPFAS濃度の相関と変動要因を調べた。母乳哺育が影響
D948	バイオモニタリング	Stein, CR; Wolff, MS; Calafat, AM; Kato, K; Engel, SM	Comparison of polyfluoroalkyl compound concentrations in maternal serum and amniotic fluid: A pilot study	2012	Reprod. Toxicol. 2012 Nov:34(3):312-316. doi: 10.1016/j.reprotox.2012.05.039.	The extent to which polyfluoroalkyl compounds (PFCs) are detectable in amniotic fluid is unknown. Using paired samples from 28 women, we compared the concentration of 8 PFCs measured in serum, the standard matrix for assessing human exposure, amniotic fluid from routine amniocentesis, and urine. Perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorooctane sulfonate (PFOS), and perfluorohexane sulfonate (PFHxS) were detected in all maternal serum samples. The number of amniotic fluid samples with detectable concentrations differed by PFC (PFOA n = 24; PFNA n = 10; PFOS n = 9; PFHxS n = 4). The correlation coefficient between maternal serum and amniotic PFC levels varied considerably by PFC (PFOA rho = 0.64, p < 0.001; PFNA rho = 0.05, p = 0.9; PFOS rho = 0.76, p = 0.01; PFHxS rho = 0.80, p = 0.2). Using linear regression, PFOA appeared to be commonly detected in amniotic fluid if the serum concentration exceeded approximately 1.5 ng/mL whereas PFOS was rarely detected in amniotic fluid until the serum concentration was about 5.5 ng/mL. No PFCs were detected in urine.			1					B	B	PK	母体血清と羊水中の10種類のPFAS濃度を比較した
D949	バイオモニタリング	Nair, AS; Ma, ZQ; Watkins, SM; Wood, SS	Demographic and exposure characteristics as predictors of serum per- and polyfluoroalkyl substances (PFASs) levels - A community-level biomonitoring project in Pennsylvania	2021	Int. J. Hyg. Environ. Health. 2021 Jan:231:113631. doi: 10.1016/j.ijheh.2020.113631.	Perand polyfluoroalkyl substances (PFASs) are widely used in industrial and consumer products and have been linked to various adverse health effects. Communities near two former military bases in Pennsylvania were exposed to PFAS through contaminated drinking water for several decades. The Pennsylvania Department of Health (DOH) conducted biomonitoring of 235 randomly selected community members living in four public water system (PWS) service areas to evaluate a toolkit developed by the Centers for Disease Control and Prevention (CDC) and the Agency for Toxic Substances and Disease Registry (ATSDR). DOH also collected data on participants' demographics, exposure history and self-reported health conditions. Serum PFAS levels were compared with the national averages for 2013-2014 and their relationships with demographic and exposure characteristics were analyzed. Of the 11 PFASs analyzed for, only perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), perfluorohexanesulfonic acid (PFHxS) and perfluorononanoic acid (PFNA) were consistently detected in the serum samples. The average levels of PFOA, PFOS, PFHxS and PFNA among the study participants were 3.13, 10.24, 6.64 and 0.74 mu g per liter (mu g/L), respectively. Overall, 75, 81, 94 and 59 percent of the study participants had levels exceeding the national average for PFOA (1.94 mu g/L), PFOS (4.99 mu g/L), PFHxS (1.35 mu g/L) and PFNA (0.66 mu g/L), respectively. Results indicated associations between serum levels of some PFAS compounds and sex, age, employment in the study area, PWS area, quantity of daily tap water consumption, and length of residence in the study area.			1					B	B	exposure source	ペンシルバニア州の汚染地域住民の血清中の10種類のPFAS濃度を測定
D950	バイオモニタリング	Burgess, JL; Fisher, JM; Nematollahi, A; Jung, AM; Calkins, MM; Graber, JM; Grant, CC; Beitel, SC; Littau, SR; Gulotta, JJ; Wallentine, DD; Hughes, RJ; Popp, C; Calafat, AM; Botelho, JC; Coleman, AD; Schaefer-Solle, N; Louzado-Feliciano, P; Oduwole, SO; Caban-Martinez, AJ	Serum per- and polyfluoroalkyl substance concentrations in four municipal US fire departments	2023	Am. J. Ind. Med. 2023 May:66(5):411-423. doi: 10.1002/ajim.23413.	Background Firefighters have occupational and environmental exposures to per- and polyfluoroalkyl substances (PFAS). The goal of this study was to compare serum PFAS concentrations across multiple United States fire departments to National Health and Nutrition Examination Survey (NHANES) participants. Methods Nine serum PFAS were compared in 290 firefighters from four municipal fire departments (coded A-D) and three NHANES participants matched to each firefighter on sex, ethnicity, age, and PFAS collection year. Only Departments A and C had sufficient women study participants (25 and six, respectively) to compare with NHANES. Results In male firefighters compared with NHANES, geometric mean perfluorohexane sulfonate (PFHxS) was elevated in Departments A-C, sum of branched perfluoromethylheptane sulfonate isomers (Sm-PFOS) was elevated in all four departments, linear perfluorooctane sulfonate (n-PFOS) was elevated in Departments B and C, linear perfluorooctanoate (n-PFOA) was elevated in Departments B-D, and perfluorononanoate (PFNA) was elevated in Departments B-D, but lower in A. In male firefighters compared with NHANES, perfluoroundecanoate (PFUnDA) was more frequently detected in Departments B and D, and 2-(N-methyl-perfluorooctane sulfonamido) acetate (MeFOSAA) was less frequently detected in Departments B-D. In female firefighters compared with NHANES, PFHxS and Sm-PFOS concentrations were elevated in Departments A and C. Other PFAS concentrations were elevated and/or reduced in only one department or not significantly different from NHANES in any department. Conclusions Serum PFHxS, Sm-PFOS, n-PFOS, n-PFOA, and PFNA concentrations were increased in at least two of four fire departments in comparison to NHANES.			1					B	B		米国の消防士の血清中PFAS濃度を測定

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D951	バイオモニタリング	Ding, N; Harlow, SD; Batterman, S; Mukherjee, B; Park, SK	Longitudinal trends in perfluoroalkyl and polyfluoroalkyl substances among multiethnic midlife women from 1999 to 2011: The Study of Women's Health Across the Nation	2020	Environ. Int. 2020 Feb:135:105381. doi: 10.1016/j.envint.2019.105381.	Background: Limited information exists regarding longitudinal trends in midlife women's exposure to perfluoroalkyl and polyfluoroalkyl substances (PFAS). Further, little is known about how patterns of exposure differ by race/ethnicity and reproductive characteristics including parity and menopause. Objective: We aimed to examine temporal variations in serum PFAS concentrations among midlife women from the Study of Women's Health Across the Nation. Methods: Serum concentrations of 11 PFAS homologues were measured in 75 White, Black and Chinese women with blood samples collected in 1999-2000, 2002-2003, 2005-2006, and 2009-2011. Rates of changes in PFAS concentrations were calculated assuming a first-order elimination model. Associations between PFAS concentrations and race/ethnicity, menstruation and parity were evaluated with linear mixed models, adjusting for age, body mass index and study site. Results: Serum concentrations of linear-chain perfluorooctanoic acid (n-PFOA), linear- and branched-chain perfluorooctane sulfonic acid (n-PFOS and sm-PFOS) decreased significantly (-6.0%, 95% CI: - 8.3%, - 3.6% per year for n-PFOA; -14.8%, 95% CI: -17.3%, -12.3% per year for n-PFOS; -16.9%, 95% CI: -19.1%, - 14.6% per year for sm-PFOS); whereas perfluorononanoic acid (PFNA) increased (16.0%, 95% CI: 10.6%, 21.6% per year). Detection rates of perfluorodecanoic acid (PFDeA) and perfluoroundecanoic acid (PFUA) doubled. Temporal trends varied significantly by race/ethnicity. Chinese women tended to have consistently higher PFNA concentrations at each follow-up visit, compared with White and Black women. Serum PFHxS concentrations significantly decreased in White and Black women, but not in Chinese. Menstruating women consistently had lower concentrations. Parity was associated with lower concentrations at baseline but the differences between nulliparous and parous women became smaller over time. Conclusions: Our results suggest longitudinal declines in serum concentrations of legacy PFAS and increases in serum concentrations of emerging compounds from 1999 to 2011 in midlife women. Temporal trends in PFAS concentrations are not uniform across race/ethnicity and parity groups.			1					B	B		1999-2011年の米国の中年女性の11種類のPFAS濃度の変化について地域、人種などの要因を解析
D952	バイオモニタリング	Siebenaler, R; Cameron, R; Butt, CM; Hoffman, K; Higgins, CP; Stapleton, HM	Serum perfluoroalkyl acids (PFAAs) and associations with behavioral attributes	2017	Chemosphere 2017 Oct:184:687-693. doi: 10.1016/j.chemosphere.2017.06.023	The ubiquitous use of poly- and perfluoroalkyl substances (PFASs) in a variety of industrial and consumer products has resulted in chronic exposure in most industrialized nations, and led to measurable concentrations in blood and other tissues in humans across all life stages; however, behavioral attributes that relate to exposure are not well studied. To further investigate how behavior may relate to PFAS exposure, 37 adults were recruited from central North Carolina. Participants provided blood samples and behavioral questionnaires were administered, asking questions about a variety of household, dietary, and behavioral outcomes. Six PFAAs, including PFHxA (geometric mean: 0.14 ng/mL), PFOA (1.57 ng/mL), PFNA (0.67 ng/mL), PFDA (0.28 ng/mL), PFHxS (3.17 ng/mL) and PFOS (4.96 ng/mL) were detected in >50% of the samples. Generally, males had higher serum levels than females across all chemicals, and levels were very similar to NHANES levels; however, PFHxS and PFDA levels were higher in our study population. Several personal characteristics and behaviors were associated with serum PFAS levels. Reported use of filtration devices was associated with lower levels of PFOA (28% lower, p = 0.03), but higher levels of PFHxA (122% higher, p = 0.04). Serum PFHxS levels were also elevated in individuals that vacuumed less often, and in individuals that reported consuming more microwavable foods. These results suggest that personal behaviors may be important determinants of PFAS exposures.			1					B	B	exposure source	6種類のPFAS濃度に及ぼす水の摂取に関する習慣の影響
D953	バイオモニタリング	Sjogren, P; Montse, R; Lampa, E; Salihovic, S; van Bavel, B; Lind, L; Lind, PM	Circulating levels of perfluoroalkyl substances are associated with dietary patterns - A cross sectional study in elderly Swedish men and women	2016	Environ. Res. 2016 Oct:150:59-65. doi: 10.1016/j.envres.2016.05.016	Background: In our daily life, we are exposed to perfluoroalkyl substances (PFAS) with possible health implications. The main exposure route for these substances is diet but comparative studies on how dietary habits influence exposure are lacking. Objectives: To examine the relations between blood levels of PFAS and adherence to three predefined dietary patterns (a WHO recommended diet, a Mediterranean-like diet, and a Low-Carbohydrate High Protein (LCHP) diet) in an elderly Swedish population. Methods: Dietary data from 7-day food records and serum concentrations of PFAS were obtained from a 70-year-old Swedish population (n=844), the Prospective Investigation of the Vasculature in Uppsala Seniors (PIVUS) study. The Healthy Diet Indicator score (based on WHO recommendations), the Mediterranean Diet Score and LCHP score were used to assess adherence. Multivariate linear regression was used to assess the associations between eight major PFAS and adherence to each dietary pattern. Results: The WHO recommended diet was positively associated with perfluorohexane sulfonic acid (PFHxS). The LCHP diet was positively related to four out of eight PFAS; namely, perfluorooctane sulfonic acid (PFOS), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA) and perfluoroundecanoic acid (PFUnDA). The Mediterranean-like diet was positively associated with most PFAS; namely perfluorooctanoic acid (PFOA), perfluorooctane sulfonamide (PFOSA), PFHxS, PFNA, PFDA, and PFUnDA. Conclusions: All dietary patterns were positively associated with blood levels of PFAS. The highest body burden of PFAS was found in individuals with high adherence to a Mediterranean-like diet, whilst individuals who more closely followed the officially recommended diet displayed a lower body burden of these compounds.			1					B	B	exposure source	スウェーデンの70歳代の人々の食生活とPFAS濃度との関連
D954	バイオモニタリング	Jain, RB	Time trends over 2003-2014 in the concentrations of selected perfluoroalkyl substances among US adults aged >= 20 years: Interpretational issues	2018	Sci. Total Environ. 2018 Dec:645:946-957. doi: 10.1016/j.scitotenv.2018.07.198	Data (N = 9650) for US adults aged >= 20 years downloaded from National Health and Nutrition Examination Survey for 2003-2014 were analyzed to study trends in adjusted and unadjusted concentrations of selected perfluoroalkyl substances (PFAS), namely, perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorodecanoic acid (PFDA), perfluorohexane sulfonate (PFHxS), and perfluorononanoic acid (PFNA). Over 2003-2014, unadjusted concentrations of PFOA decreased by 50%, by 75% for PFOS, by 32% for PFDA, by 27% for PFHxS, and by 30% for PFNA. Females not only had substantially lower concentrations of every PFAS than males but rate of decrease was also higher for females than males, for example, 36.7% for females and 30.6% for males every two years for PFOS. For each survey period of two years, percent decrease in adjusted concentrations was 17% for PFOA, 33.5% for PFOS, 11.5% for PFDA, 6.3% for PFHxS, and 7.6% for PFNA. However, these trend data must be examined within the context of design changes in NHANES over 2003-2014 resulting in oversampling of Hispanics other than Mexican Americans starting 2007-2008 survey cycle and oversampling of non-Hispanic Asians starting 2011-2012 survey cycle. In order to examine how design changes may have affected computations of adjusted and unadjusted concentrations, the data were analyzed using the racial/ethnic categories prior to and after oversampling of Hispanics other than Mexican Americans and non-Hispanic Asians was put into place.			1					B	B		2003-2014年のNHANESに基づいた5種類のPFAS濃度の人種差
D955	バイオモニタリング	Kim, K; Bennett, DH; Calafat, AM; Hertz-Picciotto, I; Shin, HM	Temporal trends and determinants of serum concentrations of per- and polyfluoroalkyl substances among Northern California mothers with a young child, 2009-2016	2020	Environ. Res. 2020 Jul:186:109491. doi: 10.1016/j.envres.2020.109491.	Background/Objective: Human exposure to per- and polyfluoroalkyl substances (PFAS) has changed since the early 2000s, in part, because of the phase-out and replacement of some long-chain PFAS. Studies of PFAS exposure and its temporal changes have been limited to date mostly to adults and pregnant women. We examined temporal trends and determinants of PFAS serum concentrations among mothers with a young child who participated in the CHARGE (CHildhood Autism Risk from Genetics and Environment) case-control study. Methods: We quantified nine PFAS in serum samples collected from 2009 to 2016 in 450 Northern California mothers when their child was 2-5 years old. With five compounds that were detected in more than 50% of the samples, we performed multiple regression to estimate least square geometric means (LSGMs) of PFAS concentrations with adjustment for sampling year and other characteristics that may affect maternal concentrations (e.g., breastfeeding duration). We also used time-related regression coefficients to calculate percent changes over the study period. Results: LSGM concentrations of perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), and perfluorohexane sulfonate (PFHxS) decreased over the study period [percent change (95% confidence interval): -10.7% (-12.7%, -8.7%); -10.8% (-12.9%, -8.5%); -8.0% (-10.5%, -5.5%), respectively]. On the other hand, perfluorononanoate (PFNA) and perfluorodecanoate (PFDA) showed mixed time trends. Among the selected covariates, longer breastfeeding duration was associated with decreased maternal serum concentrations of PFOA, PFOS, PFHxS, PFNA and PFDA. Conclusions: Our study demonstrated that body burden of some common long-chain PFAS among California mothers with a young child decreased over the study period and that breastfeeding appears to contribute to the elimination of PFAS in lactating mothers.			1					B	B	exposure source	カルフォルニア州の子供がいる母親の5種類のPFAS濃度の低下と哺乳との関係
D956	バイオモニタリング	Jain, RB; Ducatman, A	Serum concentrations of selected perfluoroalkyl substances for US females compared to males as they age?	2022	Sci. Total Environ. 2022 Oct:842:156891. doi: 10.1016/j.scitotenv.2022.156891.	Gender-age specific linear statistical models were fitted to analyze gender-based differences in serum concentrations of PFOA, PFNA, PFHxS, and PFOS for US adults and adolescents (N = 17,932) and children age < 12 years (N = 637) using nationally representative data for US for 2003-2018. Around the age of about 11-12 years for PFOS, PFNA, and PFNA, and around 15 years for PFOA, females begin to have reliably lower serum PFAS than males. This divergence is maximized around the ages of about 35 to 40 years for the alkylate compounds PFOA and PFNA, and from around 24-52 years for the sulfonate compounds PFOS and PFHxS. For example, for PFOS, gender divergence was 1.15 ng/mL at age 15, compared to 5.6 ng/mL at the age of 37 years. Uniquely, PFOS remained lower in females in most years after age 56, a contrast to the convergence in other PFAS studied. For males, increasing patterns were followed by somewhat decreasing patterns of concentration for most PFAS, the reverse was observed for females. The findings have implications for study design. Based on the results provided in detailed tables and figures for this study, we recommend separate analyses of male and female data. In addition, female serum concentration data should be considered for stratified analysis for pre-and post-menopausal time periods. From a mechanistic perspective, the data add support to existing questions about influences on gender differences in serum PFAS that may be attributed to causes other than menstruation, pregnancy, and lactation. These are amenable to further study.			1					B	B		米国の男女別の4種類のPFAS濃度

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D957	バイオモニタリング	Barton, KE; Starling, AP; Higgins, CP; McDonough, CA; Calafat, AM; Adgate, JL	Sociodemographic and behavioral determinants of serum concentrations of per- and polyfluoroalkyl substances in a community highly exposed to aqueous film-forming foam contaminants in drinking water	2020	Int. J. Hyg. Environ. Health. 2020 Jan:223(1):256-266. doi: 10.1016/j.ijheh.2019.07.012.	Background: Per- and polyfluoroalkyl substances (PFAS) are a chemical class widely used in industrial and commercial applications because of their unique physical and chemical properties. Between 2013 and 2016 PFAS were detected in public water systems and private wells in El Paso County, Colorado. The contamination was likely due to aqueous film forming foams used at a nearby Air Force base. Objective: To cross-sectionally describe the serum concentrations of PFAS in a highly exposed community, estimate associations with drinking water source, and explore potential demographic and behavioral predictors. Methods: In June 2018, serum PFAS concentrations were quantified and questionnaires administered in 213 non-smoking adult (ages 19-93) participants residing in three affected water districts. Twenty PFAS were quantified and those detected in >50% of participants were analyzed: perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorononanoate (PFNA) and perfluoroheptane sulfonate (PFHpS). Unadjusted associations were estimated between serum PFAS concentrations and several predictors, including water consumption, demographics, personal behaviors and employment. A multiple linear regression model estimated adjusted associations with smoking history. Results: Study participants' median PFHxS serum concentration (14.8 ng/mL) was approximately 12 times as high as the U.S. national average. Median serum concentrations for PFOS, PFOA, PFNA and PFHpS were 9.7 ng/mL, 3.0 ng/mL, 0.4 ng/mL and 0.2 ng/mL, respectively. Determinants of PFHxS serum concentrations were water district of residence, frequency of bottled water consumption, age, race/ethnicity, and smoking history. Determinants of serum concentrations for the other four PFAS evaluated included: water district of residence, bottled water consumption, age, sex, race/ethnicity, smoking history, and firefighter or military employment. Conclusions: Determinants of serum concentrations for multiple PFAS, including PFHxS, included water district of residence and frequency of bottled water consumption. Participants dominant PFAS exposure route was likely consumption of PFAS-contaminated water, but certain demographic and behavioral characteristics also predicted serum concentrations.			1					B	B	exposure source	コロラド州で汚染があった地域で5種類のPFAS測定。飲水の寄与度が高い
D958	バイオモニタリング	Karrman, A; Harada, KH; Inoue, K; Takasuga, T; Ohi, E; Koizumi, A	Relationship between dietary exposure and serum perfluorochemical (PFC) levels-A case study	2009	Environ. Int. 2009 May:35(4):712-717. doi: 10.1016/j.envint.2009.01.010.	Daily dietary intake of perfluorinated chemicals (PFCs) in relation to serum levels was assessed by determination of nine PFCs including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) in matched daily diet duplicates and serum samples. Diet and serum were collected in year 2004 from 20 women in Osaka and Miyagi, Japan. Only PFOS and PFOA were detected in the diet samples and no significant difference between cities was seen. After adjusted by water content, diet concentration of PFOA was significantly higher in Osaka. The median daily intake calculated using the measured diet concentrations was 1.47 ng PFOS/kg b.w. and 1.28 ng PFOA/kg b.w. for Osaka, and 1.08 ng PFOS/kg b.w. and 0.72 ng PFOA/kg b.w. for Miyagi. A significant difference between cities was seen for the serum concentrations with median of 31 ng/mL PFOS and PFOA in Osaka, compared to 14 ng/mL PFOS and 4.6 ng/mL PFOA in Miyagi. Carboxylates such as perfluorononanoic acid (PFNA) and perfluoroundecanoic acid (PFUnDA) were also detected in serum at median levels 6.9 ng/mL and 3.2 ng/mL (Osaka), and 2.8 ng/mL and 5.1 ng/mL (Miyagi). Based on one-compartment model under steady state, dietary intake of PFOS and PFOA accounted for only 22.4% and 23.7% of serum levels in Osaka females, and in contrast 92.5% and 110.6% in Miyagi females, respectively.			1					B	A	B-minor	日本人の食事と血清中PFAS濃度を測定し、大阪と宮城では寄与度が違うことを示した。N数が少ない
D959	バイオモニタリング	Park, SK; Peng, Q; Ding, N; Mukherjee, B; Harlow, SD	Determinants of per- and polyfluoroalkyl substances (PFAS) in midlife women: Evidence of racial/ethnic and geographic differences in PFAS exposure	2019	Environ. Res. 2019 Aug:175:186-199. doi: 10.1016/j.envres.2019.05.028	Background: Per- and poly-fluoroalkyl substances (PFAS) are public health concerns because of widespread exposure through contaminated foods/drinking water. Although some determinants of PFAS exposure have been suggested, the role of geographic location and race/ethnicity in PFAS exposure has not been well characterized. Objectives: We examined potential determinants of PFAS from the Study of Women's Health Across the Nation (SWAN). Methods: This study includes 1302 women aged 45-56 years from 5 SWAN sites where white women and women from one minority group were recruited (black from Southeast Michigan, Pittsburgh, Boston; Chinese from Oakland; Japanese from Los Angeles). We determined concentrations of 11 PFAS in serum samples collected in 1999-2000 and examined 7 PFAS detected in most women (> 97%). Linear regression with backward elimination was used to identify important determinants of PFAS serum concentrations among a set of pre-specified variables (age, body mass index, site, race/ethnicity, education, financial hardship, occupation, born outside the United States (US), parity, menstrual bleeding within the past year, smoking status, alcohol consumption, and consumption of fish, dairy, pizza, salty snack, and French fries). Results: Site and race/ethnicity were two major determinants of PFAS. White women had higher concentrations of linear perfluorooctanoic acid (PFOA) compared with the Chinese in Oakland ($p < 0.0001$) and blacks in Pittsburgh ($p = 0.048$). Black women in Southeast Michigan and Boston (vs. white women) had higher concentrations of linear ($p < 0.001$ for Southeast Michigan; $p < 0.0001$ for Boston) and total perfluorooctane sulfonic acid (PFOS) ($p < 0.001$ for both Southeast Michigan and Boston) and 2-(N-methyl-perfluorooctane sulfonamido) acetic acid ($p = 0.02$ for Southeast Michigan; $p < 0.001$ for Boston). Chinese (Oakland) and Japanese (Los Angeles) women had higher concentrations of perfluorononanoic acid (PFNA) compared with white women in each site ($p < 0.01$ for both). Within white women, those in Pittsburgh had relatively higher concentrations of PFAS. Within Chinese and Japanese women, those who were born outside the US had significantly lower concentrations of most PFAS but significantly higher PFNA concentrations. Menstrual bleeding and parity were significantly associated with lower PFAS concentrations. Higher intake of salty snacks including popcorn was significantly associated with higher concentrations of linear PFOA, PFOS and 2-(N-ethyl-per-fluorooctane sulfonamido) acetic acid. Discussion: Geographic locations and race/ethnicity play an important role in differential exposure to PFAS, with racial/ethnic burdens differing between PFOS, PFOA and PFNA. Menstruation and parity were also determinants of PFAS concentrations possibly as an elimination route.			1					B	B		米国各地の5種類のPFAS濃度の変動要因
D960	バイオモニタリング	LaKind, JS; Verner, MA; Rogers, RD; Goeden, H; Naiman, DQ; Marchitti, SA; Lehmann, GM; Hines, EP; Fenton, SE	Current Breast Milk PFAS Levels in the United States and Canada: After All This Time, Why Don't We Know More?	2022	Environ. Health Perspect. 2022 FEB;130(2):25002. doi: 10.1289/EHP10359.	BACKGROUND: Despite 20 y of biomonitoring studies of per- and polyfluoroalkyl substances (PFAS) in both serum and urine, we have an extremely limited understanding of PFAS concentrations in breast milk of women from the United States and Canada. The lack of robust information on PFAS concentrations in breast milk and implications for breastfed infants and their families were brought to the forefront by communities impacted by PFAS contamination. OBJECTFVES: The objectives of this work are to: a) document published PFAS breast milk concentrations in the United States and Canada; b) estimate breast milk PFAS levels from maternal serum concentrations in national surveys and communities impacted by PFAS; and c) compare measured/estimated milk PFAS concentrations to screening values. METHODS: We used three studies reporting breast milk concentrations in the United States and Canada We also estimated breast milk PFAS concentrations by multiplying publicly available serum concentrations by milk:serum partitioning ratios for perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), and perfluorononanoic acid (PFNA). Measured and estimated breast milk concentrations were compared to children's drinking water screening values. DISCUSSION: Geometric means of estimated breast milk concentrations ranged over approximately two orders of magnitude for the different surveys/ communities. All geometric mean and mean estimated and measured breast milk PFOA and PFOS concentrations exceeded drinking water screening values for children, sometimes by more than two orders of magnitude. For PFHxS and PFNA, all measured breast milk levels were below the drinking water screening values for children; the geometric mean estimated breast milk concentrations were close to-or exceeded-the children's drinking water screening values for certain communities. Exceeding a children's drinking water screening value does not indicate that adverse health effects will occur and should not be interpreted as a reason to not breastfeed; it indicates that the situation should be further evaluated. It is past time to have a better understanding of environmental chemical transfer to-and concentrations in-an exceptional source of infant nutrition.			1					B	B		カナダと米国の母乳中PFAS濃度の実測値と予測値に関する総説
D961	バイオモニタリング	Jain, RB; Ducatman, A	Associations of serum perfluoroalkyl substances with concentrations of blood manganese and selenium	2022	Environ. Sci. Pollut. Res. 2022 Dec:29(60):90098-90107. doi: 10.1007/s11356-022-22089-7.	The aim of this study was to estimate the associations of blood manganese and selenium with serum concentrations of selected perfluoroalkyl substances (PFAS). The presence or absence of this association is important because PFAS have documented pro-oxidant properties, whereas manganese and selenium are critical to antioxidant responses. For this purpose, the data from NHANES for US adults aged >= 20 years (N = 3982), adolescents aged 12-19 years (N = 1524), and children aged 3-11 years (N = 639) were analyzed. Among adults, concentrations of blood manganese were found to be inversely associated with serum concentrations of perfluorooctanoic acid or PFOA (beta = - 0.04204, $p < 0.01$), perfluorononanoic acid or PFNA (beta = - 0.02700, $p < 0.01$), perfluorohexane sulfonate or PFHxS (beta = - 0.04306, $p < 0.01$), and perfluorooctane sulfonate or PFOS (beta = - 0.04494, $p < 0.01$). Blood concentrations of selenium were found to be positively associated with PFHxS only among adults (beta = 0.000678, $p = 0.047$) and adolescents (beta = 0.01377, $p = 0.02$). The Mn results but not the less consistent Se associations were robust to adjustments for serum albumin. Possible reasons for the inverse association of PFOA, PFHxS, PFNA, and PFOS with Mn among US adults are discussed. The finding raises concerns about manganese's diminished ability to mount antioxidant responses to PFAS exposure.			1					C	B		4種類のPFAS濃度とMn、Se濃度の比較

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D962	バイオモニタリング	Weihe, P; Kato, K; Calafat, AM; Nielsen, F; Wanigatunga, AA; Needham, LL; Grandjean, P	Serum concentrations of polyfluoroalkyl compounds in Faroese whale meat consumers	2008	Environ. Sci. Technol. 2008 Aug:42(16):6291-6295. doi: 10.1021/es800695m.	To learn the extent of human exposure to polyfluoroalkyl compounds (PFCs) in a remote fishing population, we measured, in Faroese children and pregnant women, the serum concentrations of nine PFCs, including perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), and perfluorononanoate (PFNA), by using online solid-phase extraction coupled to isotope dilution high-performance liquid chromatography-tandem mass spectrometry. The serum samples analyzed had been collected between 1993 and 2005 from 103 children 7 years of age, 79 of these children at 14 years of age, and from 12 pregnant women and their children 5 years later. PFOS was detected in all samples analyzed, and both PFOA and PFNA were detected in all but one of the samples. The concentrations found are comparable to those reported elsewhere. Correlations between paired concentrations were poor. However, PFOS and PFNA concentrations correlated well with the frequency of pilot whale dinners and with concentrations of mercury and polychlorinated biphenyls. One whale meal every two weeks increased the PFOS concentration in 14-year-olds by about 25% and PFNA by 50%. The high frequency of detection of most PFCs suggests widespread exposure in the Faroe Islands already by the early 1990s, with whale meat being an important source.			1					B	A		フェロー諸島の鯨肉を摂取する子供たちの9種類のPFAS濃度の経時変化
D963	バイオモニタリング	Goralczyk, K; Pachocki, KA; Hernik, A; Strucinski, P; Czaja, K; Lindh, CH; Jonsson, BAG; Lenters, V; Korcz, W; Minorczyk, M; Matuszak, M; Ludwicki, JK	Perfluorinated chemicals in blood serum of inhabitants in central Poland in relation to gender and age	2015	Sci. Total Environ. 2015 Nov:532:548-555. doi: 10.1016/j.scitotenv.2015.06.050	The goal of this paper is to determine concentrations of seven selected perfluoroalkylated substances (PFASs): perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulfonic acid (PFHxS), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA), perfluorododecanoic acid (PFDoDA) in the blood serum of men and women of reproductive age from the central region of Poland. The relation between sex of tested subjects and the levels of compounds in blood serum of humans will also be considered and analysed as an element of the risk assessment. The study was made on the blood serum samples collected from 253 women and 176 men of reproductive age between 20 and 44 years from Warsaw and surrounding areas. Higher concentrations of five (PFOS, PFOA, PFNA, PFDA, PFUnDA) from among seven selected PFASs were observed in men in comparison to women from the same populations. Only the concentrations of PFHxS and PFDoDA were slightly higher in women than in men. These differences were statistically significant in all cases, except for PFUnDA. The hypothesis that the concentrations of said compounds increase with age of the test subjects, regardless of gender has not been confirmed.			1					B	B		ポーランドの住民の7種類のPFAS濃度
D964	バイオモニタリング	Rylander, C; Brustad, M; Falk, H; Sandanger, TM	Dietary Predictors and Plasma Concentrations of Perfluorinated Compounds in a Coastal Population from Northern Norway	2009	J. Environ. Public Health 2009:2009. doi: 10.1155/2009/268219	Dietary intake, age, gender, and body mass index were investigated as possible predictors of perfluorinated compounds in a study population from northern Norway (44 women and 16 men). In addition to donating a blood sample, the participants answered a detailed questionnaire about diet and lifestyle. Perfluorooctane sulfonate (PFOS) (29 ng/mL), perfluorooctanoate (PFOA) (3.9 ng/mL), perfluorohexane sulfonate (PFHxS) (0.5 ng/mL), perfluorononanoate (PFNA) (0.8 ng/mL), and perfluoroheptane sulfonate (PFHpS) (1.1 ng/mL) were detected in more than 95% of all samples. Of the dietary items investigated, fruit and vegetables significantly reduced the concentrations of PFOS and PFHpS, whereas fatty fish to a smaller extent significantly increased the levels of the same compounds. Men had significantly higher concentrations of PFOS, PFOA, PFHxS, and PFHpS than women. There were significant differences in PFOS isomer pattern between genders, with women having the largest proportion of linear PFOS. PFOS, PFHxS, and PFHpS concentrations also increased with age.			1					B	B	exposure source	ノルウェーの住民の5種類のPFAS濃度と食生活などとの関係
D965	バイオモニタリング	Richterova, D; Fabelova, L; Patayova, H; Pulkrabova, J; Lankova, D; Rausova, K; Sovcikova, E; Stencl, J; Hajslova, J; Trnovec, T; Murinova, LP	Determinants of prenatal exposure to perfluoroalkyl substances in the Slovak birth cohort	2018	Environ. Int. 2018 Dec;121(Pt 2):1304-1310. doi: 10.1016/j.envint.2018.10.051.	Background: Perfluoroalkyl substances (PFASs) are man-made fluorinated compounds with endocrine-disrupting properties, detected in 99% of serum samples worldwide and associated with adverse childhood health outcomes. The aim of this study was to describe determinants of prenatal exposure to PFASs in Slovakia. Methods: This study was based on Slovak multicentric prospective mother-child cohort PRENATAL (N = 796). Cord blood samples were collected within 2010-2012 and PFASs were analyzed in a subpopulation of 322 newborns. Concentrations of perfluorooctane sulfonic acid (PFOS), perfluorohexane sulfonic acid (PFHxS), perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) were measured in the samples of cord blood using an ultrahigh-performance liquid chromatography-mass spectrometry (U-HPLC-MS) method. From questionnaires, we obtained information on medical history of mother, socio-demographic factors, nutrition and environmental factors. Association between maternal characteristics and PFASs exposure was analyzed using multivariable linear regression models. Results: The highest cord blood concentration (geometric mean +/- SD) was observed for PFOA (0.79 +/- 2.21 ng/ml) followed by PFOS (0.36 +/- 2.56 ng/ml), PFNA (0.20 +/- 2.44 ng/ml) and PFHxS (0.07 +/- 2.36 ng/ml). Primiparity was associated with higher levels of all four PFAS: PFOS (exp. beta = 1.25; 95% CI[1.03; 1.53]), PFOA (exp. beta = 1.49; 95% CI[1.18; 1.89]), PFNA (exp. beta = 1.30; 95% CI[1.05; 1.60]) and PFHxS (exp. beta = 1.49; 95% CI [1.20; 1.86]). In addition, maternal age category 29 years and more was associated with higher PFNA and PFHxS levels (exp. beta = 1.27; 95% CI[1.04; 1.55] and exp. beta = 1.30; 95% CI[1.06; 1.60], respectively) and higher educational level of mother was associated with higher PFNA levels (exp. beta = 1.32; 95% CI[1.04; 1.68]). Higher fish consumption was associated with lower PFNA levels (exp. beta = 0.49; 95% CI [0.26; 0.92]). Conclusions: We observed that PFASs cord blood concentrations were comparable or lower than those measured in western or northern European countries. We identified parity as the main determinant of PFASs exposure in our population and maternal age and education as factors that might be associated with exposure to certain PFASs.			1					B	B	exposure source	スロバキアの臍帯血の4種類のPFAS濃度を測定
D966	バイオモニタリング	Pascali, JP; Piva, E; Bonasoni, MP; Migliavacca, C; Seidenari, A; Fais, P	Analysis and distribution of per- and polyfluoroalkyl substances in decidua and villi placenta explants	2023	Environ. Res. 2023 Jul:229:115955. doi: 10.1016/j.envres.2023.115955.	Placenta mediates the transfer of nutrients, oxygen and drugs from mother to fetus. It is constituted by two cellular layers separated by the intervillous space: the outer is in direct contact with maternal blood (decidua placenta), and the inner (villi) directly in contact with the fetus. Environmental contaminants, such as per-and polyfluoroalkyl substances (PFAS) also demonstrated the ability to cross the tissue multiple layers, posing at risk the health of the fetus. The aim of the present study was to analyse the PFAS amount in decidua and villi placenta explants and to study differences in their distribution among the two side of this organ. The determination of 23 PFAS was carried out by liquid chromatography coupled to high-resolution accurate mass spectrometry (LC-HRAM). Our research included women who delivered at term between 2021 and 2022. Our data indicated that all samples contained at least one PFAS, demonstrating the ubiquitarian presence of these compounds in our population. A high occurrence of PFOS, PFOA and PFHxS, followed by PFHxA, PFBS and PFUnA was found. The fluorotelomer 6:2 FTS was also present in more than 40% of samples and this represent the first data on placenta explants. Mean and median PFAS values for decidual explants were 0.5 ng/g and 0.4 ng/g (SD 0.3), while for villi explants mean and median values were 0.6 ng/g and 0.4 ng/g (SD 0.4). A different pattern of accumulation was observed between villi and decidual explants for PFOS, PFOA and PFUnA (villi > decidua) and PFHxA, PFHxS, PFBS and 6:2 FTS (decidua > villi). Even if the mechanism of this selectively accumuation is not yet understood, molecular degree of ionization and its lipophilicity could at least in part explain this difference. This study ex-pands the limited data describing PFAS levels in the placenta and pose attention on PFAS exposure during pregnancy.		1	1					C	A		イタリア人の胎盤中の23種類のPFAS濃度を測定
D967	バイオモニタリング	Tian, YP; Zhou, Y; Miao, MH; Wang, ZL; Yuan, W; Liu, X; Wang, X; Wang, ZK; Wen, S; Liang, H	Determinants of plasma concentrations of perfluoroalkyl and polyfluoroalkyl substances in pregnant women from a birth cohort in Shanghai, China	2018	Environ. Int. 2018 Oct:119:165-173. doi: 10.1016/j.envint.2018.06.015	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are widely used in commercial applications and have been commonly detected in pregnant women in Europe and North America. However, data on PFAS concentrations in pregnant women in China are limited. Additionally, the determinants of maternal PFAS concentrations with respect to diet habits have been less extensively described, especially in Asian countries. In the present study, we aimed to measure PFAS concentrations in pregnant women and evaluate sociodemographic, lifestyle, and dietary factors as potential determinants of PFAS concentrations. We analyzed eleven PFASs in maternal blood samples (N = 981) collected at 12-16 weeks of gestation between April and December 2012 at Maternal and Child Health Hospital of Minhang District in Shanghai, China. Multivariate linear regression models were used to examine the associations of PFAS concentrations with maternal sociodemographic, lifestyle, and dietary factors. Eight PFASs, including perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUdA), perfluorododecanoic acid (PFDoA), and perfluorotridecanoic acid (PFTrDA), were detected in > 85% of the samples. PFOA and PFOS were the predominant PFASs with high median concentrations (19.97 ng/mL and 10.81 ng/mL, respectively). Pregnant women who were older, multiparous, well educated, passive smokers, with lower per capita household incomes, and had lived in rooms decorated within the past two years had higher PFAS concentrations, after mutual adjustment for maternal sociodemographic characteristics and lifestyles. With regard to dietary factors, intake of red meat, poultry, animal offal, fish, pastries and fried food, and drinking tap water during pregnancy contributed to higher concentrations of most PFASs, after adjustment for sociodemographic characteristics and lifestyles. Furthermore, higher intake of wheat, coarse cereals, tubers, and soy products was associated with lower maternal PFAS concentrations. Our findings indicate that PFASs were ubiquitous among pregnant women in Shanghai. We provide new evidence for the association between dietary factors and maternal PFAS exposure in China.			1					B	B	exposure source	上海の妊婦の母体血の23種類のPFASを測定し変動要因を検討

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D968	バイオモニタリング	Chang, CJ; Ryan, PB; Smarr, MM; Kannan, K; Panuwet, P; Dunlop, AL; Corwin, EJ; Barr, DB	Serum per- and polyfluoroalkyl substance (PFAS) concentrations and predictors of exposure among pregnant African American women in the Atlanta area, Georgia	2021	Environ. Res. 2021 Jul:198:110445. doi: 10.1016/j.envres.2020.110445.	Exposure to per- and polyfluoroalkyl substances (PFAS) has been associated with adverse health outcomes, especially when exposure occurs within sensitive time windows such as the pre- and post-natal periods and early childhood. However, few studies have focused on PFAS exposure distribution and predictors in pregnant women, especially among African American women. We quantified serum concentrations of the four most common PFAS collected in all 453 participants and an additional 10 PFAS in 356 participants who were pregnant African American women enrolled from 2014 to 2018 in Atlanta, Georgia, and investigated the sociodemographic predictors of exposure. Additional home environment and behavior predictors were also examined in 130 participants. Perfluorohexane sulfonic acid (PFHxS), perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA) were detected in >95% of the samples with PFOS having the highest concentrations (geometric mean (GM) 2.03 ng/mL). N-Methyl perfluorooctane sulfonamido acetic acid (NMe-FOSAA), perfluoropentanoic acid (PFPeA), perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUnDA) were found in 40-50% of the samples, whereas the detection frequencies for the other six PFAS were below 15%. When compared to National Health and Nutrition Examination Survey (NHANES) participants matching sex, race, and age with this study, our results showed similar concentrations of most PFAS, but higher concentrations of PFHxS (GM 0.99 ng/mL in this study; 0.63 and 0.4 ng/mL in NHANES, 2014-2015 and 2016-2017 cycles). A decline in concentrations over the study period was found for most PFAS but not PFPeA. In adjusted models, education, sampling year, parity, BMI, tobacco and marijuana use, age of house, drinking water source, and cosmetic use were significantly associated with serum PFAS concentrations. Our study reports the first PFAS exposure data among pregnant African American women in the Atlanta area, Georgia. The identified predictors will facilitate the setting of research priorities and enable development of exposure mitigation strategies.			1					B	B	B-minor	ジョージア州アトランタ周辺の黒人妊婦の14種類のPFAS濃度を測定し変動要因を検討
D969	バイオモニタリング	Onteeru, M; Barnes, LE; 'Connell, K; Bhimani, J; Du, MM; Romano, ME; Kantor, ED	Association between fish oil supplements use and serum per- and polyfluoroalkyl substances (PFAS): Results from the National Health and Nutrition Examination Survey	2022	Environ. Res.2022 Dec;215(Pt 1):114205. doi: 10.1016/j.envres.2022.114205.	Background: Per-and polyfluoroalkyl substances (PFAS) are widespread pollutants and classified as potentially carcinogenic to humans. Although consumption of fish, seafood, and their byproducts is a known source of di-etary PFAS exposure, little is known about the association between use of fish oil supplements and PFAS. Here, we examine associations between fish oil supplement use and serum PFAS concentrations.Methods: This analysis includes adults, ages 25 years of age and older, surveyed as part of the National Health and Nutrition Examinations Survey (NHANES). Outcomes include five serum PFAS compounds: perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexane sulphonic acid (PFHxS) and perfluorodecanoic acid (PFDA). To determine the association between fish oil use and log -transformed PFAS concentrations, survey-weighted linear regression was used to estimate multivariate -adjusted ratios between supplement-users' and non-users' geometric mean serum PFAS concentrations.Results: No association was observed between fish oil use and PFAS. While results did not vary substantially by age, gender, study cycle, there was some indication of a potential inverse association in subgroups of interest. Specifically, an inverse association was observed between fish oil supplement use and PFOS levels in older adults, females, and in early calendar years; an inverse association was also observed between fish oil and PFNA in females and early calendar years.Conclusions: While fish oil users did not experience increased serum PFAS, there was an unexpected inverse association in some population subgroups. Further research will be needed to better understand whether this pattern reflects true differences, chance, or bias.			1					B	B	exposure source	米国での魚油サプリの摂取と5種類のPFAS濃度との予期せぬ関係
D970	バイオモニタリング	Christensen, KY; Raymond, M; Blackowicz, M; Liu, YY; Thompson, BA; Anderson, HA; Turyk, M	Perfluoroalkyl substances and fish consumption	2017	Environ. Res. 2017 Apr:154:145-151. doi: 10.1016/j.envres.2016.12.032	Background: Perfluoroalkyl substances (PFAS) are an emerging class of contaminants. Certain PFAS are regulated or voluntarily limited due to concern about environmental persistence and adverse health effects, including thyroid disease and dyslipidemia. The major source of PFAS exposure in the general population is thought to be consumption of seafood. Objectives: In this analysis we examine PFAS levels and their determinants, as well as associations between PFAS levels and self-reported fish and shellfish consumption, using a representative sample of the U.S. population. Methods: Data on PFAS levels and self-reported fish consumption over the past 30 days were collected from the 2007-2008, 2009-2010, 2011-2012, and 2013-2014 cycles of the National Health and Nutrition Examination Survey. Twelve different PFAS were measured in serum samples from participants. Ordinary least squares regression models were used to identify factors (demographic characteristics and fish consumption habits) associated with serum PFAS concentrations. Additional models were further adjusted for other potential exposures including military service and consumption of ready-to-eat and fast foods. Results: Seven PFAS were detected in at least 30% of participants and were examined in subsequent analyses (PFDA, PFOA, PFOS, PFHxS, MPAH, PFNA, PFUA). The PFAS with the highest concentrations were PFOS, followed by PFOA, PFHxS and PFNA (medians of 8.3, 2.7, 1.5 and 1.0 ng/mL). Fish consumption was generally low, with a median of 1.2 fish meals and 0.14 shellfish meals, reported over the past 30 days. After adjusting for demographic characteristics, total fish consumption was associated with reduced MPAH, and with elevated PFDE, PFNA and PFuDA. Shellfish consumption was associated with elevations of all PFAS examined except MPAH. Certain specific fish and shellfish types were also associated with specific PFAS. Adjustment for additional exposure variables resulted in little to no change in effect estimates for seafood variables. Conclusions: PFAS are emerging contaminants with widespread exposure, persistence, and potential for adverse health effects. In the general population, fish and shellfish consumption are associated with PFAS levels, which may indicate an avenue for education and outreach.			1					B	B	exposure source	過去30年間の魚介類摂取と12種類のPFAS濃度の比較 by NHANES
D971	バイオモニタリング	Richterova, D; Govarts, E; Fabelova, L; Rausova, K; Martin, LR; Gilles, L; Remy, S; Colles, A; Rambaud, L; Riou, M; Gabriel, C; Sarigiannis, D; Pedraza-Diaz, S; Ramos, JJ; Kosjek, T; Tratnik, JS; Lignell, S; Gyllenhammar, I; Thomsen, C; Haug, LS; Kolossa-Gehring, M; Vogel, N; Franken, C; Vanlarebeke, N; Bruckers, L; Stewart, L; Sepai, O; Schoeters, G; Uhl, M; Castano, A; Lopez, ME; Goen, T; Murinova, LP	PFAS levels and determinants of variability in exposure in European teenagers - Results from the HBM4EU aligned studies (2014-2021)	2023	Int. J. Hyg. Environ. Health. 2023 Jan:247:114057. doi: 10.1016/j.ijheh.2022.114057.	Background: Perfluoroalkyl substances (PFAS) are man-made fluorinated chemicals, widely used in various types of consumer products, resulting in their omnipresence in human populations. The aim of this study was to describe current PFAS levels in European teenagers and to investigate the determinants of serum/plasma con-centrations in this specific age group.Methods: PFAS concentrations were determined in serum or plasma samples from 1957 teenagers (12-18 years) from 9 European countries as part of the HBM4EU aligned studies (2014-2021). Questionnaire data were post -harmonized by each study and quality checked centrally. Only PFAS with an overall quantification frequency of at least 60% (PFOS, PFOA, PFHxS and PFNA) were included in the analyses. Sociodemographic and lifestyle factors were analysed together with food consumption frequencies to identify determinants of PFAS exposure. The variables study, sex and the highest educational level of household were included as fixed factors in the multivariable linear regression models for all PFAS and each dietary variable was added to the fixed model one by one and for each PFAS separately.Results: The European exposure values for PFAS were reported as geometric means with 95% confidence intervals (CI): PFOS [2.13 mu g/L (1.63-2.78)], PFOA ([0.97 mu g/L (0.75-1.26)]), PFNA [0.30 mu g/L (0.19-0.45)] and PFHxS [0.41 mu g/L (0.33-0.52)]. The estimated geometric mean exposure levels were significantly higher in the North and West versus the South and East of Europe. Boys had significantly higher concentrations of the four PFAS compared to girls and significantly higher PFASs concentrations were found in teenagers from households with a higher education level. Consumption of seafood and fish at least 2 times per week was significantly associated with 21% (95% CI: 12-31%) increase in PFOS concentrations and 20% (95% CI: 10-31%) increase in PFNA concentrations as compared to less frequent consumption of seafood and fish. The same trend was observed for PFOA and PFHxS but not statistically significant. Consumption of eggs at least 2 times per week was associated with 11% (95% CI: 2-22%) and 14% (95% CI: 2-27%) increase in PFOS and PFNA concentrations, respectively, as compared to less frequent consumption of eggs. Significantly higher PFOS concentrations were observed for participants consuming offal (14% (95% CI: 3-26%)), the same trend was observed for the other PFAS but not statistically significant. Local food consumption at least 2 times per week was associated with 40% (95% CI: 19-64%) increase in PFOS levels as compared to those consuming local food less frequently.Conclusion: This work provides information about current levels of PFAS in European teenagers and potential dietary sources of exposure to PFAS in European teenagers. These results can be of use for targeted monitoring of PFAS in food.			1					B	A	exposure source	HBM4EUを用いて欧州の10代の4種類のPFAS濃度と食事調査との関連を調べ、魚、卵、内臓の寄与を認めた
D972	バイオモニタリング	Pan, YY; Shi, YL; Wang, JM; Cai, YQ; Wu, YN	CONCENTRATIONS OF PERFLUORINATED COMPOUNDS IN HUMAN BLOOD FROM TWELVE CITIES IN CHINA	2010	Environ. Toxicol. Chem. 2010 Dec:29(12):2695-2701. doi: 10.1002/etc.342.	We detected nine perfluorinated compounds (PFCs) in 233 human whole blood samples collected from 12 cities (from 12 provinces and districts) in China Perfluorinated compounds could be detected in all blood samples with perfluorooctane sulfonate (C8 PFOS) as the most prominent PFC Mean PFOS concentrations were measured at 3 06 to 34 0 mu g/L accounting for the majority of the total perfluorinated compounds (Sigma PFCs) (54-87%) in blood samples except those from Kunming Perfluorooctane sulfonate and perfluoiohexane sulfonate (C6 PFHxS) concentrations were positively correlated in blood samples (p <0 01) Significant relations among perfluorooctanoate (C8 PFOA) perfluorononanoic acid (C9 PFNA) perfluorodecanoic acid (C10 PFDA) and perfluor oundecanoic acid (C11 PFUnDA) (p < 0 05) were also observed in the present study indicating that they may come from a similar exposure pathway in China In general gender related differences were found for PFHxS and Sigma PFCs concentrations which were significantly higher in males than in females (p < 0 05) In the 20 to 29 year age group gender influence was also found for PFHxS and PFOS concentrations The mean blood concentration of PFOS (10 6 mu g/L) in the present study was comparable with results from other countries while PFOA and PFHxS (1 39 mu g/L and 0 57 mu g/L respectively) were often lower This can probably be attributed to a different exposure pathway of the general population in China as compared to other countries.			1					B	B		中国の12都市の住民の7種類のPFAS濃度を測定

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D973	バイオモニタリング	Deng, Y; Wang, F; Liu, LY; Chen, D; Guo, Y; Li, Z	High density polyethylene (HDPE) and thermoplastic polyurethane (TPU) wristbands as personal passive samplers monitoring per- and polyfluoroalkyl substances (PFASs) exposure to postgraduate students	2023	J. Hazard. Mater. 2023 Mar:446:130652. doi: 10.1016/j.jhazmat.2022.130652.	Per-and polyfluoroalkyl substances (PFASs) present adverse effects for human health, which result in strong needs for reliable tools monitoring personal exposure to PFASs. This study manufactured two wristbands of high density polyethylene (HDPE) and thermoplastic polyurethane (TPU), and used the wristbands to monitor PFASs personal exposure. The analytical method was developed to measure 32 PFASs in the paired HDPE and TPU wristbands worn by 60 postgraduates. Twenty-nine of 32 PFASs were detected and hexafluoropropylene oxide dimer acid (HFPO-DA) was predominant individual PFASs with median concentrations of 337 and 554 pg/g for HDPE and TPU wristbands respectively. The gender and grade of students had moderate effects on PFASs distribution in the wristbands. Higher PFASs levels were determined in the two wristbands worn by the male students compared to the females, and the greatest PFASs concentration was observed in the wristbands worn by the first-year postgraduates, follow by second -and third-year postgraduates. Additionally, significant correlations between paired HDPE and TPU wristbands were observed for perfluorobutanoic acid (PFBA), perfluorohexane sulfonic acid (PFHxS), perfluoroheptane sulfonic acid (PFHpS), perfluorooctane sulfonic acid (PFOS), and HFPO-DA. These results suggest that HDPE and TPU wristbands can be used as effective tools for monitoring personal PFAS exposure.	1				1			C	A		リストバンドを用いて32種類のPFASへの曝露を調べた
D974	バイオモニタリング	Karrman, A; Mueller, JF; Van Bavel, B; Harden, F; Toms, LML; Lindstrom, G	Levels of 12 perfluorinated chemicals in pooled Australian serum, collected 2002-2003, in relation to age, gender, and region	2006	Environ. Sci. Technol. 2006 Jun:40(12):3742-3748. doi: 10.1021/es060301u.	Pooled serum samples from 3802 Australian residents were analyzed for four perfluoroalkylsulfonates, seven perfluoroalkylcarboxylates, and perfluorooctanesulfonamide (PFOSA). Serum was collected from men and women of five different age groups and from rural and urban regions in Australia. The highest mean concentration was obtained for perfluorooctane sulfonate (PFOS, 20.8 ng/mL) followed by perfluorooctanoic acid (PFOA, 7.6 ng/mL), perfluorohexane sulfonate (PFHxS, 6.2 ng/mL), perfluorononanoic acid (PFNA, 1.1 ng/mL), and PFOSA (0.71 ng/mL). Additional four PFCs were detected in 5-18 % of the samples at concentrations near the detection limits (0.1-0.5 ng/mL). An increase in PFOS concentration with increasing age in both regions and genders was observed. The male pool levels of some of the age groups compared to females were higher for PFOS, PFOA, and PFHxS. In contrast, PFNA concentrations were higher in the female pools. No substantial difference was found in levels of PFCs between the urban and rural regions. The levels are equal or higher than previously reported serum levels in Europe and Asia but lower compared to the U. S. A. These results suggest that emissions from production in the Northern Hemisphere are of less importance for human exposure.			1					B	B		オーストラリアのプール血清を用いて12種類のPFAS濃度を測定
D975	バイオモニタリング	Falandysz, J; Taniyasu, S; Gulkowska, A; Yamashita, N; Schulte-Oehlmann, U	Is fish a major source of fluorinated surfactants and repellents in humans living on the Baltic coast?	2006	Environ. Sci. Technol. 2006 Feb:40(3):748-751. doi: 10.1021/es051799n.	Concentrations of 19 perfluorochemicals have been quantified in human blood and in some marine food resources from the region of the Gulf of Gdansk at the Baltic Sea south coast in Poland. We indicate that in addition to PFOS and PFOA, a further 8 perfluorochemicals bioaccumulate in the human body. Food chain is an important route of exposure for all 10 perfluoroalkyl compounds detected in nonoccupationally exposed humans. Individuals who declared to have a high fish intake in their diet (mainly Baltic fish) on average contained the highest load of all 10 fluorochemicals when compared with the other human subpopulations. Baltic seafood has been found to highly influence human body burden of PFHxS, PFOS, PFOSA, PFHxA, PFHpA, PFNA, PFDA, PFUnDA, and PFDoDA, and to a lesser extent PFOA.		1	1					B	A	exposure source	ポーランドの住民の19種類のPFAS濃度と食事調査との関係からPFOS, PFOA以外のPFAS摂取への魚の重要性を示した
D976	バイオモニタリング	Lu, C; Shi, YL; Zhou, Z; Liu, NN; Meng, ZF; Cai, YQ	Perfluorinated compounds in blood of textile workers and barbers	2014	Chin. Chem. Lett. 2014 Aug:25(8):1145-1148. doi: 10.1016/j.cclet.2014.03.023.	12 perfluorinated compounds (PFCs) in human blood from workers in a textile mill in Shandong province and several barbershops in Tianjin were analyzed in this study. It was found that perfluorooctane-sulfonate (PFOS) and perfluorooctanoate (PFOA) were the most prominent PFCs, with average concentrations of 5.73 mu g/l. and 5.46 mu g/L for textile workers, and 2.55 mu g/L and 2.84 p.g/L for barbers. PFOS and perfluorohexanesulfonate (PFHxS) concentrations revealed a positive correlation in blood samples ($p < 0.01$), and concentrations among PFOS, perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) also revealed positive correlations ($p < 0.01$). The influence of gender and age on PFC concentration in blood was also investigated, and the results showed that there was no statistically significant difference between the male and female samples, as well as in samples from people with different ages. Generally speaking, the textile workers may face a higher exposure of PFCs than barbers.				1				C	D		
D977	バイオモニタリング	Toms, LML; Braunig, J; Vijayasarathy, S; Phillips, S; Hobson, P; Aylward, LL; Kirk, MD; Mueller, JF	Per- and polyfluoroalkyl substances (PFAS) in Australia: Current levels and estimated population reference values for selected compounds	2019	Int. J. Hyg. Environ. Health. 2019 Apr:222(3):387-394. doi: 10.1016/j.ijheh.2019.03.004.	Background: Increased public awareness of PFAS contamination in Australia has resulted in serum biomonitoring efforts in individuals in potentially affected communities. However, population-based reference values for assessing whether individual results exceed the typical range in the Australian general population are not currently available. Objective: Estimate population upper bound reference values based on updated serum PFAS concentrations in pooled samples from southeast Queensland, Australia and population variation observed in the US National Health and Nutrition Examination Survey (NHANES) datasets. Methods: We calculated ratios of 95th percentile to arithmetic mean (P95:AM ratios) using data from the NHANES 2013-14 and 2015-16 cycle samples for frequently detected PFASs: PFOA, linear and branched PFOS, perfluorononanoate (PFNA), perfluorodecanoate (PFDA), and perfluorohexanesulfonate (PFHxS). We estimated Australian age-specific means for PFAS using pooled serum samples collected in 2014-15 and 2016-17. We used the P95:AM ratios to estimate 95th percentile concentrations in the Australian population based on the results of the 2016-17 pooled samples. Results and conclusions: P95:AM ratios for each PFAS were similar across NHANES cycle and age group, so overall compound-specific ratios were estimated for PFOA (2.1), PFNA (2.4), PFDA (2.7), PFHxS (2.7), and linear (2.4) and summed PFOS (2.3). Australian mean PFAS concentrations continued previously reported declining trends. The estimated P95 values can be used as preliminary substitutes for more rigorous population reference values to identify samples with clearly elevated serum PFAS concentrations in Australian biomonitoring efforts. Given uncertainties and variability inherent in this evaluation, the estimated P95 values should be interpreted with caution. Mean and estimated P95 serum PFAS concentrations in Australia should continue to be monitored to document declining trends in population serum concentrations.			1					B	B		オーストラリアの住民の5種類のPFAS濃度を測定して指標値とした
D978	バイオモニタリング	Serrano, L; Iribarne-Duran, LM; Suarez, B; Artacho-Cordon, F; Vela-Soria, F; Pena-Caballero, M; Hurtado, JA; Olea, N; Fernandez, MF; Freire, C	Concentrations of perfluoroalkyl substances in donor breast milk in Southern Spain and their potential determinants	2021	Int. J. Hyg. Environ. Health. 2021 Jul:236:113796. doi: 10.1016/j.ijheh.2021.113796.	Background: Breast milk is considered to offer the best nutrition to infants; however, it may be a source of exposure to environmental chemicals such as perfluoroalkyl compounds (PFAS) for breastfeeding infants. PFAS are a complex group of synthetic chemicals whose high stability has led to their ubiquitous contamination of the environment. Objective: To assess the concentrations and profiles of PFAS in breast milk from donors to a human milk bank and explore factors potentially related to this exposure. Methods: Pooled milk samples were collected from 82 donors to the Human Milk Bank of the Virgen de las Nieves University Hospital (Granada, Spain). Ultra-high performance liquid chromatography coupled with tandem mass spectrometry (UHPLC-MS/MS) was applied to determine milk concentrations of 11 PFAS, including long-chain and short-chain compounds. A questionnaire was used to collect information on donors' socio-demographic characteristics, lifestyle, diet, and use of personal care products (PCPs). Factors related to individual and total PFAS concentrations were evaluated by multivariate regression analysis. Results: PFAS were detected in 24-100% of breast milk samples. PFHpA was detected in 100% of samples, followed by PFOA (84%), PFNA (71%), PFHxA (66%), and PFTrDA (62%). Perfluorooctane sulfonate (PFOS) was detected in only 34% of donors. The median concentrations ranged from <0.66 ng/dL (perfluorohexane sulfonic acid [PFHxS]) to 19.39 ng/L (PFHpA). The median of the sum of PFAS concentrations was 87.67 ng/L and was higher for short-chain than long-chain PFAS. Factors most frequently associated with increased PFAS concentrations included intake of creatin animal food items and use of PCPs such as skin care and makeup products. Conclusions: Several PFAS, including short-chain compounds, are detected in pooled donor milk samples. Breast milk may be an important pathway for the PFAS exposure of breastfed infants, including preterm infants in NICUs. Despite the reduced sample size, these data suggest that various lifestyle factors influence PFAS concentrations, highlighting the use of PCPs.		1	1					B	B		スペインの母乳バンクサンプルを用いて12種類のPFAS濃度を測定
D979	バイオモニタリング	Jain, RB	Associations between concentrations of selected perfluoroalkyl acids and concentrations of blood cadmium, lead, and total mercury	2021	Environ. Sci. Pollut. Res. 2021 Jun:28(21):26537-26544. doi: 10.1007/s11356-021-12493-w.	Data (N = 2552) from National Health and Nutrition Examination Survey for US adults aged >= 20 years for 2011-2016 were analyzed to estimate the associations between the concentrations of blood cadmium, lead, and total mercury and the concentrations of seven perfluoroalkyl acids (PFAA), namely, 2-(N-Methyl-perfluorooctane sulfonamido) acetic acid (MPAH), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA), perfluorohexane sulfonic acid (PFHxS), and perfluorooctane sulfonic acid (PFOS). Concentrations of blood cadmium were negatively associated with the concentrations of PFHxS (beta = - 0.05428, $p < 0.01$) and PFOS (beta = - 0.0212, $p = 0.02$). Concentrations of blood lead were positively associated with the concentrations of MPAH (beta = 0.03301, $p < 0.01$), PFOA (beta = 0.04783, $p = 0.01$), PFNA (beta = 0.11761, $p < 0.01$), PFDA (beta = 0.08007, $p < 0.01$), PFUA (beta = 0.11382, $p < 0.01$), and PFOS (beta = 0.04996, $p = 0.02$). Percent increases in the concentration of blood lead were 0.32%, 0.46%, 1.13%, 0.77%, 1.09%, and 0.48% for 10% increases in the concentrations of MPAH, PFOA, PFNA, PFDA, PFUA, and PFOS, respectively. Concentrations of blood total mercury were positively associated with the concentrations of PFNA (beta = 0.37105, $p < 0.01$), PFDA (beta = 0.46875, $p < 0.01$), PFUA (beta = 0.56934, $p < 0.01$), and PFOS (beta = 0.17557, $p < 0.01$). Percent increases in the concentration of blood total mercury were 3.6%, 4.57%, 5.58%, and 1.69% for 10% increases in the concentrations of PFNA, PFDA, PFUA, and PFOS, respectively. Associations between the concentrations of PFAAs with blood total mercury were substantially stronger than the concentrations with blood lead. Higher the carbon chain length for PFAAs, stronger were the associations between PFAAs with lead and mercury.				1				B	B		米国人の8種類のPFAS濃度とHg, Cd, Pb濃度との関係を調査、Hgとの関係が認められた

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D980	バイオモニタリング	Rylander, C; Sandanger, TM; Froyland, L; Lund, E	Dietary Patterns and Plasma Concentrations of Perfluorinated Compounds in 315 Norwegian Women: The NOWAC Postgenome Study	2010	Environ. Sci. Technol. 2010 Jul:44(13):5225-5232. doi: 10.1021/es100224q.	This study was undertaken to assess the impact of self-reported dietary habits and lifestyle on the plasma concentration of selected perfluorinated compounds (PFCs) in a representative group of 315 middle-aged Norwegian women (48-62 years of age). Perfluorooctane sulfonate (PFOS; median: 20 ng/mL), perfluorooctanoate (PFOA; 4.4 ng/mL), perfluorohexane sulfonate (PFHxS; 1.0 ng/mL), and perfluorononanoate (PFNA; 0.81 ng/mL) were detected in more than 90% of the plasma samples. By using multivariate data analysis, women who ate fish or fish eaters (high consumers of fish and shellfish) were identified as having increased plasma concentrations of PFOS, PFNA, and PFHxS. Younger women with a larger household and a western diet consisting of rice, pasta, water, white and red meat, chocolate, snacks, and pastries had lower concentrations of the same compounds. No specific food cluster was associated with increased PFOA concentrations, indicating that the dietary impact on PFOA concentrations was different from that of the other investigated PFCs. This study confirms that the total diet is a major contributor to human body burdens of selected PFCs, but the identification of dietary predictors is highly dependent on the dietary habits within the population studied due to the ubiquitous presence of PFCs in many kinds of food.			1					B	B	exposure source	ノルウェーの中年女性の4種類のPFAS濃度と食事調査との関係
D981	バイオモニタリング	Forthun, IH; Roelants, M; Haug, LS; Knutsen, HK; Schell, LM; Jugessur, A; Bjerknes, R; Sabaredzovic, A; Bruserud, IS; Juliusson, PB	Levels of per- and polyfluoroalkyl substances (PFAS) in Norwegian children stratified by age and sex-Data from the Bergen Growth Study 2	2023	Int. J. Hyg. Environ. Health. 2023 Jul:252:114199. doi: 10.1016/j.ijheh.2023.114199.	Background and aim: Due to the persistence, bioaccumulation and potential adverse health effects, there have been restrictions and phase out in the production of certain per- and polyfluoroalkyl substances (PFAS) since the early 2000s. Published serum levels of PFAS during childhood are variable and may reflect the impact of age, sex, sampling year and exposure history. Surveying the concentrations of PFAS in children is vital to provide information regarding exposure during this critical time of development. The aim of the current study was therefore to evaluate serum concentrations of PFAS in Norwegian schoolchildren according to age and sex.Material and methods: Serum samples from 1094 children (645 girls and 449 boys) aged 6-16 years, attending schools in Bergen, Norway, were analyzed for 19 PFAS. The samples were collected in 2016 as part of the Bergen Growth Study 2. Statistical analyses included Student t-test, one-way ANOVA and Spearman's correlation analysis of log-transformed data.Results: Of the 19 PFAS examined, 11 were detected in the serum samples. Perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexanesulfonic acid (PFHxS) and perfluorononaoic acid (PFNA) were present in all samples with geometric means of 2.67, 1.35, 0.47 and 0.68 ng/mL, respectively. In total, 203 children (19%) had PFAS levels above the safety limits set by the German Human Biomonitoring Commission. Significantly higher serum concentrations were found in boys compared to girls for PFOS, PFNA, PFHxS and perfluoroheptanesulfonic acid (PFHpS). Furthermore, serum concentrations of PFOS, PFOA, PFHxS and PFHpS were significantly higher in children under the age of 12 years than in older children.Conclusions: PFAS exposure was widespread in the sample population of Norwegian children analyzed in this study. Approximately one out of five children had PFAS levels above safety limits, indicating a potential risk of negative health effects. The majority of the analyzed PFAS showed higher levels in boys than in girls and decreased serum concentrations with age, which may be explained by changes related to growth and maturation.			1					B	B		ノルウェーの子供の19種類の血清PFAS濃度
D982	バイオモニタリング	Macheka, LR; Abafe, OA; Mugivhisa, LL; Olowoyo, JO	Occurrence and infant exposure assessment of per and polyfluoroalkyl substances in breast milk from South Africa	2022	Chemosphere. 2022 Feb;288(Pt 2):. doi: 10.1016/j.chemosphere.2021.132601.	The exposure of infants to per and polyfluoroalkyl substances (PFAS) through breast-feeding is of global concern owing to their numerous detrimental health effects. This study investigated the occurrence of eleven perfluorocarboxylic acids (PFCAs) and four perfluorosulfonates (PFSAs) in breast milk of nursing mothers from South Africa. The concentrations of PFAS in these samples were measured by using a validated UHPLC – MS/MS method. The median concentrations of Σ15 PFAS ranged from <LOQ – 0.420 ng mL−1, with PFCAs frequently detected in breast milk than PFSAs. However, perfluoropentanoic acid (PFPeA) accounted for 28% of total PFAS concentrations in all samples, the median concentrations of PFUdA, PFDoA and PFTrDA were at par with those of PFOA. The estimated feeding frequency and infant sex but not birth weight and gestation period, were strongly correlated with the body-burden of some short- and long-chain PFAS in breastmilk. On the average, the EDI and HQ of PFOA and Σ4 PFAS (PFOA, PFNA, PFHxS & PFOS) but not PFOS present significant risk to exclusively breastfed infants in South Africa. The results of this study reflect the widespread occurrence of short chain (i.e., C < 6) and long chain (i.e., C11 – C13) PFAS and provide preliminary data for future human biomonitoring of PFAS and other persistent organic pollutants in South Africa, and indeed the African continent.								B	B		南アフリカの母乳の15種類のPFAS濃度を測定
D983	バイオモニタリング	Fabelova, L; Beneito, A; Casas, M; Colles, A; Dalsager, L; Den Hond, E; Dereumeaux, C; Ferguson, K; Gilles, L; Govarts, E; Irizar, A; Espinosa, MJL; Montazeri, P; Morrens, B; Patayova, H; Rausova, K; Richterova, D; Martin, LR; Santa-Marina, L; Schettgen, T; Schoeters, G; Haug, LS; Uhl, M; Villanger, GD; Vrijheid, M; Zaros, C; Murinova, L	PFAS levels and exposure determinants in sensitive population groups	2023	Chemosphere. 2023 Feb:313:137530. doi: 10.1016/j.chemosphere.2022.137530.	Background: Per-and polyfluoroalkyl substances (PFAS) are persistent organic pollutants. The first exposure to PFAS occurs in utero, after birth it continues via breast milk, food intake, environment, and consumer products that contain these chemicals. Our aim was to identify determinants of PFAS concentrations in sensitive popu-lation subgroups- pregnant women and newborns.Methods: Nine European birth cohorts provided exposure data on PFAS in pregnant women (INMA-Gipuzkoa, Sabadell, Valencia, ELFE and MoBa; total N = 5897) or newborns (3xG study, FLEHS 2, FLEHS 3 and PRENATAL; total N = 940). PFOS, PFOA, PFHxS and PFNA concentrations were measured in maternal or cord blood, depending on the cohort (FLEHS 2 measured only PFOS and PFOA). PFAS concentrations were analysed ac-cording to maternal characteristics (age, BMI, parity, previous breastfeeding, smoking, and food consumption during pregnancy) and parental educational level. The association between potential determinants and PFAS concentrations was evaluated using multiple linear regression models.Results: We observed significant variations in PFAS concentrations among cohorts. Higher PFAS concentrations were associated with higher maternal age, primipara birth, and educational level, both for maternal blood and cord blood. Higher PFAS concentrations in maternal blood were associated with higher consumption of fish and seafood, meat, offal and eggs. In cord blood, higher PFHxS concentrations were associated with daily meat consumption and higher PFNA with offal consumption. Daily milk and dairy consumption were associated with lower concentrations of PFAS in both, pregnant women and newborns.Conclusion: High detection rates of the four most abundant PFAS demonstrate ubiquitous exposure of sensitive populations, which is of concern. This study identified several determinants of PFAS exposure in pregnant women and newborns, including dietary factors, and these findings can be used for proposing measures to reduce PFAS exposure, particularly from dietary sources.			1					B	B		欧州の母子の4種類のPFAS濃度を測定
D984	バイオモニタリング	Cerna, M; Grafnetterova, AP; Dvorakova, D; Pulkrabova, J; Maly, M; Janos, T; Vodrazkova, N; Tupa, Z; Puklova, V	Biomonitoring of PFOA, PFOS and PFNA in human milk from Czech Republic, time trends and estimation of infant's daily intake	2020	Environ. Res. 2020 Sep:188:109763. doi: 10.1016/j.envres.2020.109763.	Background: Perfluoralkylated substances (PFASs) are persistent and bioaccumulative environmental contaminants. They are included on the list of emergent compounds monitored in the frame of HBM4EU project. Objectives: To analyze PFASs levels in human milk samples collected in the period 2006 through 2017, to follow their time trends, to assess the PFASs exposure in breastfed infants, to calculate the daily intake of PFASs and to compare it with the tolerable daily/weekly) intakes and to quantify risk from exposure using the hazard quotient and hazard index approach. Material and methods: A broad spectrum of PFASs were analyzed by means of UHPLC-MS/MS in primipara human milk samples collected in four consecutive time periods 2006, 2010/11, 2014, and 2017; N = 46, 183, 164 and 232, respectively. Mothers living in urban and suburban residences were recruited after their delivery at maternity hospitals, and milk samples were taken within 2 and 8 weeks after delivery. The questionnaire was focused on possible sources of exposure, dietary habits and lifestyle. Results: Only perfluorooctane sulfonate (PFOS) and perfluorooctanoid acid PFOA (in 2017, also perfluorononanoic acid (PFNA)) were quantified in more than 90% of analyzed human milk samples. In all sampling periods, the levels of PFOA were higher than those of PFOS ($p < 0.05$). A significant downward temporal trend ($p < 0.001$) was observed for both PFOA and PFOS levels. The median concentrations in sampling years 2006, 2010/11, 2014, and 2017 were 0.075, 0.059, 0.035, and 0.023 ng/mL for PFOA and 0.045, 0.031, 0.029, and 0.020 ng/mL for PFOS, respectively. In 2017, PFNA was also quantified in 99% of samples with the median concentration of 0.007 ng/mL. The levels of PFASs correlated with maternal sea fish consumption. No maternal age-related relationship was observed. Using the tolerably daily intake (TDI) values for PFOS and PFOA set by the European Food Safety Authority (EFSA) in 2008, the calculated daily intakes from breastfeeding were clearly below these limits. Using the new, more conservative EFSA Provisional Tolerably Weekly Intake (PTWI) values set in 2018, we demonstrated a considerable exceedance of PTWI, with a hazard index above 1. Conclusion: Significant time-related decreasing trends in the PFOS and PFOA levels in human milk were observed. Nevertheless, the body burden of infants from breastfeeding might pose an enhanced health risk to infants when the current PTWI values are applied. These findings strongly support the present EU efforts to phase out PFOA, its salts and PFOA related compounds. Since PFOS exposure there has still been widely detected despite PFOS usage reduction measures, the major exposure routes should be further monitored and, if possible, eliminated.			1					B	B		チェコの母乳にはPFOS, PFOAおよびPFNA以外はほとんど検出されない

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D985	バイオモニタリング	Aker, A; Ayotte, P; -Beaudoin, EC; De Silva, A; Ricard, S; Gaudreau, E; Lemire, M	Plasma concentrations of perfluoroalkyl acids and their determinants in youth and adults from Nunavik, Canada	2023	Chemosphere. 2023 Jan:310:136797. doi: 10.1016/j.chemosphere.2022.136797.	Perfluoroalkyl acids (PFAAs), a subset of per- and poly-fluoroalkyl substances (PFAS), are environmentally stable, mobile and bioaccumulative compounds. This leads to high concentrations in wildlife species essential to the cultural identity and subsistence of Arctic populations. Our objective was to characterize the distribution and exposure determinants of PFAAs among Nunavik Inuit adults. The study included up to 1322 Nunavik residents aged 16-80 years who participated in the Qanuilirpitaa? 2017 Nunavik Inuit Health Survey (Q2017). Plasma concentrations were compared to those the general Canadian population using data from the Canadian Health Measures Survey Cycle 5 (2016-2017). Associations between plasma concentrations of nine PFAAs, determined by liquid chromatography-tandem mass spectrometry, and sociodemographic factors and traditional activity participation were examined using multiple linear regression models. Overall exposure to PFAAs was twice as high compared to the general Canadian population and less regulated perfluorononanoic acid (PFNA) and perfluoroundecanoic acid (PFUnDA) concentrations were 7-fold higher, and perfluorodecanoic acid (PFDA) concentrations were 4-fold higher. Males had higher concentrations of perfluorooctanoic acid (PFOA) and perfluorohexane sulfonate (PFHxS), whereas females had higher concentrations of PFDA and PFUnDA. PFAAs concentrations increased with age and were highest among those aged 60+ years. PFNA and PFOA concentrations followed a J-shaped pattern: those aged 16-29 years had higher concentrations than those aged 20-29 and 30-39 years. Ungava Bay generally had lower concentrations of all PFAAs congeners compared to Hudson Bay and Hudson Strait, with the exception of PFNA, which tended to have the lowest concentration in Hudson Strait. PFAAs concentrations were highly associated with hunting activity, omega-3 polyunsaturated fatty acids, and drinking water from environmental sources. The results highlight the importance of characterizing PFAAs exposure sources in Arctic communities and provide further evidence for the long-range transport of long-chain PFAAs and their precursors that necessitate international action.								B	B	exposure source	イヌイットの9種類のPFAA（PFOSなし）を測定
D986	バイオモニタリング	Wu, SN; Yuan, TT; Fu, W; Dong, HY; Zhang, Y; Zhang, M; Jiang, CF; Xu, Q; Zhang, LP; Qiang, ZM	Perfluorinated compound correlation between human serum and drinking water: Is drinking water a significant contributor?	2023	Sci. Total Environ. 2023 May:873:162471. doi: 10.1016/j.scitotenv.2023.162471.	Perfluorinated compounds (PFASs) are a new artificial chemical. Due to its substantial toxicity and complex degrada-tion in the natural environment, monitoring PFASs has become a hot issue for many researchers. Currently, the rela-tionship between the concentration of PFASs in serum and the concentration of PFASs in drinking water is unclear. This paper aims to study the concentration levels of PFASs in drinking water and residents' serum in a city in northern China and the relationship between them. The results show that the concentration of PFASs in drinking water is low, and the average concentrations of perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS) were 2.57 +/- 0.69 ng/L and 0.30 ng/L, respectively, which were lower than the limits specified in China's newly introduced Stan-dards for drinking water quality (GB 5749-2022). In the serum of residents, PFOA and PFOS were the two PFASs with the highest concentration. Spearman correlation analysis showed that perfluorohexane sulfonate (PFHxS) and PFOS concentrations were positively correlated with age, and PFHxS, PFOA, PFNA, and PFOS varied with sex. At the same time, the correlation analysis also showed no correlation between PFAS in drinking water and serum, indicating that drinking water was not the main factor causing the physical burden of PFAS in residents. The HI method was used to assess the health risks of PFASs to human beings. The risk entropy of all PFASs for human hepatotoxicity and repro-ductive toxicity is below 1.			1					B	B	exposure source	中国北部の13種類のPFASについて血清濃度と飲水濃度の関係を調べ、飲水の寄与が低いことを示した
D987	バイオモニタリング	Noren, E; Lindh, C; Glynn, A; Rylander, L; Pineda, D; Nielsen, C	Temporal trends, 2000-2017, of perfluoroalkyl acid (PFAA) concentrations in serum of Swedish adolescents	2021	Environ. Int. 2021 Oct:155:106716. doi: 10.1016/j.envint.2021.106716.	Per- and polyfluoroalkyl substances (PFAS) have been extensively used as surfactants because of their high stability and good water/oil-repellent properties. PFASs, especially perfluoroalkyl acids (PFAAs), have long biological half-lives, and exposure may cause adverse health effects in humans. We assessed temporal trends of concentrations of eight PFAAs in serum of Swedish adolescents (age 16-21 years) from the general population, and estimated the stability of PFAAs and serum samples after 6 years of storage. Repeated cross-sectional sampling was performed on five occasions (covering in total 1213 individuals, 83% males) in southern Sweden between 2000 and 2017. We analyzed serum for perfluorohexane sulfonic acid (PFHxS), perfluorooctane sulfonic acid (PFOS), perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA), and perfluorododecanoic acid (PFDoDA) using liquid chromatography-tandem mass spectrometry. We assessed time trends using linear regression, long-term stability was assessed by reanalyzing samples collected 2013, and the comparison was done using Pearson correlation and Bland-Altman plots. PFHxS, PFOS, and PFOA decreased by 6.7% (CI: -7.0, -6.3%), 12.6% (CI: -12.9, -12.3%), and 6.5% (CI: -6.8, -6.1%) per year, respectively, and year of sampling explained 48-81% of the variation in concentrations. PFNA and PFDA seemed to increase up to 2009 and decrease thereafter. The trends were consistent after sensitivity analyses excluding women. Strong correlations of 94-97% were observed for concentrations of all compounds, except PFHxS, after storage. The observed trends closely followed the timing of manufacturers' voluntary phaseout initiatives, and of regulatory measures governing the compounds implemented in the EU and USA. This indicates that these actions mitigated the population's exposure to PFHxS, PFOS, and PFOA and, in recent years, to PFNA and PFDA, in southern Sweden. Furthermore, the results suggest that PFAAs remain stable in serum samples after long-term storage.			1					B	B		スウェーデンの16-21歳の血清中の7種類のPFAS濃度の現状を調べた
D988	バイオモニタリング	Liu, W; Xu, L; Li, X; Jin, YH; Sasaki, K; Saito, N; Sato, I; Tsuda, S	Human Nails Analysis as Biomarker of Exposure to Perfluoroalkyl Compounds	2011	Environ. Sci. Technol. 2011 Oct:45(19):8144-8150. doi: 10.1021/es1036207.	Extensive human exposure to perfluoroallcyl compounds (PFAA) together with their persistence and various toxicities have arisen increasing concern. A noninvasive method would improve exposure assessment for large population, especially the children susceptible to contaminants. The aim of the study was to assess the use of PFAA measurements in human nails as a biomarker of exposure to PFAAs. Fingernail, toenail, and blood samples were collected from 28 volunteers. The PFAA concentrations were determined by high performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS). Six PFAA were detected in nails, with perfluorooctane sulfonate (PFOS) being the compound with the highest median concentration (33.5 and 26.1 ng/g in fingernail and toenail, respectively). Followed was perfluorononanoate (PFNA), with the median concentrations of 20.4 and 16.8 ng/g, respectively, in fingernail and toenail. Other PFAA detected were perfluorooctanoate (PFOA), perfluorodecanoate (PFDA), perfluorododecanoate (PFDoA), and perfluorotetradecanoate (PFTA), with median levels ranging between 0.19 and 8.94 ng/g. PFOS and PFNA concentrations in fingernail significantly correlated with those in serum. Fingernail PFOS and PFNA levels were 2.8 and 24.4 times, respectively, higher than the serum levels. The accumulation of PFAA in nails, together with its advantages in noninvasive sampling and ability of reflecting long-term exposure, made nails PFAA an attractive biomarker of exposure.			1					C	B		爪をPFAS汚染の指標にできないか調べて6種類のPFASを検出した
D989	バイオモニタリング	Wang, YX; Zhong, YX; Li, JG; Zhang, JQ; Lyu, B; Zhao, YF; Wu, YN	Occurrence of perfluoroalkyl substances in matched human serum, urine, hair and nail	2018	J. Environ. Sci. 2018 May:67:191-197. doi: 10.1016/j.jes.2017.08.017	The purpose of this study was to determine perfluoroalkyl substances (PFASs) in human serum, urine, hair and nail from general populations, and to investigate the possibility for human urine, hair and nail used as the biomonitoring sample for PFASs exposure. We detected the concentrations of PFHxA, PFOA, PFNA, PFDA, PFUnDA, PFDoA, PFHxS and PFOS in 39 matched human serum, urine, hair and nail samples from Shenzhen in China. The detection frequency and the median level of PFOS were all higher than that of the other PFASs in four matrices. The median concentration of PFOS in serum, urine, hair, and nail were 9.24 ng/mL, 13.96 ng/L, 0.58 ng/g and 0.63 ng/g, respectively. The results of spearman correlation test indicated that nail was an ideal matrix for biomonitoring PFOS rather than human urine and hair in general populations for the non-invasive sampling.		1	1					B	B	B-minor	ヒト血清、爪、毛髪、尿の8種類のPFAS濃度を調べ、爪が毛髪や尿よりPFOSの指標としてよいと結論
D990	バイオモニタリング	Soleman, SR; Li, M; Fujitani, T; Harada, KH	Plasma eicosapentaenoic acid, a biomarker of fish consumption, is associated with perfluoroalkyl carboxylic acid exposure in residents of Kyoto, Japan: a cross-sectional study	2023	Environ Health Prev Med . 2023:28:38. doi: 10.1265/ehpm.22-00302.	Background: Per-and polyfluoroalkyl substances (PFASs) are highly fluorinated organic compounds that have been widely used in industry during the past few decades. The main exposure routes for PFASs are thought to be the diet, drinking water, and dust. In this study, we aimed to evaluate the relationship between perfluoroalkyl carboxylic acids (PFCAs, members of the PFAS family) and the plasma eicosapentaenoic acid-to-arachidonic acid ratio (EPA/AA), a biological indicator of seafood intake, to determine whether seafood intake may represent a means of exposure to PFASs in the Japanese population. Methods: We performed a cross-sectional study using 131 plasma samples collected from residents of Kyoto, Japan in 2013 and held in the Kyoto University biological sample bank. The concentrations of perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluoroundecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA), perfluorododecanoic acid (PFDoDA), perfluorotridecanoic acid (PFTrDA), EPA, and AA were quantified by gas chromatography-mass spectrometry, and multiple linear regression was used to analyze the results. Results: In multiple linear regression analyses with age and eGFR, PFOA showed a significant positive linear association with age (p = 0.0005); PFHpA showed a significant negative linear association with estimated glomerular filtration rate (eGFR; p = 0.0338); and PFHpA, PFOA, PFNA, PFUnDA, and PFDoDA exhibited significant positive linear associations with EPA/AA (p = 0.0358, 0.0056, 0.0242, <0.0001, and <0.0001, respectively). Because only PFHpA and PFOA were associated with smoking, their concentrations were examined again with smoking variable included and neither showed an association with smoking habit. PFOA showed a significant linear association with EPA/AA ratio (p = 0.0072), but PFHpA did not (p = 0.051). Conclusions: The plasma concentrations of PFOA, PFNA, PFUnDA and PFDoDA significantly associated with the EPA/AA ratio in residents of Kyoto.			1					B	A	exposure source	京都の住民のPFAA濃度とエイコサペンタエン酸濃度から魚介類摂取の影響を評価。PFOSを測定していない

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D991	バイオモニタリング	Menzel, J; Abraham, K; Dietrich, S; Fromme, H; Volkel, W; Schwerdtle, T; Weikert, C	Internal exposure to perfluoroalkyl substances (PFAS) in vegans and omnivores	2021	Int. J. Hyg. Environ. Health. 2021 Aug:237:113808. doi: 10.1016/j.ijheh.2021.113808.	Perfluoroalkyl substances (PFAS) are a complex group of anthropogenic compounds with exceptional properties. Due to their high persistence and mobility, they have caused ubiquitous environmental contamination and in part accumulate in the food chain. In the general population, diet is the main source of PFAS exposure, with the important sources fish and meat. As a vegan diet implies the complete exclusion of any animal products, it might be expected that vegans have lower blood levels of PFAS compared to omnivores. Furthermore, lower levels of cholesterol is one of the well-documented nutritional effects in vegans, but cholesterol levels were also found to be associated with higher PFAS levels in epidemiological studies. To examine the relations of internal PFAS levels and the levels of cholesterol in vegans and omnivores, the cross-sectional Risks and Benefits of a Vegan Diet (RBVD) study was used involving 36 vegans and 36 omnivores from Berlin/Germany. Nine perfluoroalkyl substances were quantified in plasma using a triple-stage quadrupole mass spectrometer. Lower median plasma concentrations were found in vegans compared to omnivores for perfluorooctane sulfonic acid (PFOS) (2.31 vs. 3.57 ng/ml, respectively; p = 0.02) and for perfluorononanoic acid (PFNA) (<0.25 vs. 0.41 ng/ml, respectively; p < 0.0001). No significant differences of the median concentrations were observed for perfluorooctanoic acid (PFOA) (1.69 vs. 1.44 ng/ml, respectively, p = 0.26) and perfluorohexane sulfonic acid (PFHxS) (1.96 vs. 1.79 ng/ml, respectively; p = 0.70). The strongest correlations with food groups, derived from a food frequency questionnaire, were observed between levels of PFOA and water consumption (in case of the total study population, n = 72), and between levels of PFOS as well as PFNA and the consumption of 'meat and meat products' (in case of the omnivores, n = 36). Levels of Low Density Lipoprotein (LDL) cholesterol were confirmed to be considerably lower in vegans compared to omnivores (86.5 vs. 115.5 mg/dl, respectively; p = 0.001), but no associations between the four main PFAS and LDL cholesterol were observed (all p > 0.05) at the low exposure level of this study. According to the results of our study, a vegan diet may be related to lower PFAS levels in plasma. We highlight the importance of the adjustment of dietary factors like a vegan diet in case of epidemiological studies dealing with the impact of PFAS on the levels of blood lipids.			1					B	A	exposure source	菜食主義者は肉由来のPFAS、コレステロールが少ないことに着目して血清中の9種類のPFAS濃度を測定し、低いことを確認
D992	バイオモニタリング	Bangma, JT; Ragland, JM; Rainwater, TR; Bowden, JA; Gibbons, JW; Reiner, JL	Perfluoroalkyl substances in diamondback terrapins (Malaclemys terrapin) in coastal South Carolina	2019	Chemosphere 2019 Jan:215:305-312. doi: 10.1016/j.chemosphere.2018.10.023	This study focused on an estuarine wildlife species exhibiting high site fidelity and ubiquitous distribution in coastal environments along the Atlantic and Gulf coasts of the United States to monitor perand polyfluoroalkyl substances (PFAS). A total of 75 diamondback terrapin (Malaclemys terrapin) plasma samples were collected from five creeks associated with Kiawah (Oyster Creek, Fiddler Creek, Sandy Creek, Gnat Creek) and Edisto (Townsend Creek) islands in Charleston County, South Carolina and investigated for 15 legacy PFAS. Of those, PFHxS was the only PFAS found in all terrapin plasma samples. Four additional PFAS were routinely detected (greater than 90% of the samples) and were included in statistical analyses: PFOS, PFNA, PFDA, and PFUnA. Sex-differences were observed for two creeks with male plasma containing higher PFAS than female plasma (PFHxS at Townsend Creek, PFOS at Oyster Creek). Sex-specific site differences in PFAS concentrations were observed primarily for males, suggesting male terrapins may be more sensitive indicators of localized contaminant profiles than females. Three PFAS were observed to have negative correlations with body mass: PFOS in males (p = 0.045, tau = -0.220), PFNA in males (p = 0.016, tau = -0.269), and PFHxS in both males (p = 0.007, tau = -0.302) and females (p = 0.001, tau = -0.379). No relationships for body mass and PFDA and PFUnA were observed.			1					C	C		すっぽんのPFAS濃度
D993	バイオモニタリング	Liu, M; Nordstrom, M; Forand, S; Lewis-Michl, E; Wattigney, WA; Kannan, K; Wang, W; Irvin-Barnwell, E; Hwang, SA	Assessing exposures to per- and polyfluoroalkyl substances in two populations of Great Lakes Basin fish consumers in Western New York State	2022	Int. J. Hyg. Environ. Health. 2022 Mar:240:113902. doi: 10.1016/j.ijheh.2021.113902.	Background: Fish and other seafood are an important dietary source of per-and polyfluoroalkyl substances (PFAS) exposure in many areas of the world, and PFAS were found to be pervasive in fish from the Great Lakes area. Few studies, however, have examined the associations between Great Lakes Basin fish consumption and PFAS exposure. Many licensed anglers and Burmese refugees and immigrants residing in western New York State consume fish caught from the Great Lakes and surrounding waters, raising their risk of exposure to environ-mental contaminants including PFAS. The aims of this study were to: 1) present the PFAS exposure profile of the licensed anglers and Burmese refugees and 2) examine the associations between serum PFAS levels and local fish consumption.& nbsp;Methods: Licensed anglers (n = 397) and Burmese participants (n = 199) provided blood samples and completed a detailed questionnaire in 2013. We measured 12 PFAS in serum. Multiple linear regression was used to assess associations between serum PFAS concentrations and self-reported consumption of fish from Great Lakes waters.& nbsp;Results: Licensed anglers and Burmese participants reported consuming a median of 16 (IQR: 6-36) and 88 (IQR: 44-132) meals of locally caught fish in the year before sample collection, respectively (data for Burmese group restricted to 10 months of the year). Five PFAS were detected in almost all study participants (PFOS, PFOA, PFHxS, PFNA and PFDA; 97.5-100%). PFOS had the highest median serum concentration in licensed anglers (11.6 ng/mL) and the Burmese (35.6 ng/mL), approximately two and six times that of the U.S. general popu-lation, respectively. Serum levels of other PFAS in both groups were generally low and comparable to those in the general U.S. population. Among licensed anglers, Great Lakes Basin fish meals over the past year were positively associated with serum PFOS (P < 0.0001), PFDA (P < 0.0001), PFHxS (P = 0.01), and PFNA (P = 0.02) and the number of years consuming locally caught fish was positively associated with serum PFOS (P = 0.01) and PFDA (P = 0.01) levels. In the Burmese group, consuming Great Lakes Basin fish more than three times a week in the past summer was positively associated with serum PFOS (P = 0.004) and PFDA (P = 0.02) among the Burmese of non-Karen ethnicity, but not among those of Karen ethnicity, suggesting potential ethnic differences in PFAS exposure.& nbsp;Conclusions: Great Lakes Basin fish consumption was associated with an increase in blood concentrations of some PFAS, and especially of PFOS, among licensed anglers and Burmese refugees and immigrants in western New York State. In the Burmese population, there may be other important PFAS exposure routes related to residential history and ethnicity. Continued outreach efforts to increase fish advisory awareness and reduce exposure to contaminants are needed among these populations.			1					B	A	exposure source	ビルマから五大湖周辺に移住した移民が漁撈を生業としていることに注目して12種類のPFAS濃度を測定。とても高い。
D994	バイオモニタリング	Yu, CH; Riker, CD; Lu, SE; Fan, ZH	Biomonitoring of emerging contaminants, perfluoroalkyl and polyfluoroalkyl substances (PFAS), in New Jersey adults in 2016-2018	2020	Int. J. Hyg. Environ. Health. 2020 Jan:223(1):34-44. doi: 10.1016/j.ijheh.2019.10.008.	New Jersey (NJ) residents in some areas may be exposed to perfluoroalkyl and polyfluoroalkyl substances (PFAS) due to PFAS contamination of public drinking water. This contamination stems from industrial discharges and the use of aqueous film-foaming foams at military bases and commercial airports for drills and locations where fires occurred. Exposure to PFAS has raised significant public health concerns due to its persistence both in the environment and human body. The potential toxicity of these chemicals may pose risks to human health. Statewide biomonitoring data is needed to establish a baseline of exposure and to identify the subpopulations at risk. The NJ Department of Health (NJDOH) conducted a statewide NJ Biomonitoring (NJBM) study for PFAS utilizing a cost-effective sampling approach, i.e. acquiring remnant sera from both clinical laboratories and blood banks across NJ. This convenience sampling approach was adopted as an alternative to a costly and labor-intensive probability-based population sampling. One thousand and thirty human sera were collected from NJ adults between 20 and 74 years of age from 2016 to 2018, with additional information of county, sex, and age. The serum collection was demographically and geographically dispersed across four seasons. Twelve PFAS analytes were measured for the specimens collected. The data were post-stratified by county, sex, and age groups (20-39, 40-59, and 60-74 years old). Stratified individual sample weights were developed and used to estimate population means, compare least-squared mean differences, and examine contributing variables. Geometric means (GMs) and percentiles with 95% confidence intervals (CIs) of the target analytes are presented, providing preliminary baselines of the statewide PFAS exposure for NJ adults. PFOA, PFNA, PFHxS, and PFOS were selected for in-depth analyses because their GMs were greater than 0.5 ng/mL and they were detected over 99% in study population. Subjects from this study had higher serum levels of PFOA, PFNA, and PFHxS compared to the general U.S. population reported by the latest National Health and Nutrition Examination Survey (NHANES in 2015-2016). However, the distributions of PFOA, PFNA, PFHxS, and PFOS across sex and age groups were consistent with the patterns found in NHANES, i.e. all differed by sex and age group. Further sex and age stratification showed significantly lower concentrations of the 4 analytes in younger females (20-59 years old) than in older females (60-74 years old) and males (20-74 years old). Future research is needed to identify PFAS exposure sources and to develop effective intervention strategies. Continuing PFAS biomonitoring using population sampling is recommended for tracking trends and better identifying subpopulations at risk.			1					B	B		ニュージャージー州の12種類のPFAS濃度のモニタリング

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D995	バイオモニタリング	Eick, SM; Goin, DE; Trowbridge, J; Cushing, L; Smith, SC; Park, JS; DeMicco, E; Padula, AM; Woodruff, TJ; Morello-Frosch, R	Dietary predictors of prenatal per- and poly-fluoroalkyl substances exposure	2023	J. Expo. Sci. Environ. Epidemiol. 2023 Jan:33(1):32-39. doi: 10.1038/s41370-021-00386-6.	Background Per- and poly-fluoroalkyl substances (PFAS) are commonly detected in a variety of foods and food packaging materials. However, few studies have examined diet as a potential source of PFAS exposure during pregnancy. In the present cross-sectional study, we examined prenatal PFAS levels in relation to self-reported consumption of meats, dairy products, and processed foods during pregnancy. Methods Participants were enrolled in the Chemicals in Our Bodies study, a demographically diverse pregnancy cohort in San Francisco, CA (N = 509). Diet was assessed using a self-reported interview questionnaire administered during the second trimester. Participants were asked on average how many times a day, week, or month they ate 11 different foods since becoming pregnant. Responses were categorized as at least once a week or less than once a week and foods were grouped into three categories: processed foods, dairy products, and meats. Twelve PFAS (ng/mL) were measured in second trimester serum samples. We investigated relationships between consumption of individual dairy products, meats, and processed foods and natural log-transformed PFAS using separate linear regression models adjusted for maternal age, education, race/ethnicity, and nativity. Results Seven PFAS were detected in >= 65% of participants. Consumption of dairy milk and cheese at least once per week was moderately associated with elevated levels of perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDeA) relative to those who ate dairy products less than once week. The strongest associations observed were with PFDeA for dairy milk (beta = 0.2, 95% confidence interval [CI] = 0.02, 0.39) and PFNA for cheese (beta = 0.22, 95% CI = 0.02, 0.41). Eating fish, poultry, and red meat at least once per week was associated with higher levels of perfluoroundecanoic acid, PFDeA, PFNA, and perfluorooctane sulfonic acid. Conclusions Results indicate that consumption of animal products may contribute to elevated prenatal PFAS levels.			1					B	B	exposure source	サンフランシスコの妊婦の食事調査と12種類のPFAS濃度との関係
D996	バイオモニタリング	Abdallah, MAE; Wemken, N; Drage, DS; Tlustos, C; Cellarius, C; Cleere, K; Morrison, JJ; Daly, S; Coggins, MA; Harrad, S	Concentrations of perfluoroalkyl substances in human milk from Ireland: Implications for adult and nursing infant exposure	2020	Chemosphere. 2020 May:246:125724. doi: 10.1016/j.chemosphere.2019.125724.	Concentrations of 10 perfluoroalkyl substances (PFASs) were measured in 16 pools of human milk from Ireland. Only four PFASs were detected (PFOA, PFNA, PFHxS and PFOS), with concentrations dominated by PFOA which was detected in all samples at a median of 0.10 ng/mL. Concentrations and the relative abundance of PFASs in human milk from Ireland are within the range reported for other countries. Estimated exposures for nursing infants to perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) do not suggest a health concern. A one compartment pharmacokinetic model was used to predict the intakes of PFOS and PFOA required to support the observed concentrations in human milk. This suggests current adult exposure in Ireland to PFOS is below the provisional tolerable weekly intake (TWI) proposed by EFSA. In contrast, the model predicts that the maximum concentration detected in human milk in this study, implies a level of adult exposure that would exceed EFSA's provisional TWI for PFOA. As exposure of the Irish population to PFASs via drinking water, indoor air and dust is well-characterised, current understanding suggests that the major contributor to overall exposure of the Irish population is via the diet and/or less well-studied pathways like dermal uptake from PFAS-containing fabrics and cosmetics.			1					B	B	exposure source	アイルランドの母乳で4種類のPFASしか検出されなかった
D997	バイオモニタリング	Xu, YY; Nielsen, C; Li, Y; Hammarstrand, S; Andersson, EM; Li, HQ; Olsson, DS; Engstrom, K; Pineda, D; Lindh, CH; Fletcher, T; Jakobsson, K	Serum perfluoroalkyl substances in residents following long-term drinking water contamination from firefighting foam in Ronneby, Sweden	2021	Environ. Int. 2021 Feb:147:106333. doi: 10.1016/j.envint.2020.106333.	Background: In December 2013, it was discovered that drinking water supplied to one third of the households in Ronneby, southern Sweden, was highly contaminated by PFAS (sum level >10,000 ng/L) originated from firefighting foams used at a nearby military airport. Objectives: To report serum PFAS levels of Ronneby residents participating in a biomonitoring program, and to describe the variation by age, sex and calendar period for residential exposure. In addition, a reference group living in a neighboring municipality without PFAS contaminated drinking water was examined. Methods: Blood samples and demographic data were collected for 3297 Ronneby residents and 226 individuals from the reference group. Yearly residence addresses were available for 3086 Ronneby residents from the national population registry. Serum concentrations of PFHxS, PFOS and PFOA were determined in all participants, with additional PFHpA, PFNA and PFDA in subsets of the participants. Results: The population geometric means for serum PFHxS, PFOS and PFOA were 114, 135 and 6.8 ng/mL for all Ronneby residents, i.e.135, 35 and 4.5 times higher than for the reference group. Ronneby residents who resided in the area with contaminated water supply during 2005-2013 showed much higher PFAS levels in 2014 than those exposed only before 2005. Ronneby residents who never resided in the area with contaminated water supply also had higher serum PFAS levels than the reference group. All three PFAS were highly correlated (r(s) > 0.9 for each pair). Serum PFAS levels were lowest in teenage years and then increased with age. Adult females had lower PFAS levels on average than males under the age of 60 but higher above 60. Discussion: The results reveal high serum PFAS levels dominated by PFHxS and PFOS in the Ronneby residents highly exposed to PFAS originated from firefighting foams. The PFAS exposure in Ronneby permits studies of associations to a range of health parameters, as well as studies of the toxicokinetics of PFAS exposure.			1					B	B	exposure source	消火剤で汚染された水道水を飲んだスウェーデンのロネビー住民のその後の血清の6種類のPFAS濃度
D998	バイオモニタリング	Bytingsvik, J; van Leeuwen, SPJ; Hamers, T; Swart, K; Aars, J; Lie, E; Nilsen, EME; Wiig, O; Derocher, AE; Jenssen, BM	Perfluoroalkyl substances in polar bear mother-cub pairs: A comparative study based on plasma levels from 1998 and 2008	2012	Environ. Int. 2012 Nov:49:92-99. doi: 10.1016/j.envint.2012.08.004	Perfluoroalkyl substances (PFASs) are protein-binding blood-accumulating contaminants that may have detrimental toxicological effects on the early phases of mammalian development. To enable an evaluation of the potential health risks of PFAS exposure for polar bears (Ursus maritimus), an exposure assessment was made by examining plasma levels of PFASs in polar bear mothers in relation to their suckling cubs-of-the-year (similar to 4 months old). Samples were collected at Svalbard in 1998 and 2008, and we investigated the between-year differences in levels of PFASs. Seven perfluorinated carboxylic acids (Sigma 7PFCAs: PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, and PFTrDA) and two perfluorinated sulfonic acids (Sigma 2PFSAs: PFHxS and PFOS) were detected in the majority of the mothers and cubs from both years. In mothers and cubs, most PFCAs were detected in higher concentrations in 2008 than in 1998. On the contrary, levels of PFOS were lower in 2008 than in 1998, while levels of PFHxS did not differ between the two sampling years. PFOS was the dominating compound in mothers and cubs both in 1998 and in 2008. Concentration of PFHpA did not differ between mothers and cubs, while concentrations of PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFHxS, and PFOS were higher in mothers than in their cubs. Except from PFHpA, all compounds correlated significantly between mothers and their cubs. The mean cub to mother ratios ranged from 0.15 for PFNA to 1.69 for PFHpA. On average (mean +/- standard error of mean), the levels of Sigma 7PFCAs and Sigma 2PFSAs in cubs were 0.24 +/- 0.01 and 0.22 +/- 0.01 times the levels in their mothers, respectively. Although maternal transfer appears to be a substantial source of exposure for the cubs, the low cub to mother ratios indicate that maternal transfer of PFASs in polar bears is relatively low in comparison with hydrophobic contaminants (e.g. PCBs). Because the level of several PFASs in mothers and cubs from both sampling years exceeded the levels associated with health effects in humans, our findings raise concern on the potential health effects of PFASs in polar bears from Svalbard. Effort should be made to examine the potential health effects of PFASs in polar bears.			1					C	C		ホッキョクグマのPFAS濃度
D999	バイオモニタリング	Tsai, MS; Miyashita, C; Araki, A; Itoh, S; Bamai, YA; Goudarzi, H; Okada, E; Kashino, I; Matsuura, H; Kishi, R	Determinants and Temporal Trends of Perfluoroalkyl Substances in Pregnant Women: The Hokkaido Study on Environment and Children's Health	2018	Int. J. Environ. Res. Public Health. 2018 May;15(5):989. doi: 10.3390/ijerph15050989.	Perfluoroalkyl substances (PFAS) are persistent bio-accumulative chemicals that impact the health of pregnant women and their children. PFAS derive from environmental and consumer products, which depend on human lifestyle, socioeconomic characteristics, and time variation. Here, we aimed to explore the temporal trends of PFAS in pregnant women and the characteristics related to maternal PFAS concentration. Our study is part of the Hokkaido Study on Environment and Children's Health, the Hokkaido large-scale cohort that recruited pregnant women between 2003 and 2011. Blood samples were acquired from pregnant women during the third trimester to measure PFAS and cotinine concentrations. Maternal basic information was collected with a baseline structured questionnaire. Eleven PFAS were measured from 2123 samples with ultra-performance liquid chromatography coupled with triple quadrupole tandem mass spectrometry. Eight PFAS were above 80% detection rate and were included in the final analysis. We used multivariable linear regression to analyze the association of pregnant women characteristics with the levels of eight PFAS. The temporal trend of PFAS was observed in two periods (August 2003 to January 2006 and February 2006 to July 2012). The concentration of perfluorooctane sulfonate (PFOS) significantly decreased from August 2003 to January 2006 and from February 2006 to July 2012. The concentrations of perfluorododecanoic acid (PFDoDA), perfluoroundecanoic acid (PFUnDA), and perfluorotridecanoic acid (PFTrDA) increased significantly between August 2003 and January 2006, whereas they decreased significantly between February 2006 and July 2012. Women with pre-pregnancy body mass index (BMI) >25 kg/m(2) had lower PFUnDA, PFDoDA, and PFTrDA levels than did those with normal BMI (18.5-24.9 kg/m(2)). Pregnant women, who were active smokers (cotinine > 11.49 ng/mL), had higher PFOS than the non-smokers (cotinine < 0.22 ng/mL). Lower levels of PFHxS, PFOS, PFOA, PFNA, and PFDA were observed in women, who had given birth to more than one child. There were also significant positive associations between PFAS levels and annual income or maternal education. PFAS levels varied in women with higher pre-pregnancy BMI, active smoking status, higher education level and annual income. The causes of the individual PFAS differences should be explored in an independent study.			1					B	A		北海道スタディで11種類のPFAS濃度測定

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1000	バイオモニタリング	Polachova, A; Gramblicka, T; Bechynska, K; Parizek, O; Parizkova, D; Dvorakova, D; Honkova, K; Rossnerova, A; Rossner, P; Sram, RJ; Topinka, J; Pulkrabova, J	Biomonitoring of 89 POPs in blood serum samples of Czech city policemen	2021	Environ. Pollut. 2021 Dec:291:118140. doi: 10.1016/j.envpol.2021.118140.	In this biomonitoring study, we evaluated the concentrations of 8 polychlorinated biphenyls (PCBs), 11 organochlorinated pesticides (OCPs), 33 brominated flame retardants (BFRs), 7 novel brominated and chlorinated flame retardants (novel FRs) and 30 per- and polyfluoroalkylated substances (PFAS) in human serum samples (n = 274). A total of 89 persistent organic pollutants (POPs) were measured in blood serum samples of city policemen living in three large cities and their adjacent areas (Ostrava, Prague, and Ceske Budejovice) in the Czech Republic. All samples were collected during the year 2019 in two sampling periods (spring and autumn). The identification/quantification of PCBs, OCPs, BFRs, novel FRs and PFAS was performed by means of gas chromatography coupled to (tandem) mass spectrometry (GC-MS/(MS)) and ultra-high performance liquid chromatography coupled to triple quadrupole tandem mass spectrometry (UHPLC-MS/MS). The most frequently detected pollutants were perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluorooctanesulfonate (PFOS), perfluorohexanesulfonate (PFHxS), 2,2 ',3,4,4 ',5 '-hexachlorobiphenyl (CB 138), 2,2 ',4,4 ',5,5 '-hexachlorobiphenyl (CB 153), 2,2 ',3,3 ',4,4 ',5-heptachlorobiphenyl (CB 170), 2,2 ',3,4,4 ',5,5 '-heptachlorobiphenyl (CB 180), hexachlorobenzene (HCB), and p,p'-dichlorodiphenyldichloroethylene (p,p '-DDE) quantified in 100% of serum samples. In the serum samples, the concentrations of determined POPs were in the range of 0.108-900 ng g-1 lipid weight (lw) for PCBs, 0.106-1016 ng g-1 lw for OCPs, <0.1-618 ng g-1 lw for FRs and <0.01-18.3 ng mL-1 for PFAS, respectively. Locality, sampling season, and age were significantly associated with several POP concentrations. One of the important conclusions was that within the spring sampling period, statistically significant higher concentrations of CB 170 and CB 180 were observed in the samples from Ostrava (industrial area) compared to Prague and Ceske Budejovice. Older policemen had higher concentrations of five PCBs and two OCPs in blood serum.			1					B	B		チェコで多くの有機汚染物質とともに30種類のPFAS濃度を測定
D1001	バイオモニタリング	Schultz, AA; Stanton, N; Shelton, B; Pomazal, R; Lange, MA; Irving, R; Meiman, J; Malecki, KC	Biomonitoring of perfluoroalkyl and polyfluoroalkyl substances (PFAS) from the Survey of the Health of Wisconsin (SHOW) 2014-2016 and comparison with the National Health and Nutrition Examination Survey (NHANES)	2023	J Expo Sci Environ Epidemiol. 2023 Sep;33(5):766-777. doi: 10.1038/s41370-023-00593-3.	BackgroundPer- and polyfluoroalkyl substances (PFAS) are a growing class of manufactured chemical compounds found in a variety of consumer products. PFAS are ubiquitous in the environment and were found in many humans sampled in the United States (U.S.). Yet, significant gaps in understanding statewide levels of exposure to PFAS remain.ObjectiveThe goals of this study are to establish a baseline of exposure at the state level by measuring PFAS serum levels among a representative sample of Wisconsin residents and compare to United States National Health and Nutrition Examination Survey (NHANES).MethodsThe study sample included 605 adults (18+ years of age) selected from the 2014-2016 sample of the Survey of the Health of Wisconsin (SHOW). Thirty-eight PFAS serum concentrations were measured using high-pressure liquid chromatography coupled with tandem mass spectrometric detection (HPLC-MS/MS) and geometric means were presented. Weighted geometric mean serum values of eight PFAS analytes from SHOW were compared to U.S. national levels from the NHANES 2015-2016 sample (PFOS, PFOA, PFNA, PFHxS, PFHpS, PFDA, PFUnDA), and the 2017-2018 sample for Me-PFOSA, PFHPS using the Wilcoxon rank-sum test.ResultsPFOS, PFHxS, PFHpS, PFDA, PFNA, and PFOA were detected in over 96% of SHOW participants. In general, SHOW participants had lower serum levels across all PFAS when compared to NHANES. Serum levels increased with age and were higher among males and whites. Similar trends were seen in NHANES, except non-whites had higher PFAS levels at higher percentiles in NHANES.Impact statementThe present study conducts biomonitoring of 38 PFAS among representative sample of residents in the state of Wisconsin. Results suggest that while the majority of Wisconsin residents tested have detectable levels of PFAS in their blood serum, they may have a lower body burden of some PFAS compared to a nationally representative sample. Older adults, males, and whites may have a higher body burden of PFAS relative to other groups, both in Wisconsin and the wider United States.			1					B	B		ウィスコンシン州の38種類のPFAS濃度測定
D1002	バイオモニタリング	Li, J; Luo, K; Liu, XT; Tang, SQ; Zhang, J; Chen, D	Chemical-specific determinants for pre-conceptional exposure to emerging and legacy per- and polyfluoroalkyl substances	2022	Sci. Total Environ. 2022 May:819:152501. doi: 10.1016/j.scitotenv.2021.152501.	The exposure of preconception women toper- and polyfluoroalkyl substances (PFASs) could negatively affect her reproductive health. However, chemical-specific determinants for pre-conceptional exposure to PFASs, particularly the emerging ones, remain poorly understood. In the present study, it was found that the total PFAS concentration ranged from 8.9 to 440.3 ng/mL (median: 49.6 ng/mL) in 1060 preconception women. The PFAS exposure profile was dominated by PFOA (16.8 ng/mL), followed by PFOS (13.3 ng/mL), 6:2 Cl-PFESA (8.9 ng/mL), PFDA (2.4 ng/mL), PFNA (2.1 ng/mL), and others. The pre-conceptional exposure to the selected PFASs was significantly associated, in a chemical-specific pattern, with multiple demographic characteristics and the consumption frequency of different types of food. In particular, the exposure to 6:2 Cl-PFESA was associated with age, parity, alcohol drinking, educational level, household income, and the consumption frequency of red meat, marine and freshwater fish, shellfish, and shrimp. However, our analysis revealed that the investigated sociodemographic and diet variables only explained a relatively small proportion (1.3%-18.7%) of PFAS concentration variations, raising the need of exploring additional factors critical to pre-conceptional PFAS exposure. Overall, the identification of chemical-specific determinants would greatly facilitate the understanding of the link between pre-conceptional exposure and health outcomes, and the mitigation of human exposure to PFAS, particularly the emerging ones.			1					B	B		中国の妊娠前の女性の32種類のPFAS濃度を測定し、食生活などとの関連を調べた
D1003	バイオモニタリング	Hall, SM; Zhang, SR; Tait, GH; Hoffman, K; Collier, DN; Hoppin, JA; Stapleton, HM	PFAS levels in paired drinking water and serum samples collected from an exposed community in Central North Carolina	2023	Sci. Total Environ. 2023 Oct:895:165091. doi: 10.1016/j.scitotenv.2023.165091.	The community of Pittsboro, North Carolina has been documented to have extensive per-and polyfluoroalkyl sub-stances (PFAS) contamination in its drinking water source, the Haw River, over the last 20 years. However, a detailed exposure assessment has never been conducted. In this study, we sought to characterize the PFAS in paired drinking water and blood samples collected from a small cohort of Pittsboro residents (n = 49). Drinking water and serum from blood were collected from adults in late 2019 and early 2020 and were analyzed to quantify 13 PFAS analytes. In order to explore potential health effects of PFAS exposure, serum was further analyzed for clinical chemistry end-points that could be potentially associated with PFAS (e.g., cholesterol, liver function biomarkers). PFAS were detected in all serum samples, and some serum PFAS concentrations were 2 to 4 times higher than the median U.S. serum con-centrations reported in the general U.S. population. Of the 13 PFAS in drinking water, perfluorohexanoic acid (PFHxA) was measured at the highest concentrations. PFAS levels in the current drinking water were not associated with current serum PFAS, suggesting that the serum PFAS in this cohort likely reflects historical exposure to PFAS with long half-lives (e.g., PFOS and PFOA). However, one PFAS with a shorter half-life (PFHxA) was observed to increase in serum, reflecting the temporal variability of PFHxA in river and drinking water. Statistical analyses indicated that serum PFOA and PFHxS were positively associated with total cholesterol and non-HDL cholesterol. No serum PFAS was associated with HDL cholesterol. In the clinical chemistry analyses, serum PFHxA was found to be negatively as-sociated with electrolytes and liver enzymes (e.g., AST and ALT), and serum PFOS was found to be positively associated with the ratio of blood urea nitrogen to creatinine (BUN:Cre). While small in size, this study revealed exten-sive exposure to PFAS in Pittsboro and associations with clinical blood markers, suggesting potential health impacts in community residents.		1					B	A	exposure source	ノースカロライナ州で汚染があった地域の住民の血清と飲料水の13種類のPFAS濃度測定、血液生化学検査を実施
D1004	システマティックレビュー（バイオモニタリング）	McAdam, J; Bell, EM	Determinants of maternal and neonatal PFAS concentrations: a review	2023	Environ. Health. 2023 May;22(1):41. doi: 10.1186/s12940-023-00992-x.	Per- and polyfluoroalkyl substances (PFAS) are used for their properties such as stain and water resistance. The substances have been associated with adverse health outcomes in both pregnant mothers and infants, including pre-eclampsia and low birthweight. A growing body of research suggests that PFAS are transferred from mother to fetus through the placenta, leading to in utero exposure. A systematic review was performed using the PubMed database to search for studies evaluating determinants of PFAS concentrations in blood matrices of pregnant mothers and neonates shortly after birth. Studies were included in this review if an observational study design was utilized, exposure to at least one PFAS analyte was measured, PFAS were measured in maternal or neonatal matrices, at least one determinant of PFAS concentrations was assessed, and results such as beta estimates were provided. We identified 35 studies for inclusion in the review and evaluated the PFAS and determinant relationships among the factors collected in these studies. Parity, breastfeeding history, maternal race and country of origin, and household income had the strongest and most consistent evidence to support their roles as determinants of certain PFAS concentrations in pregnant mothers. Reported study findings on smoking status, alcohol consumption, and pre-pregnancy body mass index (BMI) suggest that these factors are not important determinants of PFAS concentrations in pregnant mothers or neonates. Further study into informative factors such as consumer product use, detailed dietary information, and consumed water sources as potential determinants of maternal or neonatal PFAS concentrations is needed. Research on determinants of maternal or neonatal PFAS concentrations is critical to estimate past PFAS exposure, build improved exposure models, and further our understanding on dose-response relationships, which can influence epidemiological studies and risk assessment evaluations. Given the potential for adverse outcomes in pregnant mothers and neonates exposed to PFAS, it is important to identify and understand determinants of maternal and neonatal PFAS concentrations to better implement public health interventions in these populations.								B	D	exposure source	総説

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1005	バイオモニタリング	Thepaut, E; Dirven, HAAM; Haug, LS; Lindeman, B; Poothong, S; Andreassen, M; Hjertholm, H; Husoy, T	Per- and polyfluoroalkyl substances in serum and associations with food consumption and use of personal care products in the Norwegian biomonitoring study from the EU project EuroMix	2021	Environ. Res. 2021 Apr:195:110795. doi: 10.1016/j.envres.2021.110795.	Background: Human exposure to chemicals through the oral, dermal, or inhalation routes is significant. To assess this exposure, a human biomonitoring study was conducted in Norway to examine the plausibility of source-to-dose calculations for chemical mixtures. Per- and polyfluoroalkyl substances (PFASs) are man-made compounds used for their surfactant properties, and several are persistent and bioaccumulative. Some PFASs are toxic and are regarded as endocrine disruptors and have been shown to suppress immune function and affect cholesterol homeostasis. Using the participants from the EuroMix BM study, we set out to describe PFAS concentrations and to evaluate associations with diet and use of personal care products (PCPs). Methods: Participants (44 males and 100 females) kept detailed diaries on their food consumption and their PCP use for two non-consecutive days. All urine (24 h) and blood samples were collected at the end of each study day. Levels of 25 PFASs were analysed in serum from study day 1 using a high throughput online solid phase extraction ultra-high-performance liquid chromatography tandem mass spectrometry method. Multivariable linear regressions were performed between each food and PCP category and each chemical and were sex-stratified when the consumption of food or use of PCPs was significantly different between men and women. Results: Eight PFASs were detected in all analysed samples (PFHxS, PFHpS, PFOS, PFOA, PFNA, PFDA, PFUnDA and PFDoDA), and four PFASs were below the limit of detection (PFOPA, PFDPA, PFHxA, and EtFOSA). Several PFASs were found to be positively associated with fish consumption (PFOS, PFNA, PFUnDA, PFDoDA, PFDA, PFDS and PFTrDA). Sunscreen, mouthwash, and lip gloss/lip balm were found to be positively associated with PFASs (PFOA, PFTrDA, and PFOSA). Conclusion: The participants in the EuroMix study were exposed to PFASs through their diet and PCP use. Several foods and PCPs were found to be potential sources of exposure to PFASs.		1	1					B	B	exposure source	EuroMix BM studyの参加者の25種類のPFAS濃度と変動要因を検討
D1006	バイオモニタリング	Trowbridge, J; Gerona, RR; Lin, T; Rudel, RA; Bessonneau, V; Buren, H; Morello-Frosch, R	Exposure to Perfluoroalkyl Substances in a Cohort of Women Firefighters and Office Workers in San Francisco	2020	Environ. Sci. Technol. 2020 Mar:54(6):3363-3374. doi: 10.1021/acs.est.9b05490.	Studies of firefighters have shown increased exposures to carcinogenic compounds and elevated rates of certain cancers compared to the general population, yet this research has focused almost exclusively on men. To address this gap, the Women Firefighters Biomonitoring Collaborative created a biological sample archive and analyzed levels of perfluoroalkyl substances (PFAS) among women firefighters (N = 86) and office workers (N = 84) in San Francisco. Serum samples were collected and analyzed using liquid chromatography-tandem mass spectrometry (LC-MS/MS) to measure and compare PFAS levels between firefighters and office workers. 7 of 12 PFAS congeners were detected in the least 70% of the study population, and 4 congeners were detected in 100% of participants. In regression models comparing PFAS levels by occupation and adjusting for potential confounders, firefighters had higher geometric mean concentrations of PFAS compared to office workers PFHxS (2.22 (95% CI = 1.55, 3.18)), PFUnDA (1.83 (95% CI = 0.97, 3.45)), and PFNA (1.26 (95% CI = 1.01, 1.58)). Among firefighters, occupational position predicted exposure-firefighters and officers had higher PFNA, PFOA, PFDA, and PFUnDA levels compared to drivers. Women firefighters are exposed to higher levels of some PFAS compared to office workers, suggesting that some of these exposures may be occupationally related.			1					B	B		サンフランシスコの女性消防士の12種類のPFAS濃度を測定
D1007	バイオモニタリング	Jain, RB	Contribution of diet and other factors to the observed levels of selected perfluoroalkyl acids in serum among US children aged 3-11 years	2018	Environ. Res. 2018 Feb:161:268-275. doi: 10.1016/j.envres.2017.11.018	Data from National Health and Nutrition Examination Survey for 2013-2014 for children aged 3-11 years (N = 639) were analyzed to evaluate the contribution of diet and other factors in variability associated with the observed levels of seven perfluoroalkyl acids in serum, namely, 2(N-methyl-perfluorooctane sulfonamide) acetic acid (MPAH), perfluorodecanoic acid (PFDE), perfluorononanoic acid (PFNA), perflurorohexane sulfonic acid (PFHxS), linear isomer of PFOA (NPFOA), linear isomer of PFOS (NPFOS), and monomethyl isomer of PFOS (MPFOS). Diet accounted for a low of 18.6% of the total explained variance in the adjusted levels of NPFOA and a high of 72.3% for PFNA. Consumption of meat other than fish and poultry was associated with increased levels of NPFOS (beta = 0.00035, $p < 0.01$) and MPFOS (beta = 0.00027, $p = 0.02$). However, consumption of fish was associated with decreased levels of PFDE (beta = - 0.00058, $p = 0.01$). Consumption of eggs was associated with higher levels of PFDE (beta = 0.00105, $p = 0.04$). Higher levels of PFHxS were associated with consumption of fruits and juices (beta = 0.00019, $p = 0.03$). Exposure to environmental tobacco smoke in indoor environments other than home was associated with 12.6% increase in the levels of NPFOA. Boys had higher adjusted geometric mean (AGM) than girls for MPAH (0.88 vs. 0.70 ng/mL, $p = 0.04$) and NPFOS (2.73 vs. 2.27 ng/mL, $p = 0.04$). Non-Hispanic white had higher AGMs than Hispanics for MPAH (0.15 vs. 0.07, $p < 0.01$), for NPFOA (1.98 vs. 1.64 ng/mL, $p < 0.01$), and MPFOS (1.39 vs. 1.18 ng/mL, $p = 0.03$). Non-Hispanic white also had higher AGM than non-Hispanic Asians and others for PFHxS (0.99 vs. 0.63 ng/mL, $p < 0.01$) and NPFOA (1.98 vs. 1.53 ng/mL, $p < 0.01$).			1					B	B	exposure source	米国の3-11歳の子供の7種類のPFAS濃度と食事調査との関連
D1008	メタアナリシス（バイオモニタリング）	Buekers, J; Colles, A; Cornelis, C; Morrens, B; Govarts, E; Schoeters, G	Socio-Economic Status and Health: Evaluation of Human Biomonitored Chemical Exposure to Per- and Polyfluorinated Substances across Status	2018	Int. J. Environ. Res. Public Health. 2018 Dec;15(12):2818. doi: 10.3390/ijerph15122818.	Research on the environment, health, and well-being nexus (EHWB) is shifting from a silo toward a systemic approach that includes the socio-economic context. To disentangle further the complex interplay between the socio-exposome and internal chemical exposure, we performed a meta-analysis of human biomonitoring (HBM) studies with internal exposure data on per-and polyfluoroalkyl substances (PFASs) and detailed information on risk factors, including descriptors of socio-economic status (SES) of the study population. PFASs are persistent in nature, and some have endocrine-disrupting properties. Individual studies have shown that HBM biomarker concentrations of PFASs generally increase with SES indicators, e.g., for income. Based on a meta-analysis (five studies) of the associations between PFASs and SES indicators, the magnitude of the association could be estimated. For the SES indicator income, changes in income were expressed by a factor change, which was corrected by the Gini coefficient to take into account the differences in income categories between studies, and the income range between countries. For the SES indicator education, we had to conclude that descriptors (<college, x years of study, etc.) differed too widely between studies to perform a meta-analysis. Therefore, the use of the uniform ISCED (International Standard Classification of Education) is recommended in future studies. The meta-analysis showed that a higher income is associated with a higher internal exposure to PFASs (PFOS or perfluorooctanesulfonic acid, PFOA or perfluorooctanoic acid, PFNA or perfluorononanoic acid, PFHxS or perfluorohexane sulfonate). This is opposite to the environmental justice hypothesis, referring to an inequitable distribution of detrimental environmental effects toward poor and minority communities by a practice or policy. With a doubling of the income, internal exposure increased on average by 10%-14%. Possible explanations for this difference are given, e.g., underlying differences in diet. However, other sources can also contribute, and the exact causes of SES-related differences in PFAS concentrations remain unclear. Studies are needed that include social descriptors together with lifestyle and dietary information as explanatory variables for internal chemical exposure levels. This will help clarify the underlying factors that link SES with inequity to environmental exposures, and will raise awareness and knowledge to strengthen the capacities of people and communities to advocate chemical exposure reduction in order to reduce this health inequity.			1					B	D		PFASのHBMのメタアナリシス
D1009	バイオモニタリング	Weiss, JM; Jones, B; Koekkoek, J; Bignert, A; Lamoree, MH	Per- and polyfluoroalkyl substances (PFASs) in Swedish household dust and exposure of pet cats	2021	Environ. Sci. Pollut. Res. 2021 Aug:28(29):39001-39013. doi: 10.1007/s11356-021-13343-5.	Per- and polyfluoroalkyl substances (PFASs) are used in a wide range of products and have been found ubiquitously in our indoor environment, and there is evidence that exposure to PFAS can lead to adverse endocrine effects, such as thyroid hormone disruption. Pet cats have a high dust intake due to their grooming behavior and have been shown to be a suitable sentinel species for assessment of toddler's exposure. Here we used paired household dust (n=46) and cat serum (n=27) samples to establish whether dust is a relevant exposure pathway to PFASs. An analytical method for PFAS analysis was optimized using a low volume of cat serum samples, combining solid-phase extraction and online sample cleanup. Dust was extracted with methanol by sonication and cleaned up by addition of active carbon. In total, 27 PFASs were analyzed by liquid chromatography/mass spectrometry analysis. The correlation between PFAS levels in dust and serum, serum lipids and thyroid hormone levels, and PFAS levels in dust between different rooms were statistically evaluated. PFOS and PFDA could be quantified in all cat serum samples (median 2300 pg/mL and 430 pg/mL, respectively), followed by PFOA (median 1100 pg/mL), quantified in 96% of the samples. The levels of 6:2 and 8:2 diPAPs were determined in 65% and 92% of the serum samples, respectively, and were an order of magnitude lower (1.4-160 pg/mL). Household dust on the other hand was dominated by 6:2 and 8:2 diPAPs, with a median of 65 ng/g dust and 49 ng/g dust, respectively. PFOS (median 13 ng/g dust) and PFOA (median 9 ng/g dust) were quantified in 93% of the dust samples. Only eight PFASs were detected (>LOD) in at least 50% of the samples of both matrices and could be paired. Significant correlations between cat serum and dust were found for PFOA ($r(S)=0.32$, $p<0.049$) and PFUnDA ($r(S)=0.55$, $p<0.001$). Significant positive correlations were found between serum total thyroxine ($r(S)=0.11$, $p<0.05$) and PFNA and between serum cholesterol and PFHpA ($r(S)=0.46$, $p<0.01$), PFUnDA ($r(S)=0.40$, $p<0.05$), PFDoDA ($r(S)=0.44$, $p<0.01$), and sum PFAS ($r(S)=0.48$, $p<0.01$). In conclusion, this study confirmed that dust is a relevant exposure pathway for the ingestion of some PFASs for cats, and the serum levels of PFASs could be of relevance for the cat's health.			1					C	C		ハウスダストと猫の血清中PFAS

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1010	バイオモニタリング	Graber, JM; Black, TM; Shah, NN; Caban-Martinez, AJ; Lu, SE; Brancard, T; Yu, CH; Turyk, ME; Black, K; Steinberg, MB; Fan, ZH; Burgess, JL	Prevalence and Predictors of Per- and Polyfluoroalkyl Substances (PFAS) Serum Levels among Members of a Suburban US Volunteer Fire Department	2021	Int. J. Environ. Res. Public Health. 2021 Apr;18(7):3730. doi: 10.3390/ijerph18073730.	Background: Per-and polyfluoroalkyl substances (PFAS), are ubiquitous pollutants associated with adverse health outcomes. High PFAS levels have been demonstrated among career firefighters; less is known about PFAS levels among volunteer firefighters who comprise two-thirds of US firefighters. Methods: Volunteer fire department members completed a survey and provided blood samples. We calculated geometric means and 95% CIs for PFAS reported by the National Health and Nutrition Examination Survey (NHANES). We compared PFAS distribution and levels among non-Hispanic white adult male study participants to those in the 2015-2016 and 2017-2018 NHANES cycles. We assessed associations between PFAS serum levels and years of firefighting controlling demographics and occupation using linear regression. Results: Participant's average age was 46.6 years (sd. 17.1). Perfluorododecanoic acid (PFDoA) was detected in almost half study but <3% of NHANES participants; serum levels of PFDoA, perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA) were elevated among participants compared with NHANES. Serum levels of both PFDA and PFDoA were positively associated with years of firefighting. Conclusions: Volunteer firefighters may have a different serum profile and levels of PFAS than the general population. Future work in this area should include volunteer firefighters from other geographic locations and assess sources of PFAS exposure.			1					B	C		米国のボランティアの消防士の血清PFAS濃度
D1011	バイオモニタリング	Huo, XA; Liang, W; Tang, WF; Ao, Y; Tian, Y; Zhang, QL; Zhang, J	Dietary and maternal sociodemographic determinants of perfluoroalkyl and polyfluoroalkyl substance levels in pregnant women	2023	Chemosphere. 2023 Aug:332:138863. doi: 10.1016/j.chemosphere.2023.138863.	Diet, including drinking water, and demographic characteristics have been associated with PFAS exposure levels in the general population. But data in pregnant women are scarce. We aimed to examine the PFAS levels in relation to these factors in early pregnancy and included 2545 pregnant women in early pregnancy from the Shanghai Birth Cohort. Ten PFAS were measured using high-performance liquid chromatography/tandem mass spectrometry (HPLC/MS-MS) in plasma samples at around 14 weeks of gestation. Geometric mean (GM) ratios were used to estimate the associations between demographic characteristics, food intake and source of drinking water and concentrations of nine PFAS with a detection rate of at least 70%, and the total perfluoroalkyl car-boxylic acids (n-ary sumation PFCA), perfluoroalkyl sulfonic acids (n-ary sumation PFSA) and all the PFAS concentrations (n-ary sumation PFAS). Me-dian concentrations of plasma PFAS ranged from 0.03 ng/mL for PFBS to 11.56 ng/mL for PFOA. In the multivariable linear models, maternal age, parity, parental education level, marine fish, freshwater fish, shellfish, shrimps, crabs, animal kidneys, animal liver, eggs, and bone soup in early pregnancy were positively associated with plasma concentrations of certain PFAS. Whereas pre-pregnancy BMI, plant-based foods, and drinking bottled water were negatively associated with some PFAS concentrations. In summary, this study suggested that fish and seafood, animal offal, and high-fat foods (eggs and bone soup) were significant sources of PFAS. PFAS exposure may be reduced by consuming more plant-based foods and potential interventions, such as drinking water treatment.				1				B	B	exposure source	上海の妊婦の10種類のPFAS濃度と食事調査との関連。魚、肉の寄与率が高い
D1012	バイオモニタリング	Papadopoulou, E; Haug, LS; Sakhi, AK; Andrusaityte, S; Basagana, X; Brantsaeter, AL; Casas, M; Fernandez-Barres, S; Grazuleviciene, R; Knutsen, HK; Maitre, L; Meltzer, HM; McEachan, RRC; Roumeliotaki, T; Slama, R; Vafeiadi, M; Wright, J; Vrijheid, M; Thomsen, C; Chatzi, L	Diet as a Source of Exposure to Environmental Contaminants for Pregnant Women and Children from Six European Countries	2019	Environ. Health Perspect. 2019 OCT;127(10):107005. doi: 10.1289/EHP5324.	BACKGROUND: Pregnant women and children are especially vulnerable to exposures to food contaminants, and a balanced diet during these periods is critical for optimal nutritional status. OBJECTIVES: Our objective was to study the association between diet and measured blood and urinary levels of environmental contaminants in mother-child pairs from six European birth cohorts (n = 818 mothers and 1,288 children). RESULTS: Maternal high (>= 4 times/week) versus low (<2 times/week) fish consumption was associated with 15% higher PCBs [geometric mean (GM) ratio= 1.15; 95% confidence interval (CI): 1.02, 1.29], 42% higher perfluoroundecanoate (PFUnDA) (GM ratio = 1.42; 95% CI: 1.20, 1.68), 89% higher mercury (Hg) (GM ratio =1.89; 95% CI: 1.47, 2.41) and a 487% increase in arsenic (As) (GM ratio = 4.87; 95% CI: 2.57, 9.23) levels. In children, high (>= 3 times/week) versus low (<1.5 times/week) fish consumption was associated with 23% higher perfluorononanoate (PFNA) (GM ratio = 1.23; 95% CI: 1.08, 1.40), 36% higher PFUnDA (GM ratio= 1.36; 95% CI: 1.12, 1.64), 37% higher perfluorooctane sulfonate (PFOS) (GM ratio =1.37; 95% CI: 1.22, 1.54), and >200% higher Hg and As [GM ratio =3.87 (95% CI: 1.91, 4.31) and GM ratio= 2.68 (95% CI: 2.23, 3.21)] concentrations. Using TMLE analysis, we estimated that fish consumption within the recommended 2-3 times/week resulted in lower PFAS, Hg, and As compared with higher consumption. Fruit consumption was positively associated with OP metabolites. Organic food consumption was negatively associated with OP metabolites. DISCUSSION: Fish consumption is related to higher PFAS, Hg. and As exposures. In addition, fruit consumption is a source of exposure to OPs.			1					B	B	exposure source	欧州の複数の出生コホートで母子の有機汚染物質濃度を測定、魚の摂取が多いとPFAS, Hg, Asのレベルが上昇
D1013	バイオモニタリング	Coakley, J; Bridgen, P; Mueller, J; Douwes, J; 't Mannetje, A	Polybrominated diphenyl ethers and perfluorinated alkyl substances in blood serum of New Zealand adults, 2011-2013	2018	Chemosphere 2018 Oct:208:382-389. doi: 10.1016/j.chemosphere.2018.05.191	A national survey was conducted in 2011-2013 to assess serum concentrations of brominated flame retardants (BFRs) and perfluorinated alkyl substances (PFASs) in adult New Zealanders. Participants were randomly selected from the 2010 Electoral Roll within 64 demographic strata according to 4 age groups, 4 geographic regions, 2 ethnic groups (Maori/non-Maori) and sex. Eligible participants (n = 734; response rate of contacted individuals = 37%) donated up to 30 mL of blood, after which serum was pooled (49 pools for BFRs, 63 pools for PFASs) according to demographic strata. BFRs were analysed by GC-HRMS and PFASs by LC-MS/MS. Associations between serum BFRs and PFASs and demographic variables (age, region, ethnicity, sex) were assessed using regression analysis. The weighted geometric mean (GM) serum concentrations of BDE47, BDE99, BDE100, and BDE153 were 2.0, 0.66, 0.43, and 1.2 ng/g lipid, respectively. The weighted geometric mean (GM) serum concentrations of PFOS, PFOA, PFHxS, and PFNA were 3.4, 2.4, 1.0, and 0.66 ng/mL, respectively. The majority of BFRs showed higher serum concentrations in younger age groups. Conversely, the four PFASs showed higher serum concentrations in older age groups. Concentrations of BFRs and PFASs were generally lower in females compared to males. In New Zealand, both age and sex are important determinants of BFR and PFAS serum concentrations.			1					B	B		ニュージーランドの住民のPBB、PFASの性差など
D1014	バイオモニタリング	Aker, A; Ayotte, P; Caron-Beaudoin, E; De Silva, A; Ricard, S; Lemire, M	Associations between dietary profiles and perfluoroalkyl acids in Inuit youth and adults	2023	Sci. Total Environ. 2023 Jan;857(Pt 3):159557. doi: 10.1016/j.scitotenv.2022.159557.	Background: Perfluoroalkyl acids (PFAAs), a subset of perfluoroalkyl substances (PFAS), are synthetic chemicals used in industrial and consumer applications. They are exceptionally stable and highly mobile in the environment, and were detected in high concentrations in Arctic wildlife and Nunavik Inuit. The study's objective was to study the association between dietary profiles in Nunavik and plasma PFAAs concentrations. Methods: The study used data from the Qanuilirpitaa? 2017 Nunavik Inuit Health Survey (Q2017) (N = 1172) on Inuit adults aged 16-80 years. Nine PFAAs congeners were measured in plasma samples (six were detected). Dietary profiles were identified using latent profile analysis. Two sets of dietary profiles were included; the first included market (storebought) and country foods (harvested/hunted from the land), and the second included only country foods. Multiple linear regression models regressed log-transformed PFAAs concentrations against the dietary profiles, adjusting for sociodemographic variables. Results: We identified statistically significant 24.54-57.55 % increases in all PFAAs congeners (PFOA, PFNA, PFDA, PFUnDA, PFHxS, and PFOS) in the dietary profile defined by frequent country food consumption compared to the dietary profile defined by frequent market food consumption. Individuals defined by low consumption of foods (related to food insecurity) had higher concentrations of six PFAAs compared to individuals with frequent market food consumption. The associations were stronger with profiles defined by more frequent country food consumption, and particularly those with increased marine mammal consumption. PFDA, PFUnDA, and PFOS were particularly associated with high country food consumption frequency, such that their concentrations increased by approximately 67-83 % compared to those reporting no or very little consumption of any country foods. Conclusions: Increased country food consumption was strongly associated with higher PFAAs concentrations, particu-larly PFOS, PFDA, and PFUnDA. The results provide further evidence that the quality of country foods is being threat-ened by PFAAs contamination. Additional national and international regulations are required to protect the Arctic and its inhabitants from these pollutants.			1					B	B	exposure source	イヌイットの血清中の6種類のPFAS濃度と食生活との関連、海産哺乳動物を食べるほど濃度上昇
D1015	バイオモニタリング	Li, LH; Yu, NY; Wang, XB; Shi, W; Liu, HL; Zhang, XW; Yang, LY; Pan, BC; Yu, HX; Wei, S	Comprehensive Exposure Studies of Per- and Polyfluoroalkyl Substances in the General Population: Target, Nontarget Screening, and Toxicity Prediction	2022	Environ. Sci. Technol. 2022 Oct:56(20):14617-14626. doi: 10.1021/acs.est.2c03345.	Novel per-and polyfluoroalkyl substances (PFASs) in the environment and populations have received extensive attention; however, their distribution and potential toxic effects in the general population remain unclear. Here, a comprehensive study on PFAS screening was carried out in serum samples of 202 individuals from the general population in four cities in China. A total of 165 suspected PFASs were identified using target and nontarget analysis, including seven identified PFAS homolog series, of which 16 PFASs were validated against standards, and seven PFASs [4:2 chlorinated polyfluorinated ether sulfonate (4:2 ClPFESA), 7:2 chlorinated polyfluorinated ether sulfonate (7:2 Cl-PFESA), hydrosubstituted perfluoroheptanoate (H-PFHpA), chlorine-substituted perfluorooctanoate (Cl-PFOA), chlorine-substituted perfluorononanate (Cl-PFNA), chlorine-substituted perfluorodecanoate (Cl-PFDA), and perfluorodecanedioic acid (PFLDCA n = 8)] were reported for the first time in human serum. The Tox21-GCN model (a graph convolutional neural network model based on the Tox21 database) was established to predict the toxicity of the discovered PFASs, revealing that PFASs containing sulfonic acid groups exhibited multiple potential toxic effects, such as estrogenic effects and stress responses. Our study indicated that the general population was exposed to various PFASs, and the toxicity prediction results of individual PFASs suggested potential health risks that could not be ignored.			1					B	B		中国で165種類のPFASをnon-target分析で検出

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1016	バイオモニタリング	Uhl, M; Schoeters, G; Govarts, E; Bil, W; Fletcher, T; Haug, LS; Hoogenboom, R; Gundacker, C; Trier, X; Fernandez, MF; Calvo, AC; Lopez, ME; Coertjens, D; Santonen, T; Murinova, LP; Richterova, D; De Brouwere, K; Hauzenberger, I; Kolossa-Gehring, M; Halldorrsson, PI	PFASs: What can we learn from the European Human Biomonitoring Initiative HBM4EU	2023	Int. J. Hyg. Environ. Health. 2023 May:250:114168. doi: 10.1016/j.ijheh.2023.114168.	Per-and polyfluoroalkyl substances (PFASs) were one of the priority substance groups selected which have been investigated under the ambitious European Joint programme HBM4EU (2017-2022). In order to answer policy relevant questions concerning exposure and health effects of PFASs in Europe several activities were developed under HBM4EU namely i) synthesis of HBM data generated in Europe prior to HBM4EU by developing new platforms, ii) development of a Quality Assurance/Quality Control Program covering 12 biomarkers of PFASs, iii) aligned and harmonized human biomonitoring studies of PFASs. In addition, some cohort studies (on mother -child exposure, occupational exposure to hexavalent chromium) were initiated, and literature researches on risk assessment of mixtures of PFAS, health effects and effect biomarkers were performed. The HBM4EU Aligned Studies have generated internal exposure reference levels for 12 PFASs in 1957 European teenagers aged 12-18 years. The results showed that serum levels of 14.3% of the teenagers exceeded 6.9 mu g/L PFASs, which corre-sponds to the EFSA guideline value for a tolerable weekly intake (TWI) of 4.4 ng/kg for some of the investigated PFASs (PFOA, PFOS, PFNA and PFHxS). In Northern and Western Europe, 24% of teenagers exceeded this level. The most relevant sources of exposure identified were drinking water and some foods (fish, eggs, offal and locally produced foods). HBM4EU occupational studies also revealed very high levels of PFASs exposure in workers (P95: 192 mu g/L in chrome plating facilities), highlighting the importance of monitoring PFASs exposure in specific workplaces. In addition, environmental contaminated hotspots causing high exposure to the population were identified. In conclusion, the frequent and high PFASs exposure evidenced by HBM4EU strongly suggests the need to take all possible measures to prevent further contamination of the European population, in addition to adopting			1					B	D		HBM4EUの成果を総括。高濃度のPFASが検出される例がある
D1017	バイオモニタリング	Carlsson, H; Sreenivasan, AP; Erngren, I; Larsson, A; Kultima, K	Combining the targeted and untargeted screening of environmental contaminants reveals associations between PFAS exposure and vitamin D metabolism in human plasma	2023	Environ. Sci.-Process Impacts 2023 Jun:25(6):1116-1130. doi: 10.1039/d3em00060e.	We have developed, validated, and applied a method for the targeted and untargeted screening of environmental contaminants in human plasma using liquid chromatography high-resolution mass spectrometry (LC-HRMS). The method was optimized for several classes of environmental contaminants, including PFASs, OH-PCBs, HBCDs, and bisphenols. One-hundred plasma samples from blood donors (19-75 years, men n = 50, women n = 50, from Uppsala, Sweden) were analyzed. Nineteen targeted compounds were detected across the samples, with 18 being PFASs and the 19th being OH-PCB (4-OH-PCB-187). Ten compounds were positively associated with age (in order of increasing p-values: PFNA, PFOS, PFDA, 4-OH-PCB-187, FOSA, PFUdA, L-PFHpS, PFTrDA, PFDoA, and PFHpA; p-values ranging from 2.5 x 10(-5) to 4.67 x 10(-2)). Three compounds were associated with sex (in order of increasing p-values: L-PFHpS, PFOS, and PFNA; p-values ranging from 1.71 x 10(-2) to 3.88 x 10(-2)), all with higher concentrations in male subjects compared with female subjects. Strong correlations (0.56-0.93) were observed between long-chain PFAS compounds (PFNA, PFOS, PFDA, PFUdA, PFDoA, and PFTrDA). In the non-targeted data analysis, fourteen unknown features correlating with known PFASs were found (correlation coefficients 0.48-0.99). Five endogenous compounds were identified from these features, all correlating strongly with PFHxS (correlation coefficients 0.59-0.71). Three of the identified compounds were vitamin D-3 metabolites, and two were diglyceride lipids (DG 24:6;O). The results demonstrate the potential of combining targeted and untargeted approaches to increase the coverage of compounds detected with a single method. This methodology is well suited for exposomics to detect previously unknown associations between environmental contaminants and endogenous compounds that may be important for human health.			1					C	A		ノンターゲット分析で18種類のPFASを検出、ビタミンD代謝物の変化を検出
D1018	バイオモニタリング	Mehta, SS; Applebaum, KM; James-Todd, T; Coleman-Phox, K; Adler, N; Laraia, B; Epel, E; Parry, E; Wang, MM; Park, JS; Zota, AR	Associations between sociodemographic characteristics and exposures to PBDEs, OH-PBDEs, PCBs, and PFASs in a diverse, overweight population of pregnant women	2020	J. Expo. Sci. Environ. Epidemiol. 2020 Jan:30(1):42-55. doi: 10.1038/s41370-019-0173-y.	Exposures to persistent organohalogen chemicals during pregnancy are associated with adverse health effects. Low-income, minority women with pre-existing co-morbidities may be particularly vulnerable to these exposures, but have historically been understudied. We aimed to characterize exposures to multiple chemical classes among a sample of ethnically diverse, lower income, overweight or obese pregnant women. Serum concentrations of polybrominated diphenyl ethers (PBDEs) and their hydroxylated metabolites (OH-PBDEs), polychlorinated biphenyls (PCBs), and poly- and perfluoroalkyl substances (PFASs) were measured in 98 pregnant women (California; 2011-2013). Aggregate exposures were evaluated using correlational clustering, a chemical burden score, and PCA. Associations between sociodemographic characteristics and individual and aggregate exposures were evaluated using multivariable linear regression. Clustering and PCA both produced four groupings: (PC1) PBDEs/ OH-PBDEs, (PC2) PCBs, (PC3) PFNA/PFOA/PI-1)eA, (PC4) PFHxS/PFOS. Race/ethnicity and prepregnancy BMI were associated with PBDEs, OH-PBDEs and PC1. Maternal age was associated with PCBs and PC2. Parity was associated with PBDEs, OH-PBDEs and PC2. Poverty was negatively associated with PCBs, whereas food insecurity was positively associated with PFOS. We observed variations in sociodemographic profiles of exposures by chemical class and weak across-class correlations. These findings have implications for epidemiologic studies of chemical mixtures and for exposure reduction strategies.			1					B	B	exposure source	肥満傾向の妊婦の有機汚染物質とPFAS濃度を分析
D1019	バイオモニタリング	Li, X; Zhang, JQ; Liu, W; Li, XN; Zhang, X; Jiang, YS; Zhou, J; Jin, YH	Serum levels of perfluorinated compounds in the general population in Shenzhen, China	2011	Chin. Sci. Bull. 2011 Oct:56(28-29):3092-3099. doi: 10.1007/s11434-011-4616-7.	Perfluorinated compounds (PFCs) have been detected in many environmental matrices, biota, and nonoccupationally exposed populations in China recently. However, little is known about the distribution and levels of various PFCs in the general population living in areas where there is PFC exposure. In the present study, the levels and prevalence of ten target PFCs were determined in 227 serum samples from a population of nonoccupationally exposed individuals in Shenzhen, China. Results indicated that human exposure to PFCs was prevalent in Shenzhen. Perfluorooctanoate (PFOA) was the dominant PFC contaminant in the serum samples, with a median concentration of 6.72 ng/mL, followed by perfluorooctane sulfonate (PFOS) with a median concentration of 2.07 ng/mL. Other PFCs were detected at much lower concentrations, with median concentrations ranging from 0.02 to 0.87 ng/mL. Statistically, no significant (P>0.05) gender differences were observed for any of the PFCs. Significant (P<0.01) positive correlations were found between age and serum concentrations of the target PFCs, except for perfluorobutane sulfonate (R = -0.16, P = 0.01), perfluorohexanoic acid (R = 0.08, P = 0.22), and perfluoroheptanoic acid (R = -0.11, P = 0.10). Based on the one-compartment pharmacokinetic model, the total daily intakes of PFOA and PFOS for the general population in Shenzhen were calculated as 0.63 and 0.20 ng/kg body weight/day, respectively.		1	1	1				B	D		
D1020	バイオモニタリング	Schrenk, D; Bignami, M; Bodin, L; Chipman, JK; del Mazo, J; Grasl-Kraupp, B; Hogstrand, C; Hoogenboom, L; Leblanc, JC; Nebbia, CS; Nielsen, E; Ntzani, E; Petersen, A; Sand, S; Vleminckx, C; Wallace, H; Barregard, L; Ceccatelli, S; Cravedi, JP; Halldorsson, TI; Haug, LS; Johansson, N; Knutsen, HK; Rose, M; Roudot, AC; Van Loveren, H; Vollmer, G; Mackay, K; Riolo, F; Schwerdtle, T	Risk to human health related to the presence of perfluoroalkyl substances in food	2020	EFSA J. 2020 SEP;18(9):6223. doi: 10.2903/j.efsa.2020.6223.	The European Commission asked EFSA for a scientific evaluation on the risks to human health related to the presence of perfluoroalkyl substances (PFASs) in food. Based on several similar effects in animals, toxicokinetics and observed concentrations in human blood, the CONTAM Panel decided to perform the assessment for the sum of four PFASs: PFOA, PFNA, PFHxS and PFOS. These made up half of the lower bound (LB) exposure to those PFASs with available occurrence data, the remaining contribution being primarily from PFASs with short half-lives. Equal potencies were assumed for the four PFASs included in the assessment. The mean LB exposure in adolescents and adult age groups ranged from 3 to 22, the 95th percentile from 9 to 70 ng/kg body weight (bw) per week. Toddlers and 'other children' showed a twofold higher exposure. Upper bound exposure was 4- to 49-fold higher than LB levels, but the latter were considered more reliable. 'Fish meat, 'Fruit and fruit products' and 'Eggs and egg products' contributed most to the exposure. Based on available studies in animals and humans, effects on the immune system were considered the most critical for the risk assessment. From a human study, a lowest BMDL10 of 17.5 ng/mL for the sum of the four PFASs in serum was identified for 1-year-old children. Using PBPK modelling, this serum level of 17.5 ng/mL in children was estimated to correspond to long-term maternal exposure of 0.63 ng/kg bw per day. Since accumulation over time is important, a tolerable weekly intake (TWI) of 4.4 ng/kg bw per week was established. This TWI also protects against other potential adverse effects observed in humans. Based on the estimated LB exposure, but also reported serum levels, the CONTAM Panel concluded that parts of the European population exceed this TWI, which is of concern.			1					B	D	Risk asssessment (wrong category)	EFSAの2020報告
D1021	バイオモニタリング	Xu, PW; Zheng, YB; Wang, XF; Shen, HT; Wu, LZ; Chen, Y; Xu, DD; Xiang, J; Cheng, P; Chen, ZJ; Lou, XM	Breastfed infants? exposure to polychlorinated biphenyls, polychlorinated dibenzo-p-dioxins and dibenzofurans, and per- and polyfluoroalkyl substances: A cross-sectional study of a municipal waste incinerator in China	2022	Chemosphere. 2022 Dec;309(Pt 2):136639. doi: 10.1016/j.chemosphere.2022.136639.	A municipal waste incinerator (MWI) in Zhejiang, China, operating since 2008 was completely reconstructed from 2016 to 2019. In 2013, we conducted a cross-sectional study of breastfeeding mothers living near the MWI. We evaluated the concentrations of polychlorinated biphenyls (PCBs) and polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) in the mothers' breast milk and their infants' estimated daily intake (EDI). To investigate the temporal variations of these pollutants, we conducted a cross-sectional study of 29 mothers in 2019. We assessed the levels of 18 PCB congeners, 17 PCDD/F congeners, and 21 per- and polyfluoroalkyl substance (PFAS) congeners in breast milk and estimated the EDI. The mean total concentrations of PCDD/Fs (EPCDD/Fs) and PCBs (EPCBs) were 81.2 and 4.90 ng/g lipid, respectively, while the toxic equivalent quantity (TEQ) levels of EPCDD/Fs and dioxin-like PCBs (EDL-PCBs) were 2.7 and 1.4 pg WHO-TEQ/g lipid, respectively. Compared to our 2013 measurements, the mass concentrations of EPCDD/Fs and EPCBs decreased by 13% and 35%, respectively (3.361 vs. 2.915 pg/g wet weight [ww] and 269.1 vs. 175.0 pg/g ww, respectively). The TEQEPCDD/F levels decreased by 67% (0.241 vs. 0.080 pg/g ww), but the TEQ-EDL-PCB levels increased by 11% (0.046 vs. 0.051 pg WHO-TEQ/g ww). The median concentration of PFASs was 0.250 ng/mL, ranging from 0.151 to 0.833 ng/mL. The infants' mean EDI of total PCDD/Fs and DL-PCBs was 17.7 pg TEQ/kg body weight [bw], representing a 20% decline compared to 2013. The average EDI levels of PFOS, PFOA, and PFNA were 5.8, 17.9, and 1.7 ng/kg bw, respectively. A comprehensive comparison of the results with studies from around the world showed that the potential health risks posed by legacy PCDD/F and PCB pollutants were not as grave for mothers and infants living near this MWI, but the emerging PFAS pollutants represented a new cause for concern. Main findings: The potential health risks posed by legacy PCDD/F and PCB pollutants were not particularly serious for mothers and infants living near the MWI, but the emerging PFAS pollutants raised new concerns.			1					B	B	exposure source	ごみ焼却場周辺の中国住民の母乳中PFAS21種類を測定

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1022	バイオモニタリング	Zhang, RJ; Ye, JF; Wei, QZ; Li, MJ; Xu, KH; Li, ZH; Lin, WT; Liu, PS; Chen, RP; Ma, AD; Zhou, ZF	Plasma concentration of 14 perfluoroalkyl acids (PFAAs) among children from seven cities in Guangdong, China	2018	Sci. Total Environ. 2018 Mar:616:1469-1476. doi: 10.1016/j.scitotenv.2017.10.167	The toxicity and persistence of perfluoroalkyl acids (PFAAs) in humans have drawn growing concerns, particularly for children. However, data regarding the concentrations of PFAAs in children are limited. In this study, we measured the concentrations of 14 PFAAs in plasma samples collected from 1192 children aged 0-7 years from 7 cities in Guangdong Province: Guangzhou, Shenzhen, Foshan, Dongguan, Zhaoqing, Zhongshan and Zhanjiang. Perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) were detected in >99.5% of the analysed samples. PFOS had the highest median concentration (23.6 ng/mL) in the total samples, followed by PFOA (2.8 ng/mL). The median concentrations of the other PFAAs were lower than 0.4 ng/mL. The concentrations of perfluorohexanoic acid, perfluorononanoic acid, perfluorodecanoic acid, perfluorododecanoic acid, perfluorohexane sulfonate, PFOA and PFOS in children from Foshan were significantly higher than those found in other cities ($p < 0.001$). Negative correlations between most of the PFAA concentrations and age ($r = -0.06$-0.45) were found in all children. Weak to moderate correlations ($r = 0.080$-0.698) were observed between all PFAA concentrations. Our findings indicated a high exposure of children to PFAAs in the early life-stage. The exposure sources and pathways of PFAAs in different regions are different. Considering a lack of information on the exposure pathways and health status, more studies are needed to evaluate the exposure resources and assess the health risk of PFAA exposure in children.		1	1					B	B		中国広東省の0-7歳の14種類のPFAA測定
D1023	バイオモニタリング	Kim, DH; Lee, JH; Oh, JE	Perfluoroalkyl acids in paired serum, urine, and hair samples: Correlations with demographic factors and dietary habits	2019	Environ. Pollut. 2019 May:248:175-182. doi: 10.1016/j.envpol.2019.02.017	We analyzed paired serum, urine, and hair samples from 94 Korean children and adults to investigate levels of 11 perfluoroalkyl acids (PFAAs). The effects of demographic factors and dietary habits on PFAA exposure were also assessed based on the paired samples. The total PFAA concentrations were 2.4 -31 ng/mL in serum, not detected-9.5 ng/mL in urine, and 0.48-15 ng/g in hair. Levels of perfluoropentanoic acid (PFPeA) and perfluorohexanoic acid (PFHxA), which have short carbon chains, were 1.5-5 fold higher in urine and hair than in serum. The PFAA concentrations in serum exhibited a decreasing trend with age from young childhood to adolescence, followed by an increasing trend after adolescence. For most PFAA species, concentrations in serum were higher in adult males than in adult females ($p < 0.01$). No sex difference was evident in the urine and hair samples. In addition, there was no age difference in the urine samples, but in the hair samples, we observed higher concentrations of PFAA5 in children than in the other age groups ($p < 0.01$). The consumption rates of fish and water showed significant correlations with serum (positive correlation) and hair (negative) concentrations, respectively. No relationships between serum and hair/urine levels for most PFAAs were observed, except between serum and hair levels for perfluorooctanoic acid (PFOA).		1						C	B		スペインで6種類のPFASの毛髪中濃度を測定
D1024	バイオモニタリング	Martin, J; Santos, JL; Aparicio, I; Alonso, E	Exposure assessment to parabens, bisphenol A and perfluoroalkyl compounds in children, women and men by hair analysis	2019	Sci. Total Environ. 2019 Dec:695:133864. doi: 10.1016/j.scitotenv.2019.133864.	Population is continuously exposed to endocrine disrupting compounds present in everyday products such as parabens, bisphenol A (BPA), and perfluoroalkyl compounds (PFCs). The aims of this study were, first, to evaluate human exposure to three parabens (methylparaben (MeP), ethylparaben (EtP) and propylparaben (PrP)), BPA and six PFCs (perfluorobutanoic acid, perfluoropentanoic acid, perfluorohexanoic acid, perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS)) through the analysis of hair samples fromchildren, women and men and, then, to evaluate possible relationships between pollutant concentration in hair and age, gender, smoking and dyeing habits or hair colour. Hair samples were collected from 42 volunteers from Seville (Spain) (10 children, 16 women and 16 men). Six of the monitored pollutants (MeP, EtP, PrP, BPA, PFHpA and PFOS) were detected in at least 76% of the samples analysed. The highest concentrations and frequency of detection (100% of the samples) corresponded to MeP and PrP (up to 14,187 and 9009 ng/g, respectively). BPA was found in 83% of the samples at concentrations in the range from 24 to 1427 ng/g whereas PFCs were detected at concentrations in the range from 0.6 to 15.5 ng/g, being PFHpA and PFOS the ones most frequently detected (86% and 76%, respectively). Concentrations of BPA and parabens in adults were statistically higher than those in children. The results of this study reveal the suitability of hair for biomonitoring endocrine disrupting compounds of high concern (PFCs, parabens and BPA) to which population is internally or/and externally but continuously exposed.	1	1					C	B		スペインで6種類のPFASの毛髪中濃度を測定
D1025	バイオモニタリング	Kim, JH; Moon, N; Lee, JW; Mehdi, Q; Yun, MH; Moon, HB	Time-course trend and influencing factors for per- and polyfluoroalkyl substances in the breast milk of Korean mothers	2023	Chemosphere. 2023 Jan:310:136688. doi: 10.1016/j.chemosphere.2022.136688.	Many studies have reported that neonates and infants are exposed to several per- and polyfluoroalkyl substances (PFASs) via breastfeeding; however, these studies have had small sample sizes. This study aimed to determine the concentrations and time-course trend of PFASs in breast milk and identify influencing factors governing PFAS concentrations. Between July and September (2018), 207 low-risk primiparous women were recruited from a lactation counseling clinic in Korea and their breast milk samples were tested for 14 PFASs, including four perfluoroalkyl sulfonic acids. A questionnaire survey, comprising 84 questions covering the women's demographic, obstetrical, dietary, lifestyle, behavioral, and neonatal information, was conducted to investigate associations. Twelve of the 14 PFASs were detectable in breast milk samples. Perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and perfluorodecanoic acid were detected in 100% of the samples, followed by perfluorohexanesulfonic acid (detection rate: 87%), perfluorononanoic acid (87%), and perfluorohexanoic acid (73%); the median concentrations were 0.05, 0.10, 0.031, 0.007, and 0.033 ng/mL, respectively. The PFAS concentrations in breast milk measured in our study were higher than those reported in other studies or countries. In 12 years, from 2007 to 18, the mean concentration of PFOA in breast milk increased by approximately three times (278%). The major factors associated with PFAS concentrations in the bivariate association analysis were body mass index; living area (non-metropolitan); neonatal age; , frequency of fish, ice cream , canned food consumption. In the multiple regression model, fish consumption significantly influenced the PFOS concentrations in breast milk (beta = 0.88, p = 0.033). Frequently, fish consumption has been analyzed as the main dietary factor related to PFOS concentration. Our findings suggest the need for a comprehensive cohort study on PFAS exposure and its association with infant health.		1	1					B	B	exposure source	韓国の母乳中の14種類のPFAS濃度と食生活、体形などの関連を調べた。魚の摂取量が寄与
D1026	バイオモニタリング	Dubeau, C; Aker, A; Caron-Beaudoin, E; Ayotte, P; Blanchette, C; McHugh, NGL; Lemire, M	Perfluoroalkyl acid and bisphenol-A exposure via food sources in four First Nation communities in Quebec, Canada	2023	Public Health Nutr. 2023 Jan:26(1):106-121. doi: 10.1017/S1368980022000581.	Objective: To document perfluoroalkyl acids (PFAA) and bisphenol-A (BPA) exposure in four First Nation communities in northern Quebec compared with the Canadian Health Measures Survey (CHMS Cycle 5 2016-2017) and examine the associations between dietary consumption and chemical exposure. Design: We used cross-sectional data from the JES-YEH! project conducted in collaboration with four First Nation communities in 2015. A FFQ collected information on diet, and PFAA and BPA were measured in biological samples. We used generalised linear models to test the associations between food intake and chemical biomarkers. Setting: Northern Quebec. Participants: Youth aged 3-19 years (n 198). Results: Mean perfluorononanoic acid (PFNA) levels were significantly higher in JES-YEH! than CHMS, and BPA levels were higher among those aged 12-19 years compared with CHMS. Dairy products were associated with PFNA among Anishinabe and Innu participants (geometric mean ratio 95 % CI: 1 center dot 53 (95 % CI 1 center dot 03, 2 center dot 29) and 1 center dot 52 (95 % CI 1 center dot 05, 2 center dot 20), respectively). PFNA was also associated with ultra-processed foods (1 center dot 57 (95 % CI 1 center dot 07, 2 center dot 31)) among Anishinabe, and with wild fish and berries (1 center dot 44 (95 % CI 1 center dot 07, 1 center dot 94); 1 center dot 75 (95 % CI 1 center dot 30, 2 center dot 36)) among Innu. BPA was associated with cheese (1 center dot 72 (95 % CI 1 center dot 19, 2 center dot 50)) and milk (1 center dot 53 (95 % CI 1 center dot 02, 2 center dot 29)) among Anishinabe, and with desserts (1 center dot 71 (95 % CI 1 center dot 07, 2 center dot 74)), processed meats (1 center dot 55 (95 % CI 1 center dot 00, 2 center dot 38)), wild fish (1 center dot 64 (95 % CI 1 center dot 07, 2 center dot 49)) and wild berries (2 center dot 06 (95 % CI 1 center dot 37, 3 center dot 10)) among Innu. Conclusions: These results highlight the importance of better documenting food-processing and packaging methods, particularly for dairy products, and their contribution to endocrine disruptors exposures as well as to promote minimally processed and unpackaged foods to provide healthier food environments for youth in Indigenous communities and beyond.			1					B	B	exposure source	カナダの先住民のPFAS濃度をしらべた
D1027	バイオモニタリング	Nubler, S; Lopez, ME; Castano, A; Mol, HGJ; Haji-Abbas-Zarrabi, K; Schafer, M; Muller, J; Hajslova, J; Dvorakova, D; Antignac, JP; Koch, HM; Haug, LS; Vorkamp, K; Goen, T	Interlaboratory Comparison Investigations (ICIs) and External Quality Assurance Schemes (EQUASs) for human biomonitoring of perfluoroalkyl substances (PFASs) in serum as part of the quality assurance programme under HBM4EU	2022	Sci. Total Environ. 2022 Nov:847:157481. doi: 10.1016/j.scitotenv.2022.157481.	Perfluoroalkyl substances (PFASs) are of very high concern due to their persistence and accumulative behaviour as well as their manifold adverse health effects. Human biomonitoring (HBM) based on the determination of PFASs in serum samples is an adequate and established strategy for exposure and risk assessment of the population. The suspected health risks associated with exposure levels in the general population call for reliable HBM data verified by Quality Assurance and Quality Control (QA/QC) measures. PFASs were among the chemicals selected as priority substances in HBM4EU, a pan-European project to harmonize and advance HBM within 30 European countries. For this purpose, the analytical comparability and accuracy of PFASs-analysing laboratories was assessed in a QA/QC pro-gramme comprising Interlaboratory Comparison Investigations (ICIs) and External Quality Assurance Schemes (EQUASs). This paper presents the evaluation process and discusses the results of four ICI/EQUAS rounds for the determination of eight perfluoroalkyl carboxylic acids and four perfluoroalkyl sulfonic acids (PFBS, PFHxS, PFHpS, PFOS) in serum. All 21 participating laboratories achieved satisfactory results for at least six of these biomarkers, although low limits of quantification (of about 0.1 mu g/L) were required to quantify serum PFAS levels at general pop-ulation exposure levels. The mean relative standard deviation of the participants' results (study RSDR) significantly im-proved from 22 % to 13 % over all PFAS biomarkers in the course of the four rounds. This QA/QC programme succeeded in establishing a network of laboratories with high analytical comparability and accuracy for the analysis of PFASs across 12 European countries.				1				C	C		HBM4EUに参加する国の測定値の標準化

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1028	バイオモニタリング	Hu, W; Zhang, MY; Liu, LY; Zhang, ZF; Guo, Y	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) crossing the blood-cerebrospinal fluid barrier: Their occurrence in human cerebrospinal fluid	2023	J. Hazard. Mater. 2023 Jan:442:130003. doi: 10.1016/j.jhazmat.2022.130003.	Data remain scarce regarding the occurrence of per- and polyfluoroalkyl substances (PFASs) in the human brain for better understanding the cerebral disorders. In this study, we measured the concentrations and profiles of 26 traditional and emerging PFASs in cerebrospinal fluid (CSF), which is a preferred matrix to monitor pollutants in the human brain. Our results indicated perfluorooctanesulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorohexanesulfonate (PFHxS) and n-methylperfluorooctanesulfonamidoacetic acid were the most frequently detected congeners (detection frequency >90%). As the predominant congeners, PFOA and PFOS contributed 27.7% and 14.5% of the total amount of PFASs (ΣPFASs), with respective mean concentration of 221 and 115 pg mL-1. In addition, the concentrations of ΣPFASs in CSF of males were generally higher than those of females, which may be related to the different half-lives of PFASs in different sexes. Interestingly, the concentrations of ΣPFASs and several individual congeners (e.g., perfluorohexanoic acid, perfluorodecanoic acid, perfluorononanoic acid, PFHxS and PFOS) increased with age. The highest concentration of ΣPFASs was found in the elderly compared with other age groups, which may be due to the decreased CSF output as age increased. Our data are valuable for further studies regarding the toxic effects of PFASs on the human brain.		1						B	A	PK	脳脊髄液中の26種類のPFASを測定
D1029	バイオモニタリング	Zhang, RJ; Wei, QZ; Li, MJ; Li, ZH; Lin, WT; Ma, AD; Zhou, ZF	Exposure of children aged 0-7 years to perfluorinated compounds in Foshan, China	2017	Environ. Sci. Pollut. Res. 2017 Oct:24(29):23299-23308. doi: 10.1007/s11356-017-9922-4.	To evaluate the exposure of children to 14 perfluorinated compounds (PFCs) in a typical and representative industrial city, plasma samples from 476 children aged 0-7 years in Foshan, China, were analysed. Perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) were detected in 100% of the samples, accounting for 82.27 and 11.46% of the total PFC concentrations, respectively, while PFOS peaked at age 0-1 years, for which the mean and median concentrations were 113.71 and 83.65 ng/mL, respectively, while PFOA peaked at age 3-4 years, for which the mean and median concentrations were 10.68 and 6.58 ng/mL, respectively. The concentrations of PFOS, perfluorohexane sulfonate and perfluorohexanoic acid decreased with age among children aged 0-7 years, and no gender-related differences were found in the concentrations of PFCs. A high correlation was found among all PFCs, especially between PFCs of similar carbon chains ($r = 0.161$-0.695, $p < 0.05$). In addition, the concentrations of PFOS and PFOA in children's plasma in Foshan were up to 40-fold higher than those reported in China and other countries. In conclusion, children in Foshan have extensive exposure to PFCs, especially in infancy. Further studies are needed to explore the impact of PFCs on children who live in a typical and representative industrial city in China.		1						B	B		中国の0-7歳の14種類のPFASを測定
D1030	バイオモニタリング	Nguyen, VK; Colacino, JA; Arnot, JA; Kvasnicka, J; Jolliet, O	Characterization of age-based trends to identify chemical biomarkers of higher levels in children	2019	Environ. Int. 2019 Jan:122:117-129. doi: 10.1016/j.envint.2018.10.042	Background: Chemical biomarker concentrations are driven by complex interactions between chemical use patterns, exposure pathways, and toxicokinetic parameters such as biological half-lives. Criteria to differentiate legacy from current exposures are helpful for interpreting variation in age-based and time trends of chemical exposure and identifying chemicals to which children are highly exposed. A systematic approach is needed to study temporal trends for a wide range of chemicals in the US population. Objectives: Using National Health and Nutrition Examination Survey (NHANES) data on measured biomarker concentrations for 141 chemicals from 1999 to 2014, we aim to 1) understand the influence of temporal determinants, in particular time trends, biological half-lives, and restriction dates on age-based trends, 2) systematically define an age-based pattern to identify chemicals with ongoing and high exposure in children, and 3) characterize how age-based trends for six Per-and Polyfluoroalkyl Substances (PFASs) are changing over time. Methods: We performed an integrated analysis of biological half-lives and restriction dates, compared distributions of chemical biomarker concentrations by age group, and then applied a series of regression models to evaluate the linear (beta(age)) and nonlinear (beta(age2)) relationships between age and chemical biomarker levels. Results: For restricted chemicals, a minimum persistence of 1 year in the human body is needed to observe substantial differences between the less exposed young population and historically exposed adults. We define a metric (age2/age > 1 26.9) that identifies several phthalates, brominated flame retardants, pesticides, and metals such as lead and tungsten as elevated and ongoing exposures in children. While a substantial reduction in children's exposures was reflected in PFOS and PFOA, levels of PFNA and PFHxS in children were higher in 2013-2014 compared to those in 1999-2000. Conclusions: Integrating a series of regression models with systemized stratified analyses by age group enabled us to define an age-based pattern to identify chemicals that are of higher levels in children.			1					B	B		子供のPFASの半減期評価。PFNAはむしろ増加している
D1031	バイオモニタリング	Feng, XM; Chen, X; Yang, Y; Yang, LP; Zhu, YM; Shan, GQ; Zhu, LY; Zhang, SF	External and internal human exposure to PFOA and HFPOs around a mega fluorochemical industrial park, China: Differences and implications	2021	Environ. Int. 2021 Dec:157:106824. doi: 10.1016/j.envint.2021.106824.	Hexafluoropropylene oxide dimer and trimer acids (HFPO-DA and HFPO-TA) are used as alternatives to legacy perfluorooctanoic acid (PFOA); however, little is known about their human exposure risks. In this study, the concentrations of PFOA and HFPO were measured in major human exposure matrices and human bio-samples of local residents near a mega fluorochemical industrial park in Shandong, China, to characterize their external and internal exposures. Although HFPO-DA was detected in drinking water and indoor dust, it exhibited a considerably low bioaccumulation potential in animal-origin food and human samples (urine, hair, and serum), implying that it might be a benign alternative to PFOA. Although the estimated daily intake (EDI) of HFPO-TA was comparable to that of PFOA, its concentration in urine was higher than that of PFOA, implying that it might be eliminated faster than PFOA. A simple one-compartment pharmacokinetic model was applied to estimate the serum concentrations of the target compounds and subsequently compare them with the measured concentrations. The predicted concentration of PFOA in serum based on its concentration in urine and half-life was close to the measured value, confirming the distinct internal exposure of PFOA in the local residents. However, the measured concentrations of HFPO in serum were considerably lower than those predicted from the external EDI and urine concentrations, implying that they were eliminated faster than expected in humans. Various perfluoroalkyl substances were detected in human hair, and their compositions were similar to those in human serum, suggesting that hair is a good non-invasive indicator for long-term exposure to legacy long-chain perfluoroalkyl carboxylic acids and HFPOs. This study provided valuable information about the human exposure to legacy PFOA and HFPOs in highly impacted areas near point sources and necessitates studies on the toxicokinetics of HFPOs.			1		1			B	C		PFOAと代替品HFPOの調査
D1032	バイオモニタリング	Govarts, E; Gilles, L; Martin, LR; Santonen, T; Apel, P; Alvito, P; Anastasi, E; Andersen, HR; Andersson, AM; Andryskova, L; Antignacj, JP; Appenzeller, B; Barbone, F; Barnett-Itzhaki, Z; Barouki, R; Berman, T; Bil, W; Borges, T; Buekers, J; Canas-Portilla, A; Covaci, A; Csako, Z; Den Hond, E; Dvorakova, D; Fabelova, L; Fletcherx, T; Frederiksen, H; Gabriel, C; Ganzleben, C; Goen, T; Halldorsson, TI; Haug, LS; Horvat, M; Huuskonen, P; Imboden, M; Hudobivnik, MJ; Janasik, B; Holcer, NJ; Karakitsios, S; Katsonouri, A; Klanova, J; Kokaraki, V; Jensen, TK; Koponen, J; Laeremans, M; Laguzzi, F; Lange, R; Lemke, N; Lignell, S; Lindroos, AK; Vicente, JL; Luijten, M; Makris, KC; Mazej, D;	Harmonized human biomonitoring in European children, teenagers and adults: EU-wide exposure data of 11 chemical substance groups from the HBM4EU Aligned Studies (2014-2021)	2023	Int. J. Hyg. Environ. Health. 2023 Apr:249:114119. doi: 10.1016/j.ijheh.2023.114119.	As one of the core elements of the European Human Biomonitoring Initiative (HBM4EU) a human biomonitoring (HBM) survey was conducted in 23 countries to generate EU-wide comparable HBM data. This survey has built on existing HBM capacity in Europe by aligning national or regional HBM studies, referred to as the HBM4EU Aligned Studies. The HBM4EU Aligned Studies included a total of 10,795 participants of three age groups: (i) 3,576 children aged 6-12 years, (ii) 3,117 teenagers aged 12-18 years and (iii) 4,102 young adults aged 20-39 years. The participants were recruited between 2014 and 2021 in 11-12 countries per age group, geographically distributed across Europe. Depending on the age group, internal exposure to phthalates and the substitute DINCH, halogenated and organophosphorus flame retardants, per-and polyfluoroalkyl substances (PFASs), cadmium, bisphenols, polycyclic aromatic hydrocarbons (PAHs), arsenic species, acrylamide, mycotoxins (deoxynivalenol (total DON)), benzophenones and selected pesticides was assessed by measuring substance specific biomarkers subjected to stringent quality control programs for chemical analysis. For substance groups analyzed in different age groups higher average exposure levels were observed in the youngest age group, i.e., phthalates/DINCH in children versus teenagers, acrylamide and pesticides in children versus adults, benzo-phenones in teenagers versus adults. Many biomarkers in teenagers and adults varied significantly according to educational attainment, with higher exposure levels of bisphenols, phthalates, benzophenones, PAHs and acrylamide in participants (from households) with lower educational attainment, while teenagers from house-holds with higher educational attainment have higher exposure levels for PFASs and arsenic. In children, a social gradient was only observed for the non-specific pyrethroid metabolite 3-PBA and di-isodecyl phthalate (DiDP), with higher levels in children from households with higher educational attainment. Geographical variations were seen for all exposure biomarkers. For 15 biomarkers, the available health-based HBM guidance values were exceeded with highest exceedance rates for toxicologically relevant arsenic in teenagers (40%), 3-PBA in children (36%), and between 11 and 14% for total DON, Sigma (PFOA + PFNA + PFHxS + PFOS), bisphenol S and cadmium. The infrastructure and harmonized approach succeeded in obtaining comparable European wide internal exposure data for a prioritized set of 11 chemical groups. These data serve as a reference for comparison at the global level, provide a baseline to compare the efficacy of the European Commission's chemical strategy for sustainability and will give leverage to national policy makers for the implementation of targeted measures.			1					B	D		HBM4EUの結果の総括

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1033	バイオモニタリング	Tyrrell, J; Melzer, D; Henley, W; Galloway, TS; Osborne, NJ	Associations between socioeconomic status and environmental toxicant concentrations in adults in the USA: NHANES 2001-2010	2013	Environ. Int. 2013 Sep:59:328-335. doi: 10.1016/j.envint.2013.06.017	Low level chronic exposure to toxicants is associated with a range of adverse health effects. Understanding the various factors that influence the chemical burden of an individual is of critical importance to public health strategies. We investigated the relationships between socioeconomic status (SES) and bio-monitored chemical concentration in five cross-sectional waves of the U.S. National Health and Nutrition Examination Survey (NHANES). We utilised adjusted linear regression models to investigate the association between 179 toxicants and the poverty income ratio (PIR) for five NHANES waves. We then selected a subset of chemicals associated with PIR in 3 or more NHANES waves and investigated potential mediating factors using structural equation modelling. PIR was associated with 18 chemicals in 3 or more NHANES waves. Higher SES individuals had higher burdens of serum and urinary mercury, arsenic, caesium, thallium, perfluorooctanoic acid, perfluorononanoic acid, mono(carboxyoctyl) phthalate and benzophenone-3. Inverse associations were noted between PIR and serum and urinary lead and cadmium, antimony, bisphenol A and three phthalates (mono-benzyl, mono-isobutyl, mono-n-butyl). Key mediators included fish and shellfish consumption for the PIR, mercury, arsenic, thallium and perfluorononanoic acid associations. Sunscreen use was an important mediator in the benzophenone-3/PIR relationship. The association between PIR and cadmium or lead was partially mediated by smoking, occupation and diet. These results provide a comprehensive analysis of exposure patterns as a function of socioeconomic status in US adults, providing important information to guide future public health remediation measures to decrease toxicant and disease burdens within society.			1					B	C	exposure source	化学物質ばく露と社会経済的背景との関係
D1034	バイオモニタリング	Gibson, JC	Emerging persistent chemicals in human biomonitoring for populations in the Arctic: A Canadian perspective	2020	Sci. Total Environ. 2020 Mar:708:134538. doi: 10.1016/j.scitotenv.2019.134538.	The future of human biomonitoring in the Arctic will be influenced by the presence of emerging persistent chemicals. Many modelling studies have attempted to predict which contaminants will be of concern next in the Arctic based on chemical and physical properties as well as known risk factors from existing Arctic contaminants of concern. An amalgamated list of emerging persistent chemicals identified through predictive modelling cross referenced with Arctic wildlife monitoring results provides a basis upon which to prioritize future human biomonitoring in the Arctic. Persistent chemicals identified by this analysis are those in common across models (i.e., HCCPD, PCTP, 1,3,5-triBB, 1,2,4,5-tetrachlorobenzene, hexaBDE, pentabromochlorocyclohexane) and those both identified by models and found in Artic biota (e.g., PFNA, PFUnDA, PFDA, PFTrDA, HCBD, HBCDD, PCA, PFDoDA, BTBPE, PCNB, Endosulfan, etc.). Tracking the appearance of new chemicals in environmental monitoring will allow human biomonitoring to keep pace with emerging issues.			1					B	C		北極周辺の環境モニタリング
D1035	バイオモニタリング	Long, MH; Wielsoe, M; Bonefeld-Jorgensen, EC	Time Trend of Persistent Organic Pollutants and Metals in Greenlandic Inuit during 1994-2015	2021	Int. J. Environ. Res. Public Health. 2021 Mar;18(5):2774. doi: 10.3390/ijerph18052774.	Persistent organic pollutants (POPs), including polychlorinated biphenyls (PCBs), organchlorine pesticides and perfluoroalkylated substances (PFASs) and heavy metals bioaccumulate in the marine food chain in the Arctic regions, and thus, the Greenlandic population has a higher body burden due to relatively high intake of marine mammals. We assessed the temporal trend for POPs, including PCB 153; 1,1-dichloro-2,2-bis (p-chlorophenyl)-ethylene (p,p'-DDE); oxychlordane; six PFASs; mercury; lead and selenium in Inuit from Ilulissat, Nuuk, and across Greenland (including thirteen towns/districts), from 1994 to 2015. Data showed a significant annual decrease of 6.85-8.61% for PCB153, 6.67-8.61% for p,p'-DDE, 6.11-9.52% for oxychlordane, 5.92-6.76% for mercury and 6.48-9.43% for lead in Inuit women from Nuuk, Ilulissat, and across thirteen Greenlandic districts. The blood selenium level of all Greenlandic women increased 1.01% annually, while the trend direction was negative for Nuuk women. A similar pattern was seen for men across Greenland, with a yearly decrease of 11.3% for PCB 153, 8.61% for p,p'-DDE, 15.6% for oxychlordane, 13.1% for mercury and 12.2% for lead. Perfluorooctane sulfonate, perfluorohexane sulfonate and perfluorooctanoic acid significantly decreased 5.82-11.7% annually for both women and men across Greenland. For perfluorononanoic acid, perfluorodecanoic acid and perfluoroundecanoic acid, we observed an increasing trend for women across Greenland. In conclusion, there was a decreasing trend of the regulated POPs and metals but a potential increasing trend of the nonregulated PFASs in the Greenlandic population between 1994 and 2015. The continuing biomonitoring of contaminants of concern is important to protect the Arctic population heath.			1					B	B		グリーンランドのイヌイットの6種類のPFAS濃度の経時変化
D1036	バイオモニタリング	Kato, K; Wanigatunga, AA; Needham, LL; Calafat, AM	Analysis of blood spots for polyfluoroalkyl chemicals	2009	Anal. Chim. Acta. 2009 Dec:656(1-2):51-55. doi: 10.1016/j.aca.2009.10.007.	Polyfluoroalkyl chemicals (PFCs) have been detected in humans, in the environment, and in ecosystems around the world. The potential for developmental and reproductive toxicities of some PFCs is of concern especially to children's health. In the United States, a sample of a baby's blood, called a dried blood spot (DBS), is obtained from a heel stick within 48 h of a child's birth. DBS could be useful for assessing prenatal exposure to PFCs. We developed a method based on online solid phase extraction coupled with high performance liquid chromatography-isotope dilution tandem mass spectrometry for measuring four PFCs in DBS, perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate, perfluorooctanoate (PFOA), and perfluorononanoate. The analytical limits of detection using one whole DBS (similar to 75 mu L of blood) were < 0.5 ng mL(-1). To validate the method, we analyzed 98 DBS collected in May 2007 in the United States. PFOS and PFOA were detected in all DBS at concentrations in the low ng mL(-1) range. These data suggest that DBS may be a suitable matrix for assessing perinatal exposure to PFCs, but additional information related to sampling and specimen storage is needed to demonstrate the utility of these measures for assessing exposure.			1					B	C		新生児の血液塗抹標本からのPFOS, PFOA分析
D1037	バイオモニタリング	Vriens, A; Nawrot, TS; Baeyens, W; Den Hond, E; Bruckers, L; Covaci, A; Croes, K; De Craemer, S; Govarts, E; Lambrechts, N; Loots, I; Nelen, V; Peusens, M; De Henauw, S; Schoeters, G; Plusquin, M	Neonatal exposure to environmental pollutants and placental mitochondrial DNA content: A multi-pollutant approach	2017	Environ. Int. 2017 Sep:106:60-68. doi: 10.1016/j.envint.2017.05.022	Background: Placental mitochondrial DNA (mtDNA) content can be indicative of oxidative damage to the placenta during fetal development and is responsive to external stressors. In utero exposure to environmental pollutants that may influence placental mtDNA needs further exploration. Objectives: We evaluated if placental mtDNA content is altered by environmental pollution in newborns and identified pollutants independently associated to alterations in placental mtDNA content. Methods: mtDNA content was measured in placental tissue of 233 newborns. Four perfluoroalkyl compounds and nine organochlorine compounds were quantified in cord blood plasma samples and six toxic metals in whole cord blood. We first applied a LASSO (least absolute shrinkage and selection operator) penalized regression model to identify independent associations between environmental pollutants and placental mtDNA content, without penalization of several covariates. Then adjusted estimates were obtained using an ordinary least squares (OLS) regression model evaluating the pollutants' association with placental mtDNA content, adjusted for several covariates. Results: Based on LASSO penalized regression, oxychlordane, p,p'-dichlorodiphenyldichloroethylene, beta-hexachlorocyclohexane, perfluorononanoic acid, arsenic, cadmium and thallium were identified to be independently associated with placental mtDNA content. The OLS model showed a higher placental mtDNA content of 2.71% (95% CI: 0.3 to 5.2%; p = 0.03) and 1.41% (0.1 to 2.8%, p = 0.04) for a 25% concentration increase of respectively cord blood beta-hexachlorocyclohexane and arsenic. For a 25% concentration increase of cord blood thallium, a 4.88% lower placental mtDNA content (95% CI: -9.1 to -0.5%, p = 0.03) was observed. Conclusion: In a multi-pollutant approach, low fetal exposure levels of environmental organic and inorganic pollutants might compromise placental mitochondrial function as exemplified in this study by alterations in mtDNA content.			1					B	C	B-minor	酸化ストレスの指標としての胎盤のミトコンドリアDNA
D1038	バイオモニタリング	Ramli, MR; Yoneda, M; Mohd, MA; Haron, DEM; Ahmad, ED	Level and determinants of serum perfluoroalkyl acids (PFAAs) in a population in Klang Valley, Malaysia	2020	Int. J. Hyg. Environ. Health. 2020 Jan:223(1):179-186. doi: 10.1016/j.ijheh.2019.09.005.	For decades, perfluoroalkyl acids (PFAAs) have been commonly used for industrial and commercial purposes due to their water- and stain-resistant properties. Persistent pollutants that contain PFAAs have been associated with adverse health effects in humans, and many studies have documented dietary intake, indoor air inhalation, and dermal contact as the potential routes for human exposure to PFAAs. The aim of this study was to assess the level of PFAAs in the serum samples of a general population in a specific region in Malaysia. Using 219 serum samples collected from residents of Klang Valley, Malaysia, the levels of nine PFAAs were analyzed using liquid chromatography-tandem mass spectrometry. In addition, questionnaire surveys on the dietary habits and lifestyles of the subjects were conducted. The results showed that PFAA concentrations of up to 32.57 ng/mL were detected in all serum samples. In 82.6% of the participants, at least seven PFAAs were detected in the serum samples, with perfluorooctanesulfonic acid being the predominant PFAA (median = 8.79 ng/mL). In the adjusted regression model, the concentrations of most PFAAs were higher in men than in women and positively correlated with age, although body mass index and smoking were not significantly associated with the serum PFAA concentrations. Taking into consideration the lifestyle variables, significant associations were found between nonstick cookware and perfluorononanoic acid, between dental floss and cosmetics and perfluorodecanoic acid (PFDA), and between leather sofa and perfluoroundecanoic acid (PFUnDA). Besides, consumption of beef was significantly associated with increased levels of serum PFUnDA, whereas consumption of lamb and chicken eggs was negatively associated with the serum levels of PFUnDA and PFDA, respectively.			1					B	B	exposure source	マレーシアのPFASレベルと食生活
D1039	バイオモニタリング	Zheng, GM; Schreder, E; Dempsey, JC; Uding, N; Chu, V; Andres, G; Sathyanarayana, S; Salamova, A	Per- and Polyfluoroalkyl Substances (PFAS) in Breast Milk: Concerning Trends for Current-Use PFAS	2021	Environ. Sci. Technol. 2021 Jun:55(11):7510-7520. doi: 10.1021/acs.est.0c06978.	This is the first study in the last 15 years to analyze per- and polyfluoroalkyl substances (PFAS) in breast milk collected from mothers (n = 50) in the United States, and our findings indicate that both legacy and current-use PFAS now contaminate breast milk, exposing nursing infants. Breast milk was analyzed for 39 PFAS, including 9 short-chain and 30 long-chain compounds, and 16 of these PFAS were detected in 4-100% of the samples. The SPFAS concentration in breast milk ranged from 52.0 to 1850 pg/mL with a median concentration of 121 pg/mL. Perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) were the most abundant PFAS in these samples (medians 30.4 and 13.9 pg/mL, respectively). Two short-chain PFAS, including perfluoro-n-hexanoic acid (PFHxA, C6) and perfluoro-nheptanoic acid (PFHpA, C7), were detected in most of the samples with median concentrations of 9.69 and 6.10 pg/mL, respectively. Analysis of the available breast milk PFAS data from around the world over the period of 1996-2019 showed that while the levels of the phased-out PFOS and PFOA have been declining with halving times of 8.1 and 17 years, respectively, the detection frequencies of current-use short-chain PFAS have been increasing with a doubling time of 4.1 years.		1						B	A		母乳中の39種類のPFAS濃度の経時変化

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1040	バイオモニタリング	Rokoff, LB; Wallenborn, JT; Harris, MH; Rifas-Shiman, SL; Criswell, R; Romano, ME; Young, JG; Calafat, AM; Oken, E; Sagiv, SK; Fleisch, AF	Plasma concentrations of per- and polyfluoroalkyl substances in pregnancy and breastfeeding duration in Project Viva	2023	Sci. Total Environ. 2023 Sep:891:164724. doi: 10.1016/j.scitotenv.2023.164724.	Background: Per-and polyfluoroalkyl substances (PFAS) may disrupt mammary gland development and function; thereby inhibiting milk supply and breastfeeding duration. However, conclusions on the potential effects of PFAS and breastfeeding duration are limited by prior epidemiologic studies that inconsistently adjusted for past cumulative breastfeeding duration and by a lack of examination of the joint effects of PFAS mixtures. Methods: In Project Viva, a longitudinal cohort that enrolled pregnant participants from 1999 to 2002 in the greater Boston, MA area, we studied 1079 women who ever attempted to lactate. We investigated associations of plasma con-centrations of select PFAS in early pregnancy (mean: 10.1 weeks gestation) with breastfeeding termination by 9 months, after which women typically cite self-weaning as the reason for terminating breastfeeding. We used Cox regression for single-PFAS models and quantile g-computation for mixture models, adjusting for sociodemographics, prior breastfeeding duration, and weeks of gestation at the time of blood draw. Results: We detected 6 PFAS [perfluorooctane sulfonate; perfluorooctanoate (PFOA); perfluorohexane sulfonate; perfluorononanoate; 2-(N-ethyl-perfluorooctane sulfonamido) acetate (EtFOSAA); 2-(N-methyl-perfluorooctane sul-fonamide) acetate (MeFOSAA)] in >98 % of samples. Sixty percent of lactating women terminated breastfeeding by 9 months postpartum. Women with higher plasma concentrations of PFOA, EtFOSAA, and MeFOSAA had a greater hazard of terminating breastfeeding in the first 9 months postpartum [HR (95 % CI) per doubling concentration: 1.20 (1.04, 1.38) for PFOA; 1.10 (1.01, 1.20) for EtFOSAA; 1.18 (1.08, 1.30) for MeFOSAA]. In the quantile g -computation model, simultaneously increasing all PFAS in the mixture by one quartile was associated with 1.17 (95 % CI: 1.05, 1.31) greater hazard of terminating breastfeeding in the first 9 months. Conclusion: Our findings suggest that exposure to PFAS may be associated with reduced breastfeeding duration and draw further attention to environmental chemicals that may dysregulate human lactation.			1					B	B		Viva cohortでの妊婦の血清中6種類のPFASと断乳までの期間の関係
D1041	バイオモニタリング	Zhang, YF; Beesoon, S; Zhu, LY; Martin, JW	Isomers of perfluorooctanesulfonate and perfluorooctanoate and total perfluoroalkyl acids in human serum from two cities in North China	2013	Environ. Int. 2013 Mar:53:9-17. doi: 10.1016/j.envint.2012.12.007	The sources and pathways of human exposure to perfluoroalkyl acids (PFAAs) are not well characterized, particularly in China where many perfluorinated substances are now manufactured. Here, isomer-specific PFAA analysis was used for the first time to evaluate exposure sources for Chinese people, by applying the method to 129 serum samples collected in two typical cities (Shijiazhuang and Handan) in North China. Among all samples, total perfluorooctanesulfonate (Sigma PFOS, mean 33.3 ng/ml) was the predominant PFAA followed by perfluorohexanesulfonate (2.95 ng/ml), total perfluorooctanoate (Sigma PFOA, 2.38 ng/ml), and perfluorononanoate (0.51 ng/ml). The level of Sigma PFOS was higher than in people from North America in recent years. The mean concentrations of Sigma PFAAs in the participants living in urban Shijiazhuang (59.0 ng/ml) and urban Handan (35.6 ng/ml) were significantly higher ($p<0.001$ and $p = 0.041$, respectively) than those living in the rural district of Shijiazhuang (24.3 ng/ml). The young female sub-population had the lowest Sigma PFAA concentrations compared with older females and all males. On average, the proportion of linear PFOS (n-PFOS) was only 48.1% of Sigma PFOS, which is much lower than what was present in technical PFOS from the major historical manufacturer (ca. 70% linear), and which is also lower than data reported from any other countries. Moreover, the proportion of n-PFOS decreased significantly with increasing Sigma PFOS concentration in the serum samples ($r = -0.694$, $p<0.001$). Taken together, the data lend weight to previous suggestions that i) high branched PFOS content in serum is a biomarker of exposure to PFOS-precursors, and ii) that people with the highest Sigma PFOS concentrations are exposed disproportionately to high concentrations of PFOS-precursors. On average, linear PFOA (n-PFOA) contributed 96.1% of Sigma PFOA, significantly higher than in technical PFOA (ca. 75-80% linear), but lower than in Americans, suggesting higher exposure to electrochemically fluorinated PFOA than in other countries, including the United States.			1					B	C	B-minor	北部中国の血清PFASのisomerごとの濃度
D1042	バイオモニタリング	Struciński P, Góralczyk K, Ludwicki JK, Czaja K, Hernik A, Korcz W.	[Levels of selected organochlorine insecticides, polychlorinated biphenyls, phthalates and perfluorinated aliphatic substances in blood--Polish WWF study]	2006	Rocz Panstw Zakl Hig. 2006;57(2):99-112.	In June 2004, blood samples of fifteen volunteers were analyzed for presence of selected groups of chemical contaminants. The aim of this survey organized by WWF Poland (World Wildlife Fund) was highlighting the problem of man-made, persistent and bioaccumulative chemicals constantly present in surrounding environment and in our tissues. It was a part of European WWF "Detox" campaign supporting proposal of a new EU regulation that should lead to the identification and phasing out of the most harmful chemicals (known as REACH). Three laboratories in Czech Republic, Sweden and Belgium have analyzed blood samples for presence of the following groups of contaminants: organochlorine compounds (pesticides and polychlorinated pesticides), phthalates and perfluorinated aliphatic substances. The total number of single chemicals found in the blood samples was 25, that represents 64% of the 39 chemicals looked for. The average number of compounds found in the samples was 21 (from 19 to 22). Among organochlorine compounds analyzed, the predominant chemical found in the highest concentration was p,p'-DDE (range from 130 to 1310 ng/g of fat), which similarly like p,p'-DDT, beta-HCH, and HCB (concentrations ranging from 6,4 to 46 ng/g of fat) was present in every person's blood. Among analyzed polychlorinated biphenyls, in all samples the following congeners have been present: PCB-118, PCB-138, PCB-153, and PCB-180 (concentrations ranging from 3,7 to 61 ng/g of fat). The two predominant phtalates from total eight analyzed present in all samples were di(2-ethylhexyl)phthalate (DEHP) (concentration range from 49 to 293 ng/g of blood) and diisobutyl phthalate (DIBP) (concentration range from 10 to 63 ng/g of blood). Among fifteen perfluorinated aliphatic substances analyzed, six have been present in each single sample (perfluorohexanesulfonic acid - PFHxS, perfluorooctanoic acid - PFOA, perfluorooctane-sulfonic acid - PFOS, perfluorooctanesulfonylamide - PFOSA, perfluorononanoic acid - PFNA, and perfluorododecanoic acid - PFDA). The predominant compound in this class of contaminants was PFOS with the concentration ranging from 4,4 to 14 ng/ml of blood. The limited number of samples does not allow for making an analysis of potential impact of different factors on concentrations of particular contaminants in human blood. Results obtained in this survey confirm the ubiquitous contamination by a cocktail of hazardous chemicals of every person tested. Humans being a part of the environment are being contaminated with the same chemicals which are present in surrounding air, water, food, consumer articles, etc.			1					B	B	Non English?	チェコ、スウェーデン、ベルギーの15種類のPFAS濃度
D1043	バイオモニタリング	Kärrman A, Domingo JL, Llebaria X, Nadal M, Bigas E, van Bavel B, Lindström G.	Biomonitoring perfluorinated compounds in Catalonia, Spain: concentrations and trends in human liver and milk samples	2010	Environ Sci Pollut Res Int. 2010 Mar;17(3):750-8. doi: 10.1007/s11356-009-0178-5. Epub 2009 May 21.	Background, aim and scope: Perfluorinated compounds (PFCs) are global environmental pollutants that bioaccumulate in wildlife and humans. Laboratory experiments have revealed toxic effects such as delayed development, humoral suppression, and hepatotoxicity. Although numerous human blood levels have been reported, little is known about distribution in the human body. Knowledge about PFC distribution and accumulation in the human body is crucial to understanding uptake and subsequent effects as well as to conduct risk assessments. The present study reports PFC levels in human liver and breast milk from a general population living in Catalonia, Spain. Liver and milk levels are compared to previously reported levels in blood from the same geographic area as well as to other existing reports on human liver and milk levels in other countries. Materials and methods: Human liver (n = 12) and milk (n = 10) samples were collected in 2007 and 2008 in Catalonia, Spain. Liver samples were taken postmortem from six males and six females aged 27-79 years. Milk samples were from healthy primipara women (30-39 years old). Both liver and milk were analyzed by solid-phase extraction and ultra-performance liquid chromatography tandem mass spectrometry. Results: Six PFCs were detected in liver, with perfluorooctanesulfonate (PFOS, 26.6 ng/g wet weight) being the chemical with the highest mean concentration. Other PFCs such as perfluorohexanesulfonate (PFHxS), perfluorooctanoic acid (PFOA), and acids with chain lengths up to C11 were also detected, with mean levels ranging between 0.50 and 1.45 ng/g wet weight. On the other hand, PFOS and PFHxS were the only PFCs detected in human milk, with mean concentrations of 0.12 and 0.04 ng/mL, respectively. Discussion: While milk concentrations were similar to reported levels from other countries, liver samples contained more PFCs above quantification limits and higher PFOS concentrations compared to the only two other reports found in the literature. Differences between the results of the present study and those concerning previous investigations can be due to declining levels of some PFCs, which have been reported for the USA. The relationship between PFC concentrations in human liver, milk, and blood was assessed using blood concentrations previously determined in Catalonia. Those levels resulted in liver/serum ratios of 1.7:1, 1.4:1, and 2.1:1 for PFOS, perfluorodecanoic acid, and perfluoroundecanoic acid, respectively. Accumulation in liver is suggested for PFOS and the perfluorocarboxylic acids with carbon chain lengths C9, C10, and C11. For PFOA and PFHxS, fivefold and 14-fold higher concentrations, respectively, were seen in serum as compared to liver. The			1					B	B		スペインカタロニア地方の剖検試料の肝臓及び別の人の母乳中のPFAS濃度を測定

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1044	バイオモニタリング	Yao D, Zhang H, Chai ZF, Shen JC, Yang B, Wang YP, Liu GQ.	[Residue of organic fluorine pollutants in hair and nails collected from Tianjin]	2013	Huan Jing Ke Xue. 2013 Feb;34(2):718-23.	In order to explore the residue and distributions of organic fluorine pollutants in hair and nails, the residue levels of total fluorine (TF), extractable organic fluorine (EOF) and perfluorinated chemicals (PFCs) in hair and nails collected from Tianjin adults were measured by the cyclic neutron activation analysis (CNAA) combined with the high performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS). The results showed that inorganic fluorine (mean: 2.0 mg.kg-1, 4.5 mg.kg-1) was the primary fluorine in TF while EOF(mean: 0.7 mg.kg-1, 1.8 mg.kg-1) was minor. The average amount of identified fluorine (IF) was 0.038 mg.kg-1 in hair and 0.047 mg.kg-1 in nails, accounting or 7.1% (2.6%-16%) and 3.5% (1.1%-11%) of EOF, respectively, which indicated that more than 84% of EOF was unknown. The major residue in hair and nails were medium-and short-chain PFCs,in which perfluorooctane sulfonate, perfluorooctanoic acid and perfluorononanoic acid were the main species. TF, EOF and IF levels in dyed and permed hair were significantly higher than untreated hair (P <0.05), and the concentrations of Sigma PFCs in hair and nails showed no difference between genders. With significantly higher levels of sigma PFCs and PFOS residues than hair (P <0.01), nails could potentially become a more sensitive bioindicator for the exposure level of PFCs in human.			1					B	C	Non English?	中国におけるPFASを含む有機汚染物質の爪と毛髪中濃度
D1045	バイオモニタリング	Dobraca D, Israel L, McNeel S, Voss R, Wang M, Gajek R, Park JS, Harwani S, Barley F, She J, Das R.	Biomonitoring in California firefighters: metals and perfluorinated chemicals	2015	J Occup Environ Med. 2015 Jan;57(1):88-97. doi: 10.1097/JOM.0000000000000307.	Objective: To assess California firefighters' blood concentrations of selected chemicals and compare with a representative US population. Methods: We report laboratory methods and analytic results for cadmium, lead, mercury, and manganese in whole blood and 12 serum perfluorinated chemicals in a sample of 101 Southern California firefighters. Results: Firefighters' blood metal concentrations were all similar to or lower than the National Health and Nutrition Examination Survey (NHANES) values, except for six participants whose mercury concentrations (range: 9.79 to 13.42 μg/L) were close to or higher than the NHANES reporting threshold of 10 μg/L. Perfluorodecanoic acid concentrations were elevated compared with NHANES and other firefighter studies. Conclusions: Perfluorodecanoic acid concentrations were three times higher in this firefighter group than in NHANES adult males. Firefighters may have unidentified sources of occupational exposure to perfluorinated chemicals.								B	B	B-minor	カルフォルニア州の消防士の12種類のPFAS濃度と重金属濃度
D1046	バイオモニタリング	Yu M, Teitelbaum SL, Dolios G, Dang LT, Tu P, Wolff MS, Petrick LM.	Molecular Gatekeeper Discovery: Workflow for Linking Multiple Exposure Biomarkers to Metabolomics	2022	Environ Sci Technol. 2022 May 17;56(10):6162-6171. doi: 10.1021/acs.est.1c04039. Epub 2022 Feb 7.	The exposome reflects multiple exposures across the life-course that can affect health. Metabolomics can reveal the underlying molecular basis linking exposures to health conditions. Here, we explore the concept and general data analysis framework of "molecular gatekeepers"—key metabolites that link single or multiple exposure biomarkers with correlated clusters of endogenous metabolites—to inform health-relevant biological targets. We performed untargeted metabolomics on plasma from 152 adolescent girls participating in the Growing Up Healthy Study in New York City. We then performed network analysis to link metabolites to exposure biomarkers including five trace elements (Cd, Mn, Pb, Se, and Hg) and five perfluorinated chemicals (PFCs; n-PFOS, Sm-PFOS, n-PFOA, PFHxS, and PFNA). We found 144 molecular gatekeepers and annotated 22 of them. Lysophosphatidylcholine (16:0) and taurodeoxycholate were correlated with both n-PFOA and n-PFOS, suggesting a shared dysregulation from multiple xenobiotic exposures. Sphingomyelin (d18:2/14:0) was significantly associated with age at menarche; yet, no direct association was detected between any exposure biomarkers and age at menarche. Thus, molecular gatekeepers can also discover molecular linkages between exposure biomarkers and health outcomes that may otherwise be obscured by complex interactions in direct measurements.			1					C	B		5種類のPFASとゲートキーパーとなる代謝物との関係
D1047	バイオモニタリング	Nyström J, Benskin JP, Plassmann M, Sandblom O, Glynn A, Lampa E, Gyllenhammar I, Lignell S, Moraeus L.	Healthy eating index and diet diversity score as determinants of serum perfluoroalkyl acid (PFAA) concentrations in a national survey of Swedish adolescents	2022	Environ Res. 2022 Sep;212(Pt A):113170. doi: 10.1016/j.envres.2022.113170. Epub 2022 Mar 24.	Food is an important source of perfluoroalkyl acid (PFAA) exposure for the general adult population, but few data exist for adolescents. Healthy food habits established during adolescence may positively influence health later in life. Associations between serum PFAA concentrations and a healthy eating index (SHEIA15), as well as a diet diversity score (RADDS), were determined in a nationally representative adolescent population from Sweden (Riksmaten Adolescents 2016-2017, RMA). Using consumption data from food registrations and frequency questionnaires, we additionally analyzed associations with commonly consumed food groups. Associations were analyzed by fitting a cumulative probability model using ordinal regression. Among the seven PFAAs detected in ≥70% of the 1098 participants (age 10-21 years), median concentrations ranged from <1 ng/g serum of perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perflurorundecanoic acid (PFUnDA), linear (lin-) perfluorohexanesulfonic acid (PFHxS) and branched (br-) perfluorooctanesulfonic acid (PFOS) to 1-2 ng/g serum of lin-perfluorooctanoic acid (PFOA) and lin-PFOS. PFNA, PFDA, PFUnDA and lin-PFOS concentrations were positively associated with both SHEIA15 and RADDS, a finding most likely driven by higher consumption of seafood. PFDA, PFUnDA and lin-PFOS concentrations were positively related to commonly consumed fish/shellfish groups, such as lean marine fish and shellfish. Inverse associations between PFAA concentrations and dairy consumption suggest an underlying factor behind dairy consumption that similarly affects adolescent exposure to the different PFAAs. Isomeric differences in dietary exposure between lin-PFOS and br-PFOS were suggested, as br-PFOS concentrations, in contrast to lin-PFOS, were not associated with SHEIA15, RADDS and consumption of different food groups. We conclude that Swedish adolescents, adhering to a diverse and healthy diet, appears to be more highly exposed to legacy PFAAs than those eating less healthy. Additional research is necessary for a better understanding of the health implications of healthy eating from a PFAA exposure perspective.			1					B	B	exposure source	10代のスウェーデン人の7種類のPFAS濃度と健康食事傾向との関係は、健康食指向ほどPFAS濃度が高かった
D1048	バイオモニタリング	Schultz A, Stanton N, Pomazal R, Lange M, Irving R, Meiman J, Shelton B, Malecki KC.	Biomonitoring of perfluoroalkyl and polyfluoroalkyl substances (PFAS) from the Survey of the Health of Wisconsin (SHOW) 2014-2016 and comparison with the National Health and Nutrition Examination Survey (NHANES)	2023	medRxiv. 2023 Feb 22:2023.02.14.23285850. doi: 10.1101/2023.02.14.23285850. Preprint.	Background: Per- and polyfluoroalkyl substances (PFAS) are a growing class of manufactured chemical compounds found in a variety of consumer products. PFAS have become ubiquitous in the environment and were found in many humans sampled in the United States (U.S.). Yet, significant gaps in understanding statewide level exposures to PFAS remain. Objective: The goals of this study are to establish a baseline of exposure at the state level by measuring PFAS serum levels among a representative sample of Wisconsin residents and compare to United States National Health and Nutrition Examination Survey (NHANES). Methods: The study sample included 605 adults (18+ years of age) selected from the 2014-2016 sample of the Survey of the Health of Wisconsin (SHOW). Thirty-eight PFAS serum concentrations were measured using high-pressure liquid chromatography coupled with tandem mass spectrometric detection (HPLC-MS/MS) and geometric means presented. Weighted geometric mean serum values of eight PFAS analytes from SHOW were compared to U.S. national levels from the NHANES 2015-2016 sample (PFOS, PFOA, PFNA, PFHxS, PFHpS, PFDA, PFUnDA), and the 2017-2018 sample for Me-PFOSA, PFHPS using the Wilcoxon rank-sum test. Results: Over 96% of SHOW participants had positive results for PFOS, PFHxS, PFHpS, PFDA, PFNA, and PFOA. In general, SHOW participants had lower serum levels across all PFAS when compared to NHANES. Serum levels increased with age and were higher among males and whites. These trends were seen in NHANES, except non-whites had higher PFAS levels at higher percentiles. Significance: Wisconsin residents may have a lower overall body burden of some PFAS compounds compared to those seen by a nationally representative sample. Additional testing and characterization may be needed in Wisconsin, particularly among non-whites and low socioeconomic status, for which the SHOW sample had less representation compared to NHANES. Impact statement: The present study conducts biomonitoring of 38 PFAS in the state of Wisconsin and suggests that while most residents of Wisconsin have detectable levels of PFAS in their blood serum, they may have a lower body burden of some PFAS compared to a nationally			1				No. D1001と重複		B	B		ウィスコンシン州の38種類のPFAS濃度測定
D1049	バイオモニタリング	中田 彩子(星薬科大学 薬品分析化学教室), 斉藤 貢一, 岩崎 雄介, 伊藤 里恵, 岸 玲子, 中澤 裕之	乳汁中ペルフルオロ化合物の定量及び母体血からの移行性	2009	分析化学(0525-1931)58巻8号 Page653-659(2009.08). doi: 10.2116/bunsekikagaku.58.653	本研究では、ペルフルオロ化合物(PFCs)の子どもへの暴露源として乳汁に着目し、高速液体クロマトグラフィー/タンデム質量分析法(LC/MS/MS)による高感度分析法を構築した。前処理にはOasis WAXによる固相抽出法を採用した。添加回収試験では、平均回収率94.3～109.0%(RSD<10.3%)と良好な結果が得られ、本法による定量限界は、ペルフルオロオクタン酸(PFOA)に関しては0.012ng/mL、ペルフルオロオクタンスルホン酸(PFOS)、ペルフルオロヘキサンスルホン酸(PFHxS)及びペルフルオロノナン酸(PFNA)では0.004ng/mLであった。本法を用いてヒト母乳、育児用粉ミルク及び牛乳の分析を行ったところ、ヒト母乳中から比較的高濃度のPFCsが検出され、その濃度範囲はPFOSで0.046～0.098ng/mL、PFOAでは0.016～0.270ng/mLであった。更に、ヒト母体血から母乳へのPFCs移行性を調べるために、母乳と同一個人から採取した母体血中のPFCs濃度を測定したところ、母体血と母乳の間には有意な相関性が示された。			1					B	B	exposure source	日本の母乳及び粉ミルクの4種類のPFAS濃度

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1050	ADME	Satbhai, K; Vogs, C; Crago, J	Comparative toxicokinetics and toxicity of PFOA and its replacement GenX in the early stages of zebrafish	2022	Chemosphere. 2022 Dec;308(Pt 1):136131. doi: 10.1016/j.chemosphere.2022.136131.	Per: and poly-fluoroalkyl substances (PFAS) are receiving attention due to their persistence, and potential adverse effects on environmental and human health. Efforts to reduce long-chained PFAS (& GE;C8) compounds were implemented in 2006 as a part of PFOA Stewardship Program Initiative (PFOA-perfluorooctanoic acid). Short -chained PFAS (8) were introduced as replacements, which were believed to have lower potential for envi-ronmental persistence and bioaccumulation. Little is known about the uptake and elimination, and potential toxic effects of these replacement compounds. Hence, it is important to compare toxicokinetics and toxicity of long-chain PFAS to their replacement compounds. To this end, zebrafish (ZF), Danio rerio, embryos were exposed to PFOA and its short-chain replacement perfluoro (2-methyl-3-oxahexanoic) acid (GenX) with the aim to assess uptake and elimination kinetics, hatching success, morphology, startle response, and survival. At 24 hpf, LC50 was 82 mu M for PFOA and 170 mu M for GenX. At 54 hpf, GenX but not PFOA showed an increase in hatching success. At 120 hpf, no statistically significant differences were seen in white light startle response below the LC50. PFAS internal concentrations were measured at 72 and 120 hpf during exposure phase, and at 168 hpf during depuration phase. GenX and PFOA internal concentrations in 120 hpf larvae exposed to highest con-centration (20 mu M) were 35.02 and 44.51 mu M, respectively. Concentrations were eliminated almost completely at 168 hpf for GenX up to 95%, while for PFOA up to 50%. As steady-state was not reached, we estimated kinetic bioconcentration factors (BCFkin). BCFkin for GenX was lower than PFOA at equimolar concentrations. How-ever, bioconcentration factors were higher at the lower exposure concentrations for both chemicals, suggesting a concentration-dependent uptake of PFASs. The predicted internal effect concentrations, accounting for the dif-ferences in bioconcentration factors, were 229 mu M for GenX and 226 mu M for PFOA, suggesting similar toxic potencies.					1			C	C		
D1051	ADME	Su, S; Jones, PD; Raine, JC; Yang, ZL; Gong, YF; Xie, YW; Tang, J; Wang, C; Zhao, XL; Giesy, JP	Absorption and elimination of per and poly-fluoroalkyl substances substitutes in salmonid species after pre-fertilization exposure	2022	Sci. Total Environ. 2022 Mar:814:152547. doi: 10.1016/j.scitotenv.2021.152547.	Due to their relatively large production and few restrictions on uses, novel substitutes for historically used per and poly-fluoroalkyl substances (PFAS) are being used and accumulating in the environment. However, due to a lack of information on their toxicological properties their hazards and risks are hard to estimate. Before fertilization, oocytes of two salmonid species, Arctic Char (Salvelinus alpinus) and Rainbow Trout (Oncorhynchus mykiss), were exposed to three PFAS substances used as substitutes for traditional PFAS, PFBA, PFBS or GenX or two archetypical, historically used, longer-chain PFAS, PFOA and PFOS. Exposed oocytes were subsequently fertilized, incubated and were sampled during several developmental stages, until swim-up. All five PFAS were accumulated into egg yolks with similar absorption rates, and their concentrations in egg yolks were less than respective concentrations in/on egg chorions. Rapid elimination of the five PFAS was observed during the first 3 days after fertilization. Thereafter, amounts of PFOS and PFOA were stable until swim-up, while PFBA, PFBS and GenX were further eliminated during development from one month after the fertilization to swim-up. In these two salmonid species, PFBA, PFBS and GenX were eliminated faster than were PFOS or PFOA.	1			1	1			B	C		
D1052	ADME	Alesio, JL; Slitt, A; Bothun, GD	Critical new insights into the binding of poly- and perfluoroalkyl substances (PFAS) to albumin protein	2022	Chemosphere. 2022 Jan;287(Pt 1):131979. doi: 10.1016/j.chemosphere.2021.131979.	With an increasing number of health-related impacts of per- and polyfluoroalkyl substances (PFAS) being reported, there is a pressing need to understand PFAS transport within both the human body and the environment. As proteins can serve as a primary transport mechanism for PFAS, understanding PFAS binding to proteins is essential for predictive physiological models where accurate values of protein binding constants are vital. In this work we present a critical analysis of three common models for analyzing PFAS binding to bovine serum albumin (BSA) based on fluorescence quenching: the Stern-Volmer model, the modified Stern-Volmer model, and the Hill equation. The PFAS examined include perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluorobutanesulfonic acid (PFBS), perfluorohexanesulfonic acid (PFHxS), perfluorooctanesulfonic acid (PFOS), and the replacement compound 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy) propanoate (HFPO-DA or GenX). While all three models capture the general effects of hydrophobicity and steric limitations to PFAS binding, the Hill equation highlighted a unique relationship between binding cooperativity and the number of fluorinated carbons, with PFOA exhibiting the greatest binding cooperativity. The significance of steric limitations was confirmed by comparing results obtained by fluorescence quenching, which is an indirect method based on specific binding, to those obtained by equilibrium dialysis where PFAS binding directly correlated with traditional measures of hydrophobicity. Finally, the binding constants were correlated with PFAS physicochemical properties where van der Waals volume best described the steric limitations observed by fluorescence quenching.			1	1	1			C	B		
D1053	ADME	You, D; Chang, XC; Guo, LJ; Xie, W; Huang, SP; Li, X; Chai, HL; Wang, YJ	Per- and polyfluoroalkyl substances (PFASs) in the blood of police and Beagle dogs from Harbin, China: Concentrations and associations with hematological parameters	2022	Chemosphere. 2022 Jul:299:134367. doi: 10.1016/j.chemosphere.2022.134367.	Per-and polyfluoroalkyl substances (PFASs) have been omnipresent in the environment and marine organisms. However, little is known about these compounds and their associations with hematological parameters in dogs. In this research, we investigated the concentrations and distributions of PFASs in the blood of dogs and explored the associations between PFASs concentrations in blood and hematological parameters. Perfluorooctanoate (PFOA) was found to be the dominant PFAS in the blood (54.23%), followed by perfluorobutyric acid (PFBA) (16.05%) and perfluorooctanesulfonate (PFOS) (12.05%). On average, PFASs concentration in dogs was 3.553 ng/mL (SD: 2.146). Moreover, age is a key factor influencing the levels of PFBA, PFOA, and PFBS in males, as well as seven PFASs (6:2 Cl-PFESA, PFBA, PFOA, PFOS, PFHxS, PFDA, and PFNA) in female dogs' blood. The results revealed that PFHxS in dietary food accounted for most of the total daily PFASs consumption. We also discovered that greater PFASs exposure (including PFOA and PFOS) could significantly increase amylase (AMY) and decrease cholesterol (CHOL) levels. Furthermore, there are linear relationships between PFDA, PFNA and many biochemical parameters (AMY, CHOL, albumin/globulin (A/G), blood urea nitrogen (BUN), alkaline phosphatase (ALP), creatinine (CREA)). Thus, PFAS accumulation has a certain influence on dogs' health, and we must pay attention to the potential threat posed by these elements to dogs.								C	B		
D1054	ADME	Siddiqui, S; Fitzwater, M; Scarpa, J; Conkle, JL	Comparison of bioconcentration and kinetics of GenX in tilapia Oreochromis mossambicus in fresh and brackish water	2022	Chemosphere. 2022 Jan;287(Pt 3):132289. doi: 10.1016/j.chemosphere.2021.132289.	Contaminants of emerging concern (CEC) are a broad suite of chemicals commonly found in the environment, aquatic organisms and even drinking water. They include pharmaceuticals, personal care products, industrial chemicals and compounds added to consumer products. The CEC ammonium 2,3,3,3-tetrafluoro-2-heptafluoropropoxy propanoic acid, which is more commonly known as generic name GenX, is a replacement of common processing aid longer chain perfluorinated compounds (PFAS) due to a manufacturing shift in 2002 following the EPA stewardship program of 2015/16 in USA (USEPA, 2006). However, recently reported in North Carolina drinking water, GenX raising concerns about its accumulation in aquatic organisms, both wild and cultured, which could be a pathway for human exposure. To examine GenX accumulation and potential for human exposure, tilapia (Oreochromis mossambicus) fingerlings were dosed with GenX for up to 96 h in fresh (0 ppt) or brackish (16 ppt) water to determine uptake and bioconcentration. Depuration values were also determined after a 96 h exposure followed by 96 h without exposure. Bioconcentration was in decreasing order of plasma > liver > carcass > muscle, with higher distribution to liver followed by carcass and muscle. Muscle was found to have the highest half-life (1278 h) followed by carcass (532 h), plasma (106 h), and liver (152 h). The rate of uptake and depuration was positively affected by the salinity. As bioconcentration in all tissues increased with increasing salinity, this may raise concern for marine organisms and human exposure.					1			C	C		
D1055	ADME	Hvizdak, M; Kandel, SE; Work, HM; Gracey, EG; McCullough, RL; Lampe, JN	Per- and polyfluoroalkyl substances (PFAS) inhibit cytochrome P450 CYP3A7 through direct coordination to the heme iron and water displacement	2023	J. Inorg. Biochem. 2023 Mar:240:112120. doi: 10.1016/j.jinorgbio.2023.112120.	Per- and polyfluoroalkyl substances (PFAS) are a chemical class of highly stable, fluorinated compounds popular for use in a variety of consumer products. PFAS environmental persistence in drinking water contributes to acute exposure in humans and subsequent bioaccumulation of the compounds in the liver and lung tissue. Prenatal PFAS exposure has been associated with lowered birth weight, premature birth, and developmental defects including cranio-facial abnormalities. The cytochrome P450 enzyme CYP3A7 is responsible for facilitating a variety of reactions essential for proper fetal development in humans. In addition to drug metabolism, CYP3A7 is responsible for metabolizing endogenous ligands in the developing human liver, including the steroid precursor dehydroepiandrosterone 3-sulfate (DHEA-S), essential for estriol synthesis during pregnancy, along with the morphogen all-trans-retinoic acid (atRA). Interference with estriol synthesis during pregnancy, as well as atRA clearance, is known to result in similar effects associated with prenatal PFAS exposure including lowered birth weight, premature birth, and developmental defects. We hypothesized that PFAS compounds bind to the CYP3A7 enzyme resulting in its inhibition. We implemented a series of binding studies using spectral characterization of six PFAS compounds (PFOA, PFOS, GenX, PFNA, PFNS, and PFHxS), and evaluated their interactions with re-combinant CYP3A7. In addition, we screened PFAS for their ability to inhibit CYP3A7 oxidative activity using dibenzylfluorescein, a fluorescent probe, and DHEA-S, an endogenous substrate of CYP3A7. Our data demon-strate that of the six PFAS tested, PFOA, PFOS, PFNA, and PFHxS bind to and inhibit CYP3A7.			1		1			B	C		
D1056	ADME	Delva-Wiley, J; Jahan, I; Newman, RH; Zhang, LF; Dong, M	Computational Analysis of the Binding Mechanism of GenX and HSA	2021	ACS Omega. 2021 Nov:6(43):29166-29170. doi: 10.1021/acsomega.1c04592.	One PFOS alternative, ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy) propanoate, known as GenX, was created to replace one of the original PFAS. This small and tough molecule has been found in surface water, groundwater, drinking water, rainwater, and air emissions in some areas in the United States. Recently, GenX has been shown to have an impact on several disease-related proteins in humans, and just like PFOS, it binds to human protein human serum albumin (HSA). In this paper, we reported four binding sites of GenX on HSA protein via docking and molecular dynamics simulation.					1			C	B		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1057	ADME	Pizzurro, DM; Seeley, M; Kerper, LE; Beck, BD	Interspecies differences in perfluoroalkyl substances (PFAS) toxicokinetics and application to health-based criteria	2019	Regul. Toxicol. Pharmacol. 2019 Aug:106:239-250. doi: 10.1016/j.yrtph.2019.05.008	Toxicokinetics are important for extrapolating health effects and effect levels observed in laboratory animals to humans for purposes of establishing health-based criteria. We conducted a comprehensive review of key absorption, distribution, metabolism, and excretion (ADME) parameters across different mammalian species for five perfluoroalkyl substances (PFAS) and discussed how these data can be used to inform human health risk assessment of these substances. Our analysis revealed several notable differences among the different PFAS regarding species- and substance-specific tissue partitioning, half-life, and transfer to developing offspring via the placenta or lactation, as well as highlighted data gaps for certain substances. We incorporated these observations in an analysis of whether health-based values for specific PFAS can be applied to other PFAS of differing chain length or toxicological mode of action. Overall, our analysis provides one of the first syntheses of available empirical PFAS toxicokinetic data to facilitate interpreting human relevance of animal study findings and developing health-based criteria for PFAS from such studies.								D	B	PFASのTK試験に関する知見であるが対象化合物のデータが不明	PFBS, PFBAあり
D1058	ADME	Rice, PA; Cooper, J; Koh-Fallet, SE; Kabadi, SV	Comparative analysis of the physicochemical, toxicokinetic, and toxicological properties of ether-PFAS	2021	Toxicol. Appl. Pharmacol. 2021 Jul:422:115531. doi: 10.1016/j.taap.2021.115531.	Perfluoropolyethers, also known as ether-PFAS, are linear or branched alkyl ether polymers, where the substituent hydrogens on the carbon atoms in the chain have been fully replaced by fluorine atoms. Some of these molecules may have a carboxylate functional group attached to one of the terminal carbon atoms to form an ether-PFAS carboxylate. Perfluoropolyethers are used as processing aids in the manufacture of various types of perfluorinated polymeric materials which are used in a variety of consumer applications. Although the physicochemical and toxicological properties of certain perfluoropolyether compounds have been extensively studied, data are relatively sparse for some members of this class of compounds. Moreover, the physicochemical, toxicokinetic, and toxicological properties of ether-PFAS as a class have not been elucidated in previous comprehensive review articles. This article reviews the nomenclature and uses of ether-PFAS and compares the physicochemical properties, toxicokinetic characteristics, apical effects in toxicological studies, and doseresponse profiles across four specific ether-PFAS compounds. This comparison, including a description of identified data gaps should help to inform the design of studies to further elucidate the characteristics of etherPFAS and to propose potential read-across assessment strategies for members of this class.								C	B		
D1059	ADME	Appel, M; Forsthuber, M; Ramos, R; Widhalm, R; Granitzer, S; Uhl, M; Hengstschlager, M; Stamm, T; Gundacker, C	The transplacental transfer efficiency of per- and polyfluoroalkyl substances (PFAS): a first meta-analysis	2022	J. Toxicol. Env. Health-Pt b-Crit. Rev. 2022 Jan:25(1):23-42. doi: 10.1080/10937404.2021.2009946.	Per- and polyfluorinated substances (PFAS), ubiquitously present in the environment and biota, are transferred to the fetus via the placenta. PFAS can be distinguished, among other things, by their different carbon chain lengths and functional groups. The aim of this study was to provide comprehensive evidence on PFAS transfer rates across the human placental barrier by means of a meta-analysis based upon a systematic review. The available literature up to April 2021 was reviewed and transplacental transfer efficiencies (TTEs) of PFAS assessed. A total of 39 studies reporting data on 20 PFAS were included in the systematic review. Of these, 20 studies with data on 19 compounds were included in the meta-analysis. Comprehensive Meta-Analysis (CMA v3.0) was used for quantitative, statistical analyses with random effects models. A curvilinear relationship was found with short and long chains of perfluorocarboxylic acids (PFCAs) exhibiting higher TTE than compounds with intermediate chain length. Among the less well studied PFAS, perfluorohexanoic acid (PFHxA), 6:2 fluorotelomersulfonic acid (6:2 FTS) and perfluorobutanoic acid (PFBA) stood out the most with a high TEEs. The dependence of TTEs on chain length and functional group is clearly shown in this first meta-analysis on PFAS transfer across the human placenta. More data on effects of less well studied PFAS in pregnant women and neonates are needed to assess the potential risk for fetal exposure.	1	1					1	A	A	ヒト胎盤関門移行性に関する知見	
D1060	ADME	Cai, D; Li, QQ; Chu, C; Wang, SZ; Tang, YT; Appleton, AA; Qiu, RL; Yang, BY; Hu, LW; Dong, GH; Zeng, XW	High trans-placental transfer of perfluoroalkyl substances alternatives in the matched maternal-cord blood serum: Evidence from a birth cohort study	2020	Sci. Total Environ. 2020 Feb:705:135885. doi: 10.1016/j.scitotenv.2019.135885.	Background: Recent studies suggest that perfluoroalkyl substances (PFAS) and PFAS alternatives can cross the placental barrier. However, little is known on the differential patterns of trans-placental transfer (TPT) among conventional PFAS and PFAS alternatives in epidemiological study. Objectives: We aimed to characterize comprehensive TPT patterns in conventional PFAS and PFAS alternatives using matched maternal-cord blood serum from a birth cohort. Methods: A total of 424 mother-fetus pairs were recruited from the Maoming Birth Cohort during 2015-2018. We detected 20 PFAS in cord and maternal serum using an ultraperformance liquid chromatography tandem mass spectrometry (UPLC-MS/MS). TPT of PFAS was calculated via cord to maternal scrum concentration ratios. Results: Both of PFOS alternatives (chlorinated polyfluorinated ether sulfonates, Cl-PFESAs) and PFOA short-chain alternative (perfluorobutanoic acid, PFBA) were widely detected in the cord and maternal scrum. In cord serum, the predominant PEAS was Pros (1.93 ng/mL), followed by PFBA (1.45 ng/mL), PFOA (0.75 ng/mL) and 6:2 Cl-PFESA (0.32 ng/mL). We found that the PEAS alternatives had higher TPT than Pros and PFOA, such as PFBA vs. PFOA (median: 1.41 vs. 0.73, P < 0.001) and 8:2 Cl-PFESA vs. PFOS (median: 0.98 vs. 0.42,P< 0.001). Moreover, the TPT of 8:2 Cl-PFESA was higher than the precursor, linear and isomeric PFOS, respectively (P< 0.01). Furthermore, we found a U-shaped pattern for TPT in perfluorocarboxylic acid compounds (PFCAs) across different length of carbon chain. Conclusion: Our findings suggest that PEAS alternatives may be more easily across the placenta than conventional PFAS. Given the widespread usage of PFAS alternatives, our results indicate that more research is needed to assess the potential health risks of prenatal exposure to PFAS alternatives in children.	1						1	A	A	ヒト胎盤関門移行性に関する知見	
D1061	ADME	Khalil, N; Lee, M; Steenland, K	Epidemiological Findings	2015	MOLEC INTEGR TOXICOL. 2015, 305-335. doi: 10.1007/978-3-319-15518-0_13	Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are man-made compounds which have been extensively used over the past 60 years. They are detectable globally in humans and animals. Among several PFAS compounds, perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorohexane sulfonate (PFHxS), and perfluorononanoic acid (PFNA) have been most examined in epidemiological studies. In the United States PFOS is found at the highest levels in human serum, followed by PFOA. Median human serum levels are dropping for most PFAS in the US since phase out of production, but they are still being used in manufacturing a variety of products. PFHxS has a much longer elimination half-life [geometric mean: GM (GM: 7.3 years)] than PFOS (GM: 4.8 years) or PFOA (GM: 3.5 years). Serum PFOA concentration has been linked with increased serum lipids, and uric acid levels in occupational cohorts, a highly exposed community population, and general population studies. PFAS exposure has also been associated with adverse effects on thyroid homeostasis, liver enzymes, osteoarthritis, non-malignant kidney disease, and immunotoxicity, in some studies but the associations are inconsistent. Data are sparse but largely negative for Type 2 diabetes neurodegenerative disease, children's cognition, adult CVD and stroke, immune function, liver disease, and obesity. Despite a large body of literature, and some positive findings regarding low birth weight, the data are overall inconsistent regarding reproductive/developmental outcomes in relation to PFAS. In conclusion current epidemiologic evidence suggests that there is an association between PFOA and six health outcomes: high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer, and pregnancy-induced hypertension, although some of the findings come from only one large longitudinal study of a high exposed population, and have not been replicated elsewhere. Data remains limited for health effects of other PFAS. Longitudinal studies in populations with exposure above general background levels are needed to corroborate these results and increase our understanding of PFAS exposure and health outcomes.			1			原著確認段階で疫学総説のため対象外とした		A	A	ヒト血清濃度、半減期に関する知見	
D1062	ADME	Zhao, SY; Liu, TQ; Zhu, LY; Yang, LP; Zong, Y; Zhao, HT; Hu, LH; Zhan, JJ	Formation of perfluorocarboxylic acids (PFCAs) during the exposure of earthworms to 6:2 fluorotelomer sulfonic acid (6:2 FTSA)	2021	Sci. Total Environ. 2021 Mar:760:143356. doi: 10.1016/j.scitotenv.2020.143356.	6:2 fluorotelomer sulfonic acid (6:2 FTSA) is a novel perfluorooctane sulfonate (PFOS) alternative used globally in aqueous film forming foams (AFFFs). Although 6:2 FTSA has been recently detected in the environment, its fate in terrestrial invertebrates remains unclear. The uptake, elimination and biotransformation of 6:2 FTSA in earthworms (Eisenia fetida) were investigated after in vivo and in vitro exposure. 6:2 FTSA could be biodegraded by microorganismsin soil to trifluoroacetic acid (TFA), perfluoropropionic acid (PFPrA), perfluorobutanoic acid (PFBA), perfluoropentanoic acid (PFPeA) and perfluorohexanoic acid (PFHxA). The uptake rate constant (k(u)) and biotato-soil accumulation factor (BSAF) of 6:2 FTSA in earthworms were 0.185 g(oc)/g(ww)/d and 0.685 g(oc)/g(ww), respectively, indicating high bioaccumulative ability in earthworms. Five terminal perfluorocarboxylic acids (PFCAs) metabolites, including TFA, PFPrA, PFBA, PFPeA and PFHxA were observed in both in vivo and in vitro exposure tests, with TFA as the predominant metabolite. However, no perfluoroheptanoic acid (PFHpA) was observed in the present study. The elimination rate constants (ke) increased in the order: 6:2 FTSA (0.057/d) < TFA (0.058/d) < PFPrA (0.071/d) < PFBA (0.084/d) < PFHxA (0.182/d) < PFPeA (0.193/d). Biodegradation of 6:2 FTSA in the earthworm homogenates, cytolchrome P450 (CYP450) enzyme solutions and glutathione-s-transferase (GST) enzyme solutions fitted well with the first order kinetics. The biotransformation rate constants (k) were in the following order: homogenates (0.012/h) > CYP450 (0.009/h) > GST (0.007/h), implying that CYP450 and GST were involved in biotransformation of 6:2 FTSA in earthworms. This study provides important theoretical evidence for the fate of 6:2 FTSA in earthworms.	1	1						C	C		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1063	ADME	Lu, Y; Meng, LY; Ma, DH; Cao, HM; Liang, Y; Liu, HW; Wang, YW; Jiang, GB	The occurrence of PFAS in human placenta and their binding abilities to human serum albumin and organic anion transporter 4	2021	Environ. Pollut. 2021 Mar:273:116460. doi: 10.1016/j.envpol.2021.116460.	Both legacy and emerging per- and polyfluoroalkyl substances (PFAS) have been found to be threats to human health. In particular, fetuses are sensitive to xenobiotics and the placenta functions as a significant barrier for environmental pollutants. The placental transfer of PFAS is closely related to their interactions with proteins. In this study, 54 human placental samples were collected to investigate the occurrence of legacy and emerging PFAS in human placenta, including perfluorinated carboxylates (PFCAs), perfluorinated sulfonates (PFSAs), chlorinated polyfluoroalkyl ether sulfonic acids (Cl-PFESAs), and fluorotelomer sulfonates (FTSAs). Among the legacy PFAS, perfluorooctanesulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA) were detected in all samples, with PFOS and PFOA being the two predominant (mean: 0.457 and 0.242 ng/g wet weight, respectively). Among the emerging PFAS, 6:2 Cl-PFESA was detected in all samples with the mean value of 0.104 ng/g wet weight, while the detect frequency (DF) of 8:2 Cl-PFESAs was only 24%. The concentration and DF of the four FTSA congeners were low in the placentas. Molecular docking calculation results showed that the binding affinities of PFAS to the human serum albumin (HSA) were increased with chain length in each category except for the PFCAs, of which the perfluoroundecanoic acid (PFUnDA) was the turning point of binding affinity to HSA. For PFSAs, their binding affinities to organic anion transporter 4 (OAT4) were increased with the chain length except for the sodium perfluoro-1-heptanesulfonate (PFHpS) and sodium perfluoro-1-nonanesulfonate (PFNS). The calculation results demonstrated that the placental transfer of PFAS is closely related to chain length. The findings in the study can help better understand the occurrence of the PFAS in the human placenta and the placental transfer mechanisms of PFAS in human beings.								A	B		
D1064	ADME	Chen, DM; Zhao, Y; Xu, W; Pan, YH; Wei, Q; Xie, SY	Biotransformation and tissue bioaccumulation of 8:2 fluorotelomer alcohol in broiler by oral exposure	2020	Environ. Pollut. 2020 Dec:267:115611. doi: 10.1016/j.envpol.2020.115611.	In order to examine whether 8:2 FTOH exposure would lead to a contamination risk of perfluoroalkyl and polyfluoroalkyl substances (PFASs) in broiler derived food, the biotransformation, and tissue distribution and accumulation of 8:2 FTOH following oral exposure in male broilers were investigated. The main metabolites of 8:2 FTOH in plasma and six tissues (muscle, liver, kidney, fat, heart, and lungs) identified by LC-Q-TOF were 2-perfluorooctyl ethanoic acid (8:2 FTCA), 8:2 fluorotelomer unsaturated carboxylic acid (8:2 FTUCA), 3-perfluoroheptyl propanoic acid (7:3 FTCA), perfluoropentanoic acid (PFPeA), perfluorooctanoic acid (PFOA), perfluoroheptanoic acid (PFHpA), perfluorohexanoic acid (PFHxA), perfluorononanoic acid (PFNA), 8:2 FTOH glucuronide conjugate, and 8:2 FTOH sulfate conjugate. The tissue distribution and bioaccumulation of 8:2 FTOH and its unconjugated metabolites were determinated by LC-MS/MS. 8:2 FTOH was quickly depleted in plasma and all six tested tissues, while PFOA, PFNA, and 7:3 FTCA showed strong accumulation in blood and all six examined tissues and were eliminated more slowly than the other metabolites. The tissues with the highest accumulation levels for 8:2 FTOH and its metabolites were heart, kidneys and liver, and the tissue with the lowest accumulation levels was muscle. The elimination half-lifes of PFNA in kidney and 7:3 FTCA in lung were longer compared to those of other metabolites in all six determined tissues. Thus, PFNA and 7:3 FTCA can be selected as potential biomonitoring markers after 8:2 FTOH exposure. This study has improved our understanding of 8:2 FTOH biotransformation and tissue bioaccumulation in broilers, which will help us monitor human exposure risk via food derived from broilers polluted by 8:2 FTOH.		1	1					B	C		
D1065	ADME	Chen, HL; Wang, QY; Cai, YP; Yuan, RF; Wang, F; Zhou, BH	Investigation of the Interaction Mechanism of Perfluoroalkyl Carboxylic Acids with Human Serum Albumin by Spectroscopic Methods	2020	Int. J. Environ. Res. Public Health. 2020 Feb;17(4):1319. doi: 10.3390/ijerph17041319.	Perfluoroalkyl carboxylic acids (PFCAs) are some of the most significant pollutants in human serum, and are reported to be potentially toxic to humans. In this study, the binding mechanism of PFCAs with different carbon lengths to human serum albumin (HSA) was studied at the molecular level by means of fluorescence spectroscopy under simulated physiological conditions and molecular modeling. Fluorescence data indicate that PFCAs with a longer carbon chain have a stronger fluorescence quenching ability. Perfluorobutanoic acid (PFBA) and perfluorohexanoic acid (PFHxA) had little effect on HSA. Fluorescence quenching of HSA by perfluorooctanoic acid (PFOA) and perfluorodecanoic acid (PFDA) was a static process that formed a PFCA-HSA complex. Electrostatic interactions were the main intermolecular forces between PFOA and HSA, while hydrogen bonding and van der Waals interactions played important roles in the combination of PFDA and HSA. In fact, the binding of PFDA to HSA was stronger than that of PFOA as supported by fluorescence quenching and molecular docking. In addition, infrared spectroscopy demonstrated that the binding of PFOA/PFDA resulted in a sharp decrease in the beta-sheet and alpha-helix conformations of HSA. Our results indicated that the carbon chain length of PFCAs had a great impact on its binding affinity, and that PFCAs with longer carbon chains bound more strongly.	1	1						B	B		
D1066	PBPK	Chiu, WA; Lynch, MT; Lay, CR; Antezana, A; Malek, P; Sokolinski, S; Rogers, RD	Bayesian Estimation of Human Population Toxicokinetics of PFOA, PFOS, PFHxS, and PFNA from Studies of Contaminated Drinking Water	2022	Environ. Health Perspect. 2022 DEC;130(12):127001. doi: 10.1289/EHP10103.	BACKGROUND: Setting health-protective standards for poly-and perfluoroalkyl substances (PFAS) exposure requires estimates of their population toxicokinetics, but existing studies have reported widely varying PFAS half-lives (T1/2) and volumes of distribution (Vd).OBJECTIVES: We combined data from multiple studies to develop harmonized estimates of T1/2 and Vd, along with their interindividual variability, for four PFAS commonly found in drinking water: perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA), and perfluorohexane sulfonate (PFHxS).METHODS: We identified published data on PFAS concentrations in human serum with corresponding drinking water measurements, separated into training and testing data sets. We fit training data sets to a one-compartment model incorporating interindividual variability, time-dependent drinking water concentrations, and background exposures. Use of a hierarchical Bayesian approach allowed us to incorporate informative priors at the population level, as well as at the study level. We compared posterior predictions to testing data sets to evaluate model performance.RESULTS: Posterior median (95% CI) estimates of T1/2 (in years) for the population geometric mean were 3.14 (2.69, 3.73) for PFOA, 3.36 (2.52, 4.42) for PFOS, 2.35 (1.65, 3.16) for PFNA, and 8.30 (5.38, 13.5) for PFHxS, all of which were within the range of previously published values. The extensive individual-level data for PFOA allowed accurate estimation of population variability, with a population geometric standard deviation of 1.57 (95% CI: 1.42, 1.73); data from other PFAS were also consistent with this degree of population variability. Vd estimates ranged from 0.19 to 0.43 L/kg across the four PFAS, which tended to be slightly higher than previously published estimates.DISCUSSION: These results have direct application in both risk assessment (quantitative interspecies extrapolation and uncertainty factors for interindividual variability) and risk communication (interpretation of monitoring data). In addition, this study provides a rigorous methodology for further refinement with additional data, as well as application to other PFAS.			1				1	A	A	飲料水濃度、ヒト半減期に関する知見	
D1067	ADME	Burkemper, JL; Aweda, TA; Rosenberg, AJ; Lunderberg, DM; Peaslee, GF; Lapi, SE	Radiosynthesis and Biological Distribution of F-18-Labeled Perfluorinated Alkyl Substances	2017	Environ. Sci. Technol. Lett. 2017 Jun;4(6):211-215. doi: 10.1021/acs.estlett.7b00042.	A novel method for radiolabeling perfluorinated alkyl substances (PFAS) with fluorine 18 has been developed, and after purification, the stability and biological distribution in healthy mice were evaluated. Three PFAS, [F-18]PFOA (C8), [F-18]PFHxA (C6), and [F-18]PFBA (C4), were readily labeled and isolated in average yields between 12 and 31%. The stability of each compound was monitored in 0.1% ammonium hydroxide (NH4OH) in methanol, in saline, and in human, mouse, and rat sera. The amount of intact, radiolabeled PFAS was determined by radiometric instant thin layer chromatography and was calculated by the amount of free fluorine 18 observed over time. All compounds were highly stable in 0.1% NH4OH in methanol and saline, with <10% defluorination observed after 4 h. Interestingly, each compound had differing affinities for the serum proteins. In vivo biodistribution studies in mice showed uptake in all organs examined, with the highest uptake being exhibited in the liver for both [F-18]PFOA and [F-18]PFHxA and the stomach for [F-18]PFBA. The results of this initial study suggest that this method could be valuable in helping to determine the biological uptake of any PFAS in mammals.	1	1						A	B	マウスにおける組織分布に関する知見	
D1068	ADME	Drew, R; Hagen, TG; Champness, D; Sellier, A	Half-lives of several polyfluoroalkyl substances (PFAS) in cattle serum and tissues	2022	Food Addit. Contam. Part A-Chem. 2022 Feb:39(2):320-340. doi: 10.1080/19440049.2021.1991004.	Cattle that were at steady-state serum polyfluoroalkyl substances (PFAS) concentrations due to several years of exposure to water contaminated by residues of Aqueous Film-Forming (AFFF) firefighting foam had perfluorooctane sulphonate (PFOS) isomers, perfluoroheptane sulphonate (PFHpS), perfluorohexane sulphonate (PFHxS), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) in serum. Elimination serum half-lives were determined in five heifers from serial blood sampling over 215 days. Eleven additional animals that had blood sampled on day 19 (d19) were euthanised on d63. PFAS half-life estimates from the serial blood sampling and from d19/d63 data were not significantly different. The combined (n = 16) serum half-lives (in days) were: total PFOS (tPFOS, 74.1 +/- 13.4), PFHpS (45.7 +/- 9.4), PFHxS (9.3 +/- 1.3), PFNA (12.3 +/- 3.2) and PFDA (60.4 +/- 10.4). The half-lives of linear PFOS (L-PFOS, 69.4 +/- 11.6) and mono branched PFOS isomers (m-PFOS, 83.6 +/- 19) were not significantly different from tPFOS, but for the di-branched isomers (di-PFOS), the serum half-life was significantly lower (29.9 +/- 5.8). Animal age (1.4-12.3 years old) and serum concentration at the start of depuration did not influence half-lives, and there was no difference between steers and heifers. Consideration of serum and tissue PFAS concentrations at d63 and d215 indicated there was no difference in tPFOS depuration from serum or muscle, but elimination from liver and kidney may be slightly longer. Depuration of PFHpS is essentially the same in serum, kidney and liver, and it is expected depletion from muscle would be comparable. The short half-life of di-PFOS, PFHxS and PFNA did not allow an assessment of clearance from tissues because they were not measurable at d215 but based on the results for PFOS and PFHpS, elimination of PFHxS from tissues is expected to mirror that from serum. Human health risk assessment implications are discussed.			1					B	C		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1069	ADME	Fedorenko, M; Alesio, J; Fedorenko, A; Slitt, A; Bothun, GD	Dominant entropic binding of perfluoroalkyl substances (PFASs) to albumin protein revealed by F-19 NMR	2021	Chemosphere. 2021 Jan:263:128083. doi: 10.1016/j.chemosphere.2020.128083.	Mechanistic insight into protein binding by poly- and perfluoroalkyl substances (PFASs) is critical to understanding how PFASs distribute and accumulate within the body and to developing predictive models within and across classes of PFASs. Fluorine nuclear magnetic resonance spectroscopy (F-19 NMR) has proven to be a powerful, yet underutilized tool to study PFAS binding; chemical shifts of each fluorine group reflect the local environment along the length of the PFAS molecule. Using bovine serum albumin (BSA), we report dissociation constants, Kd, for four common PFASs well below reported critical micelle concentrations (CMCs) - perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), and perfluorooctanesulfonic acid (PFOS) - as a function of temperature in phosphate buffered saline. Kd values were determined based on the difluoroethyl group adjacent to the anionic headgroups and the terminal trifluoromethyl groups. Our results indicate that the hydrophobic tails exhibit greater binding affinity relative to the headgroup, and that the binding affinities are generally consistent with previous results showing that greater PFAS hydrophobicity leads to greater protein binding. However, the binding mechanism was dominated by entropic hydrophobic interactions attributed to desolvation of the PFAS tails within the hydrophobic cavities of the protein and on the surface of the protein. In addition, PFNA appears to form hemimicelles on the protein surfaces below reported CMC values. This work provides a renewed approach to utilizing F-19 NMR for PFAS-protein binding studies and a new perspective on the role of solvent entropy.			1					B	C		
D1070	ADME	Bogdanska, J; Borg, D; Bergstrom, U; Mellring, M; Bergman, A; DePierre, J; Nobel, S	Tissue distribution of C-14-labelled perfluorooctanoic acid in adult mice after 1-5 days of dietary exposure to an experimental dose or a lower dose that resulted in blood levels similar to those detected in exposed humans	2020	Chemosphere. 2020 Jan:239:124755. doi: 10.1016/j.chemosphere.2019.124755.	Perfluorooctanoic acid (PFOA), a global environmental pollutant detected in both wildlife and human populations, has several pathophysiological effects in experimental animals, including hepatotoxicity, immunotoxicity, and developmental toxicity. However, details concerning the tissue distribution of PFOA, in particular at levels relevant to humans, are lacking, which limits our understanding of how humans, and other mammals, may be affected by this compound. Therefore, we characterized the tissue distribution of C-14-PFOA in mice in the same manner as we earlier examined its analogues perfluorooctanesulfonate (PFOS) and perfluorobutanesulfonate (PFBS) in order to allow direct comparisons. Following dietary exposure of adult male C57/BL6 mice for 1, 3 or 5 days to a low dose (0.06 mg/kg/day) or a higher experimental dose (22 mg/kg/day) of C-14-PFOA, both scintillation counting and whole-body autoradiography revealed the presence of PFOA in most of the 19 different tissues examined, demonstrating its ability to leave the bloodstream and enter tissues. There were no differences in the pattern of tissue distribution with the low and high dose and the tissue-to-blood ratios were similar. At both doses, PFOA levels were highest in the liver, followed by blood, lungs and kidneys. The body compartments estimated to contain the largest amounts of PFOA were the liver, blood, skin and muscle. In comparison with our identical studies on PFOS and PFBS, PFOA reached considerably higher tissue levels than PFBS, but lower than PFOS. Furthermore, the distribution of PFOA differed notably from that of PFOS, with lower tissue-to-blood ratios in the liver, lungs, kidneys and skin.				1				A	B	マウスにおける組織分布に関する知見	
D1071	ADME	Mamsen, LS; Jonsson, BAG; Lindh, CH; Olesen, RH; Larsen, A; Ernst, E; Kelsey, TW; Andersen, CY	Concentration of perfluorinated compounds and cotinine in human foetal organs, placenta, and maternal plasma	2017	Sci. Total Environ. 2017 Oct:596:97-105. doi: 10.1016/j.scitotenv.2017.04.058	Background: Perfluoroalkyl substances (PFASs) are bio-accumulative pollutants, and prenatal exposure to PFASs is believed to impact human foetal development and may have long-term adverse health effects later in life. Additionally, maternal cigarette smoking may be associated with PFAS levels. Foetal exposure has previously been estimated from umbilical cord plasma, but the actual concentration in foetal organs has never been measured. Objectives: The concentrations of 5 PFASs and cotinine - the primary metabolite of nicotine - were measured in human foetuses, placentas, and maternal plasma to evaluate to what extent these compounds were transferred from mother to foetus and to determine if the PFAS concentrations were associated with maternal cigarette smoking. Methods: Thirty-nine Danish women who underwent legal termination of pregnancy before gestational week 12 were included; 24 maternal blood samples were obtained together with 34 placental samples and 108 foetal organs. PFASs and cotinine were assayed by liquid chromatography/triple quadrupole mass spectrometry. Results: In foetal organs, the average concentrations of perfluorooctanesulphonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluoroundecanoic acid (PFUnDa), and perfluorodecanoic acid (PFDA) were 0.6 ng/g, 0.2 ng/g, 0.1 ng/g, 0.1 ng/g, and 0.1 ng/g, respectively. A significant positive correlation was found between the exposure duration, defined as foetal age, and foetal to maternal ratio for all five PFASs and cotinine. Smokers presented 99 ng/g cotinine in plasma, 108 ng/g in placenta, and 61 ng/g in foetal organs. No correlation between the maternal cotinine concentrations and PFAS concentrations was found. Conclusions: PFASs were transferred from mother to foetus, however, with different efficiencies. The concentrations of PFOS, PFOA, PFNA, PFUnDA, and PFDA in foetal organs were much lower than the maternal concentrations. Furthermore, a significant correlation between the exposure duration and all of the evaluated PFASs was found. The health-compromising concentrations of these substances during foetal development are unknown.			1					A	B	ヒト胎児移行に関する知見	
D1072	ADME	Drew, R; Hagen, TG; Champness, D	Accumulation of PFAS by livestock - determination of transfer factors from water to serum for cattle and sheep in Australia	2021	Food Addit. Contam. Part A-Chem. 2021 Nov:38(11):1897-1913. doi: 10.1080/19440049.2021.1942562.	In this study accumulation has been determined of several per- and polyfluoroalkyl substances (PFAS) from ingested water to steady state serum concentration for adult beef cattle and sheep raised on a hobby farm impacted by PFAS contamination. PFAS concentrations in stock water were stable for more than a year, they were non-measurable in grass but present at very low levels in soil which equated to just 1% of the intake from water. Prior to quantifying PFAS in cattle serum there had been no breeding for 18 months. Although there were high concentrations of several PFAS in the water, only perfluorooctane sulphonate (PFOS) and perfluorohexane sulphonate (PFHxS) were in cattle serum in appreciable amounts; perfluoroheptane sulphonate (PFHpS), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) were much lower. Transfer factors (TFs) for cattle were calculated by dividing steady state serum concentration (ng PFAS/mL) by water concentration (mu g PFAS/L). Average and upper estimate TF values for cattle were calculated; the former were 140 (total PFOS, i.e. tPFOS), 130 (PFHpS), 65 (PFHxS), 170 (PFNA), and 120 (PFDA). Previous investigation campaigns at the farm provided relative steady state serum PFAS concentrations for sheep and cattle that allowed adjustment of the cattle TFs. The resulting average estimate TFs for ewes (non-pregnant and not lactating) were 20 (tPFOS) and 30 (PFHxS), other PFAS were not measurable in sheep serum. Discussion on using these TFs in human health risk assessments is provided. With certain assumptions/caveats the TFs allow estimations of PFAS steady state serum concentrations for use in preliminary human health risk assessments (HHRAs) when only PFAS in stock water is known.			1					B	C		
D1073	ADME	Yu, CH; Weisel, CP; Alimokhtari, S; Georgopoulos, PG; Fan, ZH	Biomonitoring: A tool to assess PFNA body burdens and evaluate the effectiveness of drinking water intervention for communities in New Jersey	2021	Int. J. Hyg. Environ. Health. 2021 Jun:235:113757. doi: 10.1016/j.ijheh.2021.113757.	Elevated perfluorononanoic acid (PFNA) levels, one of many manmade per- and polyfluoroalkyl substances (PFAS), were detected in public water systems/private wells in New Jersey communities. Interventions to end exposure through drinking water were carried out from 2014 to 2016. To evaluate the effectiveness of interventions, a community biomonitoring study was conducted for the communities between 2017 and 2020. A convenience sampling design was used with 120 participants in Year 1 between ages of 20-74 who consumed PFNA-contaminated water. Three blood samples, one year apart, were drawn from each participant and completed for 99 participants. Separated serum samples were measured for 12 PFAS including PFNA. Questionnaires were administered to collect information on demographics and potential sources. Drinking water and house dust collected at the first visit were analyzed for 14 PFAS including PFNA. The PFNA sera levels (Year 1) found 84 out of 120 (70%) participants were higher than the 95th percentile of a nationally representative sample of US adults (NHANES2015-16). Current drinking water and house dust were not significant contributing sources for the study participants. On average, PFNA sera levels were 12 +/- 16% (Year 2) and 27 +/- 16% (Year 3) lower than the level measured in Year 1 ($p < 0.01$). The PFNA half-life was estimated around 3.52 years, using a mixed model from 68 high-exposed participants (>95th percentile of NHANES2015-16) with controlling for physiological covariates. The decline in adult serum PFNA levels seen in the years following a community drinking water intervention suggests the intervention effectively reduced PFNA exposure via drinking water.			1					A	B	飲料水と曝露濃度に関する知見	
D1074	ADME	East, A; Dawson, DE; Brady, S; Vallero, DA; Tornero-Velez, R	A Scoping Assessment of Implemented Toxicokinetic Models of Per- and Polyfluoro-Alkyl Substances, with a Focus on One-Compartment Models	2023	Toxics. 2023 Feb;11(2):163. doi: 10.3390/toxics11020163.	Toxicokinetic (TK) models have been used for decades to estimate concentrations of per-and polyfluoroalkyl substances (PFAS) in serum. However, model complexity has varied across studies depending on the application and the state of the science. This scoping effort seeks to systematically map the current landscape of PFAS TK models by categorizing different trends and similarities across model type, PFAS, and use scenario. A literature review using Web of Science and SWIFT-Review was used to identify TK models used for PFAS. The assessment covered publications from 2005-2020. PFOA, the PFAS for which most models were designed, was included in 69 of the 92 papers, followed by PFOS with 60, PFHxS with 22, and PFNA with 15. Only 4 of the 92 papers did not include analysis of PFOA, PFOS, PFNA, or PFHxS. Within the corpus, 50 papers contained a one-compartment model, 17 two-compartment models were found, and 33 used physiologically based pharmacokinetic (PBTK) models. The scoping assessment suggests that scientific interest has centered around two chemicals-PFOA and PFOS-and most analyses use one-compartment models in human exposure scenarios.			1				1	A	A	1コンパートメントモデルによるTK評価に関する知見	PFNAのTK

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1075	ADME	Li, L; Xu, ZS; Song, GW	Study on the Langmuir aggregation of fluorinated surfactants on protein	2009	J. Fluor. Chem. 2009 Feb:130(2):225-230. doi: 10.1016/j.jfluchem.2008.10.007.	The microphase adsorption-spectral correction (MPASC) technique was described and applied to the study of the interactions of fluorinated surfactants such as potassium perfluorooctanesulfonate (PFOS) and potassium perfluorobutanesulfonate (PFBS) with human serum albumin (HSA). Sodium octanesulfonate (SOS) was also studied as non-fluorinated surfactant. The aggregation of PFOS, PFBS and SOS obeys the Langmuir monolayer adsorption. The results show that the adsorption ratios of surfactants to HSA are PFOS:HSA = 120:1, PFBS:HSA = 205:1 and SOS:HSA = 18:1. The adsorption constants are KPFOS-HSA = 5.01 x 10(3), KPFBS-HSA = 9.79 x 10(2) and KSOS-HSA = 4.03 x 10(3). The detection limits are 2.7 mg/L for BSA using PFOS, 3.1 mg/L using PFBS and 3.1 mg/L using SOS. It was found that fluorinated surfactant exhibited stronger interaction with protein than hydrogenated one, and fluorinated surfactant with long hydrophobic chain exhibited stronger interaction with protein than that with short hydrophobic chain.				1				C	C		
D1076	ADME	Kang, QY; Gao, FM; Zhang, XH; Wang, L; Liu, JY; Fu, M; Zhang, SY; Wan, Y; Shen, H; Hu, JY	Nontargeted identification of per- and polyfluoroalkyl substances in human follicular fluid and their blood-follicle transfer	2020	Environ. Int. 2020 Jun:139:105686. doi: 10.1016/j.envint.2020.105686.	The female reproductive toxicity of per- and polyfluoroalkyl substances (PFAS) has raised concerns, but knowledge about their human preconception exposure is limited. In this study, 15 emerging PFAS were identified in follicular fluid samples from healthy women by using high-resolution mass spectrometry, and Cl-substituted perfluoroalkyl ether sulfonates (Cl-PFESAs) including 4:2, 5:2, 6:2, and 8:2 Cl-PFESAs, 4:4 C-8 perfluoroalkyl ether sulfonate (PFESA), C-8 perfluoroalkyl ether carboxylate (PFECA), and C-8 polyether PFECA (Po-PFECA) were detected in over 50% of 28 follicular fluid samples. Ten legacy PFAS were also detected, and the geometric mean concentration of PFOS was the highest (4.82 ng/mL), followed by PFOA (4.60 ng/mL), 6:2 Cl-PFESA (1.09 ng/mL), PFHxS (0.515 ng/mL), PFNA (0.498 ng/mL), and C-8 PFECA (0.367 ng/mL). The blood-follicle transfer efficiencies for PFCAs decreased with increasing chain length (0.96 for PFHpA, 0.56 for PFTriDA), and the transfer efficiencies of C-8 PFECA (0.78) was significantly higher than that of PFOA (0.76). The transfer efficiencies of 4:2 Cl-PFESA (0.73), 6:2 Cl-PFESA (0.75) and 8:2 Cl-PFESA (0.91) were significantly higher than that (0.70) of PFOS (p = 0.028, 0.026 and 0.002, respectively). This study constitutes the first report of the human oocyte exposure to emerging PFAS and their blood-follicle transfer abilities.			1					A	B	血液ー卵胞移行に関する知見	
D1077	ADME	Vogs, C; Johanson, G; Naslund, M; Wulff, S; Sjodin, M; Hellstrandh, M; Lindberg, J; Wincent, E	Toxicokinetics of Perfluorinated Alkyl Acids Influences Their Toxic Potency in the Zebrafish Embryo (Danio rerio)	2019	Environ. Sci. Technol. 2019 Apr:53(7):3898-3907. doi: 10.1021/acs.est.8b07188.	Perfluorinated alkyl acids (PFAA) are highly persistent and bioaccumulative and have been associated with several adverse health effects. The chemical structure mainly differs in two ways: the length of the hydrophobic alkyl chain and the type of hydrophilic end group. Little is known how the chemical structure affects the toxicokinetics (TK) in different organisms. We studied the TK of four PFAA (PFOS, PFHxS, PFOA, and PFBA) with different chain lengths (4-8 carbons) and functional groups (sulfonic and carboxylic acid) in zebrafish (Danio rerio) embryo. The time courses of the external (ambient water) and internal concentrations were determined at three exposure concentrations from 2 up to 120 h postfertilization (hpf). Three of the four PFAA showed a biphasic uptake pattern with slow uptake before hatching (around 48 hpf) and faster uptake thereafter. A two-compartment TK model adequately described the biphasic uptake pattern, suggesting that the chorion functions as an uptake barrier until 48 hpf. The bioconcentration factors (BCF) determined at 120 hpf varied widely between PFAA with averages of approximately 4000 (PFOS), 200 (PFHxS), 50 (PFOA), and 0.8 (PFBA) L kg dry weight(-1), suggesting that both the alkyl chain length and the functional group influence the TK. The differences in toxic potency were reduced by 3 orders of magnitude when comparing internal effect concentrations instead of effective external concentrations.	1							C	C		
D1078	ADME	Narizzano, AM; Bohannon, ME; East, AG; McDonough, C; Choyke, S; Higgins, CP; Quinn, MJ	Patterns in Serum Toxicokinetics in Peromyscus Exposed to Per- and Polyfluoroalkyl Substances	2021	Environ. Toxicol. Chem. 2021 Oct:40(10):2886-2898. doi: 10.1002/etc.5151.	Per- and polyfluoroalkyl substances (PFAS) are compounds manufactured for use in paints, cleaning agents, fire suppressants, nonstick cookware, food containers, and water-resistant products. Concerns about PFAS stem from their ubiquitous presence in the environment, persistence, and variable/uncertain bioaccumulation and toxicity. In the present study, 5 perfluoroalkyl acids and one polyfluoroalkyl substance were administered to white-footed mice (Peromyscus leucopus) to elucidate the kinetics of each chemical over 28 d of exposure. Perfluorooctanoate, perfluorohexane sulfonate (PFHxS), and perfluorobutane sulfonate were administered to male and female mice via drinking water. Perfluorooctane sulfonate, perfluorononanoate, 6:2 fluorotelomer sulfonate, and PFHxS were administered to male and female mice via oral gavage. Blood samples collected after 14 or 21 and 28 d of exposure were analyzed for individual PFAS concentrations via liquid chromatography-tandem mass spectrometry. In general, a plateau in serum concentration in this toxicity test-relevant timeline depended on interactions between 1) the type of PFAS (i.e., perfluoroalkyl sulfonic acids [PFSAs] vs perfluoroalkyl carboxylic acids [PFCAs] vs polyfluorinated), 2) continuous versus bolus dosing, and 3) to a lesser extent, sex. Specifically, PFCAs were detected at higher concentration in females than males, whereas PFSAs were generally detected at similar levels across sex. An exception occurred when PFHxS yielded higher serum levels in males than females through bolus, but not continuous, dosing. Type of PFAS had the largest impact on serum concentrations, whereas sex had the lowest. As such, future work on the toxicokinetics of PFAS in common ecological receptors would be valuable to further explore these patterns.			1	1				A	C	マウスにおける体内動態に関する知見	マウス（ただし一般的な実験動物ではない）の実験だけど、環境影響を意図していると思われた。
D1079	ADME	Zheng, P; Liu, YX; An, Q; Yang, XM; Yin, SS; Ma, LQ; Liu, WP	Prenatal and postnatal exposure to emerging and legacy per-/polyfluoroalkyl substances: Levels and transfer in maternal serum, cord serum, and breast milk	2022	Sci. Total Environ. 2022 Mar:812:152446. doi: 10.1016/j.scitotenv.2021.152446.	Gestation and lactation are critical and vulnerable stages for fetuses and newborns. During these periods, per-/ polyfluoroalkyl substances (PFASs) accumulated in mothers can be transferred to newborns through placenta and/ or breastfeeding, causing potential health risks. To investigate the pre- and postnatal PFAS exposure of newborns, we analyzed 21 emerging and legacy PFASs in 60 sets of matched maternal serum, cord serum, and breast milk samples. In serum, perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and 6:2 chlorinated polyfluorinated ether sulfonates (6:2 Cl-PFESA) were the most predominant PFASs, while PFOA, PFOS and 6:2 fluorotelomer phosphate diester (6:2 diPAP) contributed most to breast milk. For most PFASs, the levels followed the order of maternal serum cord serum > breast milk. The 6:2 Cl-PFESA was positively associated with birth weight and ponderal index ($p < 0.05$). The breastfeeding transfer efficiencies (RBM, median: 0.02-0.10) of most PFASs were 1-2 orders of magnitude lower than transplacental transfer efficiencies (RCM, median: 0.40-1.45), except for perfluorobutanesulfonic acid (PFBS) showing high transfer efficiency both through placenta (median at 0.89) and breastfeeding (median at 0.86). The one-month postnatal exposure to PFASs via breastfeeding was much higher than prenatal exposure in utero. This study enhances the understanding of transplacental and breastfeeding transfer of PFASs and provides assessments of prenatal and postnatal exposure of newborns to emerging and legacy PFASs.				1			1	A	A	ヒト母体血清、臍帯血、母乳における濃度に関する知見	
D1080	ADME→バイオモニタリング	Guzman, MM; Clementini, C; Perez-Carceles, MD; Rejon, SJ; Cascone, A; Martellini, T; Guerranti, C; Cincinelli, A	Perfluorinated carboxylic acids in human breast milk from Spain and estimation of infant's daily intake	2016	Sci. Total Environ. 2016 Feb:544:595-600. doi: 10.1016/j.scitotenv.2015.11.059	Human milk samples were collected from 67 mothers in 2014 at a Primary Care Centre in Murcia (Spain) and analyzed for perfluorinated carboxylic acids (PFCAs). Concentrations measured for perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA) and perfluorododecanoic acid (PFDoDA) ranged from < LOQ (< 10 ng/L) to 397 ng/L with a mean concentration of 66 +/- 68 ng/L and a median of 29 ng/L. The presence of these compounds was revealed in 50 samples out of 67 analyzed. Influence of number of pregnancies and food habits on PFCAs concentrations was also investigated. Statistically significant differences in PFCA levels were found when the women were divided into maternal age classes and into the categories primiparae and multiparae. A greater transfer of PFC during breastfeeding by primiparous was evidenced and thus a higher exposure to these contaminants for the first child. Moreover, it was possible to hypothesize that the content of PFCs is in general correlated to the eating habits of donors and, in particular, with the fish consumption. Finally, PFOA daily intakes and risk index (RI) were estimated for the first six months of life and we found that ingestion rates of PFOA did not exceed the tolerable daily intake (TDI) recommended by the European Food Safety Authority (EFSA).			1					A	A	ヒト母乳における濃度に関する知見	
D1081	ADME	Ishibashi, H; Iwata, H; Kim, EY; Tao, L; Kannan, K; Amano, M; Miyazaki, N; Tanabe, S; Batoev, VB; Petrov, EA	Contamination and effects of perfluorochemicals in Baikal Seal (Pusa sibirica). 1. Residue level, tissue distribution, and temporal trend	2008	Environ. Sci. Technol. 2008 Apr:42(7):2295-2301. doi: 10.1021/es072054f.	Concentrations of perfluorochemicals (PFCs) including perfluoroalkylsulfonates (PFSAs) and perfluoroalkylcarboxylates (PFCAs) were determined in liver and serum of Baikal seals (Pusa sibirica) collected from Lake Baikal, Russia in 2005. Among the 10 PFC compounds measured, perfluorononanoic acid (PFNA, 3.3-72 ng/g wet wt) concentrations were the highest in liver, followed by perfluorooctanesulfonate (PFOS, 2.6-38 ng/g). The accumulation profile of long-chain (C7-C12) PFCAs in particular, the predominance of PFNA, indicated that 8:2 fluorotelomer alcohol or commercially manufactured PFNA is a major local source of PFCs in Lake Baikal. No gender-related differences in the concentrations of individual PFCs or total PFCs were found. Tissues from pups and juveniles contained relatively higher concentrations of PFCs than tissues from subadults and adults, suggesting that maternal transfer of PFCs is of critical importance, Comparison of concentrations of PFCs in livers and sera collected from the same individuals of Baikal seals revealed that residue levels of PFOS, PFNA, perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUnDA) were significantly higher in liver than in serum. The concentration ratios of PFNA and PFDA between liver and serum were calculated to be 14 and 15, respectively, whereas the ratio of PFOS was 2.4. This suggests preferential retention of both PFNA and PFDA in liver. Concentrations of PFOS, PFNA, and PFDA in liver were significantly correlated with those in serum, whereas concentrations of PFUnDA were not correlated in between the two tissues, suggesting differences in pharmacokinetics among these PFCs. Temporal comparisons of hepatic PFC concentrations in seals collected between 1992 and 2005 showed that the concentrations of PFOS ($p = 0.0006$), PFNA ($p = 0.061$) and PFDA ($p = 0.017$) were higher in animals collected in recent years, indicating ongoing sources of PFC contamination in Lake Baikal.			1					C	C		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1082	ADME	Yao, JZ; Dong, ZM; Jiang, LL; Pan, YT; Zhao, MR; Bai, XX; Dai, JY	Emerging and Legacy Perfluoroalkyl Substances in Breastfed Chinese Infants: Renal Clearance, Body Burden, and Implications	2023	Environ. Health Perspect. 2023 MAR;131(3):37003. doi: 10.1289/EHP11403.	BACKGROUND: Human breast milk is a primary route of exposure to perfluoroalkyl substances (PFAS) in infants. To understand the associated risks, the occurrence of PFAS in human milk and the toxicokinetics of PFAS in infants need to be addressed. OBJECTIVES: We determined levels of emerging and legacy PFAS in human milk and urine samples from Chinese breastfed infants, estimated renal clearance, and predicted infant serum PFAS levels. METHODS: In total, human milk samples were collected from 1,151 lactating mothers in 21 cities in China. In addition, 80 paired infant cord blood and urine samples were obtained from two cities. Nine emerging PFAS and 13 legacy PFAS were analyzed in the samples using ultra high-performance liquid chromatography tandem mass spectrometry. Renal clearance rates (CLrenals) of PFAS were estimated in the paired samples. PFAS serum concentrations in infants (<1 year of age) were predicted using a first-order pharmacokinetic model. RESULTS: All nine emerging PFAS were detected in human milk, with the detection rates of 6:2 Cl-PFESA, PFMOAA, and PFO5DoDA all exceeding 70%. The level of 6:2 Cl-PFESA in human milk (median concentration = 13.6 ng/L) ranked third after PFOA (336 ng/L) and PFOS (49.7 ng/L). The estimated daily intake (EDI) values of PFOA and PFOS exceeded the reference dose (RfD) of 20 ng/kg BW per day recommended by the U.S. Environmental Protection Agency in 78% and 17% of breastfed infant samples, respectively. 6:2 Cl-PFESA had the lowest infant CLrenal (0.009 mL/kg BW per day), corresponding to the longest estimated half-life of 49 y. The average half-lives of PFMOAA, PFO2HxA, and PFO3OA were 0.221, 0.075, and 0.304 y, respectively. The CLrenals of PFOA, PFNA, and PFDA were slower in infants than in adults. CONCLUSIONS: Our results demonstrate the widespread occurrence of emerging PFAS in human milk in China. The relatively high EDIs and half-lives of emerging PFAS suggest potential health risks of postnatal exposure in newborns.			1				1	A	A	ヒト腎クリアランスに関する知見	
D1083	ADME	Zhang, QQ; Dong, XJ; Lu, JW; Song, JK; Wang, YS	Chemoproteomic Approach toward Probing the Interactomes of Perfluoroalkyl Substances	2021	Anal. Chem. 2021 Jul:93(27):9634-9639. doi: 10.1021/acs.analchem.1c01948.	Poly- and perfluoroalkyl substances (PFASs) are widely used in industrial products and consumer goods. Due to their extremely recalcitrant nature and potential bioaccumulation and toxicity, exposure to PFASs may result in adverse health outcomes in humans and wildlife. In this study, we developed a chemoproteomic strategy, based on the use of isotope-coded desthiobiotin-perfluorooctanephosphonic acid (PFOPA) probe and liquid chromatography with tandem mass spectrometry (LC-MS/MS) analysis, to profile PFAS-binding proteins. Targeted proteins were labeled with the desthiobiotin-PFOPA probe, digested with trypsin, and the ensuing desthiobiotin-conjugated peptides were enriched with streptavidin beads for LC-MS/MS analysis. We were able to identify 469 putative PFOPA-binding proteins. By conducting competitive binding experiments using low (10 mu M) and high (100 mu M) concentrations of stable isotope-labeled PFOPA probes, we further identified 128 nonredundant peptides derived from 75 unique proteins that exhibit selective binding toward PFOPA. Additionally, we demonstrated that one of these proteins, fatty acid-binding protein 5 (FABP5), could interact directly with PFASs, including perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), perfluorohex-anesulfonic acid (PFHxS), and perfluorobutanesulfonic acid (PFBS). Furthermore, desthiobiotin-labeled lysine residues are located close to the fatty acid-binding pocket of FABP5, and the binding affinity varies with the structures of PFASs. Taken together, we developed a novel chemoproteomic method for interrogating the PFAS-interacting proteome. The identification of these proteins sets the stage for understanding the mechanisms through which exposure to PFASs confers adverse human health effects.				1				C	C		
D1084	ADME	Louisse, J; Dellafiora, L; van den Heuvel, JJMW; Rijkers, D; Leenders, L; Dorne, JLCM; Punt, A; Russel, FGM; Koenderink, JB	Perfluoroalkyl substances (PFASs) are substrates of the renal human organic anion transporter 4 (OAT4)	2022	Arch Toxicol. 2023 Mar;97(3):685-696. doi: 10.1007/s00204-022-03428-6.	Poly- and perfluoroalkyl substances (PFASs) are omnipresent in the environment and have been shown to accumulate in humans. Most PFASs are not biotransformed in animals and humans, so that elimination is largely dependent on non-metabolic clearance via bile and urine. Accumulation of certain PFASs in humans may relate to their reabsorption from the pre-urine by transporter proteins in the proximal tubules of the kidney, such as URAT1 and OAT4. The present study assessed the in vitro transport of 7 PFASs (PFHpA, PFOA, PFNA, PFDA, PFBS, PFHxS and PFOS) applying URAT1- or OAT4-transfected human embryonic kidney (HEK) cells. Virtually no transport of PFASs could be measured in URAT1-transfected HEK cells. All PFASs, except PFBS, showed clear uptake in OAT4-transfected HEK cells. In addition, these in vitro results were further supported by in silico docking and molecular dynamic simulation studies assessing transporter-ligand interactions. Information on OAT4-mediated transport may provide insight into the accumulation potential of PFASs in humans, but other kinetic aspects may play a role and should also be taken into account. Quantitative information on all relevant kinetic processes should be integrated in physiologically based kinetic (PBK) models, to predict congener-specific accumulation of PFASs in humans in a more accurate manner.			1	1				B	C		
D1085	ADME	van Beijsterveldt, IALP; van Zelst, BD; van den Berg, SAA; de Fluiter, KS; van der Steen, M; Hokken-Koelega, ACS	Longitudinal poly- and perfluoroalkyl substances (PFAS) levels in Dutch infants	2022	Environ. Int. 2022 Feb:160:107068. doi: 10.1016/j.envint.2021.107068.	Background and aims: Per- and polyfluoroalkyl substances (PFAS) are a potential hazard for public health. These man-made-chemicals are non-degradable with an elimination half-life of multiple years, causing accumulation in the environment and humans. Rodent studies demonstrated that PFAS are harmful, especially when present during the critical window in the first months of life. Because longitudinal data during infancy are limited, we investigated longitudinal plasma levels in infants aged 3 months and 2 years and its most important determinants. Methods: In 369 healthy term-born Dutch infants, we determined plasma PFOS, PFOA, PFHxS, PFNA and PFDA levels at age 3 months and 2 years, using liquid chromatography-electrospray-ionization-tandem-massspectrometry (LC-ESI-MS/MS). We studied the associations with maternal and child characteristics by multiple regression models. Results: At age 3 months, median plasma levels of PFOS, PFOA, PFHxS, PFNA and PFDA were 1.48, 2.40, 0.43, 0.23 and 0.07 ng/mL, resp. Levels decreased slightly until age 2 years to 1.30, 1.81, 0.40, 0.21 and 0.08 ng/mL, resp. Maternal age, first born, Caucasian ethnicity and exclusive breastfeeding were associated with higher infant's plasma levels at age 3 months. Levels at 3 months were the most important predictor for PFAS levels at age 2 years. Infants with exclusive breastfeeding during the first 3 months of life (EBF) had 2-3 fold higher levels throughout infancy compared to infants with exclusive formula feeding (EFF), with PFOA levels at 3 months 3.72 ng/mL versus 1.26 ng/mL and at 2 years 3.15 ng/mL versus 1.22 ng/mL, respectively. Conclusion: Plasma PFAS levels decreased only slightly during infancy. Higher levels at age 3 months were found in Caucasian, first-born infants from older mothers and throughout infancy in EBF-infants. Our findings indicate that trans-placental transmission and breastfeeding are the most important determinants of PFAS exposure in early life.			1				1	A	A	乳児における血漿濃度に関する知見	
D1086	ADME	Yong, L; Huang, MT; Wei, YC; Xu, J; Yi, ZS	Investigating the interaction between three perfluorinated carboxylic acids and the G protein-coupled estrogen receptor: spectroscopic analyses and computational simulations	2020	Anal. Methods. 2020 Aug:12(31):3944-3953. doi: 10.1039/d0ay01052a.	In this paper, perfluorinated compounds (PFCs), such as perfluorobutyric acid (PFBA), perfluorooctanoic acid (PFOA) and perfluorododecanoic acid (PFDoA), were selected as typical representatives of perfluorinated carboxylic acids (PFCAs) to study the effects of PFCAs on the G protein-coupled estrogen receptor (GPER). The interaction mechanism of the three types of PFCAs with the GPER was investigated using steady-state fluorescence spectroscopy, ultraviolet-visible spectroscopy, three-dimensional fluorescence spectroscopy, and Fourier transform infrared spectroscopy combined with molecular docking and molecular dynamics simulations. Among these techniques, steady-state fluorescence and ultraviolet-visible spectroscopic analyses showed that PFBA, PFOA and PFDoA quenched the endogenous GPER fluorescence by combined dynamic and static quenching and non-radiative energy transfer. The binding constants (K-a) of PFCAs on the GPER were all larger than 10(5)L mol(-1), indicating that their affinity for the GPER was strong. Fourier transform infrared spectroscopy and three-dimensional fluorescence showed that the secondary structure of the GPER changed after binding to PFCAs. Thermodynamic analysis showed Delta G< 0, which indicated that the interaction between the GPER and PFCAs was spontaneous. For the binding of PFBA and PFOA to the GPER, Delta H> 0 and Delta S> 0, indicating that the interaction was mainly driven by hydrophobic forces; for the binding of PFDoA to the GPER, Delta H< 0 and Delta S< 0, suggesting that van der Waals force and hydrogen bonding were the main interaction forces. Molecular dynamics simulations suggested that the stability of the GPER-PFCA complexes was higher than that of the free GPER, and also that the structure and hydrophobicity of the GPER changed after binding to PFCAs. Molecular docking analysis showed that all three PFCAs could form hydrogen bonds with the GPER, which improved the stability of the complex.	1							C	C		
D1087	ADME	Prince, N; Begum, S; Minguez-Alarcon, L; Genard-Walton, M; Huang, MN; Soeteman, DI; Wheelock, C; Litonjua, AA; Weiss, ST; Kelly, RS; Lasky-Su, J	Plasma concentrations of per- and polyfluoroalkyl substances are associated with perturbations in lipid and amino acid metabolism	2023	Chemosphere. 2023 May:324:138228. doi: 10.1016/j.chemosphere.2023.138228.	Exposure to per-and polyfluoroalkyl substances (PFAS) through the environment can lead to harmful health outcomes and the development of disease. However, little is known about how PFAS impact underlying biology that contributes to these adverse health effects. The metabolome represents the end product of cellular processes and has been used previously to understand physiological changes that lead to disease. In this study, we investigated whether exposure to PFAS was associated with the global, untargeted metabolome. In a cohort of 459 pregnant mothers and 401 children, we quantified plasma concentrations of six individual PFAS-PFOA, PFOS, PFHXS, PFDEA, and PFNA-and performed plasma metabolomic profiling by UPLC-MS. In adjusted linear regression analysis, we found associations between plasma PFAS and perturbations in lipid and amino acid metabolites in both mothers and children. In mothers, metabolites of 19 lipid pathways and 8 amino acid pathways were significantly associated with PFAS exposure at an FDR<0.05 threshold; in children, metabolites of 28 lipid pathways and 10 amino acid pathways exhibited significant associations at FDR<0.05 with PFAS exposure. Our investigation found that metabolites of the Sphingomyelin, Lysophospholipid, Long Chain Poly-unsaturated Fatty Acid (n3 and n6), Fatty Acid-Dicarboxylate, and Urea Cycle showed the most significant associations with PFAS, suggesting these may be particular pathways of interest in the physiological response to PFAS. To our knowledge, this is the first study to characterize associations between the global metabolome and PFAS across multiple periods in the life course to understand impacts on underlying biology, and the findings presented here are relevant in understanding how PFAS disrupt normal biological function and may ultimately give rise to harmful health effects.			1					B	A		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1088	ADME	Kirk, AB; Plasse, KM; Kirk, KC; Martin, CF; Ozsoy, G	Predicting Exposure to Perfluorinated Alkyl Substances (PFAS) among US Infants	2022	Int. J. Environ. Res. Public Health. 2022 Jul;19(14):8402. doi: 10.3390/ijerph19148402.	PFASs have been detected in nearly every serum sample collected over the last two decades from US adults as part of the National Health and Nutrition Examination Survey (NHANES) and are commonly found in other data sets from around the world. However, less is known about infant PFAS exposures, primarily because the collection of infant serum samples is less common and frequently avoided. Cord blood samples are often preferred for chemical exposure assessments because this is thought to provide a good representation of infant serum concentrations, at least at the time of birth. In this paper, we will provide a statistical and probabilistic analysis of what can be expected for infants living in the US using NHANES from 2007 to 2008, which contains a rare subset of infant data. Regulatory efforts that require estimation of exposures among the very youth can be challenging, both because of a lack of data in general and because variability among this most vulnerable population can be uncertain. We report that US infant exposures are extremely common and that serum concentrations remain fairly constant, despite infant growth rates and relatively high caloric and fluid intake, with the possible exception of PFOS. Infant serum PFOS concentrations between months 1 and 3 are consistently higher than at less than one month, even though healthy infants at 1 and 2 months weigh more than they did at birth. This suggests that the babies are exposed to greater concentrations of PFOS after birth or that excretion kinetics differ for this PFAS.									D	A	乳児曝露に関する知見であるが対象PFASが含まれているか不明	NHANES、PFNAあり
D1089	ADME	Buck, R; Gannon, S	Perfluorohexanoic acid pharmacokinetics in mouse, rat, microminipig, pig, monkey and human	2017	Abstr. Pap. Am. Chem. Soc. 2017 Apr:253:881.	Perfluorohexanoic acid (PFHxA) is a perfluorocarboxylic acid (PFCA) that has been widely identified in the aqueous environment. In order to conduct a human health risk characterization, it is necessary to understand both its toxicology and phamacokinetics in mammals. The elimination kinetics of PFHxA have been determined from published data for multiple mammalian species: mouse, rat, microminipig, pig, monkey and human. For each species, the data was compiled and modeled to identify the kinetic profile of elimination from blood including calculation of elimination rate (hr-1) and elimination half-life (hr). The study shows that PFHxA elimination kinetics in mammals is consistent with a rapid initial (alpha) phase followed by a slower terminal (beta) phase. Further, the PFHxA alpha phase elimination has a first-order half-life range of 1-2 hours in mouse, rat, microminipig, pig, monkey and human. The alpha phase elimination in mammals accounts for over 99.7% of the total PFHxA elimination in mammals. PFHx- elimination is extensive in the rapid alpha phase and there are no significant pharmacokinetic differences across mammals: mice, rats, monkeys, pigs and humans. The overall conclusion of this kinetic assessment is that PFHxA does not appear to exhibit significantly different elimination kinetics across a wide range of mammalian species. The results suggest that for human health risk assessment, the interspecies pharmacokinetics adjustment factor applied to a hazard assessment benchmark should be small. Details of the assessment for each species will be presented.		1				入手不可		A	A	各動物種における体内動態に関する知見	
D1090	PBPK	Cho, HY; Choi, GW; Lee, YB	Evaluation of perfluorohexanoic acid exposure using physiologically-based pharmacokinetic modeling and simulation	2019	Eur. J. Clin. Pharmacol. 2019 Jun:75;EACPT-1179;S93-S94.	Introduction: Perfluorohexanoic acid (PFHxA) is one of the perfluoroalkyl acids (PFAAs) that are a group of synthetic chemicals. It is classified as short-chain PFAAs (i.e., perfluoroalkyl carboxylic acid with < 7 perfluorinated carbons). Although short-chain PFAAs have more favorable environmental, health, safety, and kinetic profile than longchain PFAAs, several epidemiological studies of PFHxA have provided limited and/or weak evidence for a relationship between PFHxA exposure and specific adverse health effects. Therefore, the investigation of pharmacokinetics (PKs) and health risk assessment of PFHxA are needed. Objectives: The purpose of this study is the development of physiologically-based pharmacokinetic (PBPK) model for PFHxA in rats for applying its human health risk assessment. Methods: The rat PBPK model of PFHxA has been built based on in vivo PK data after an oral or intravenous administration of PFHxA in male (2-10 mg/kg) and female rats (10 mg/kg). The biological samples including plasma, liver, kidney, heart, lung, spleen, brain, gastrointestinal tract, muscle, adipose tissue, urine, and feces were analyzed by Ultra-Performance Liquid Chromatography coupled tandem mass spectrometry. The PK analysis of PFHxA was conducted by non-compartmental and compartmental analysis using WinNonlin® software (version 8.0, Pharsight®, a Certara™ Company). The construction of PBPK model and parameter estimation were performed by Berkeley Madonna V 8.3.14 software (Berkeley, CA, USA). For the calculation of external and reference dose, the Korean biomonitoring values were applied. Results: The key parameters of the PBPK model were estimated at 122.21 μg/h of transport maximum, and 500.12 μg/L of transport affinity constant. The PBPK model of PFHxA in rats was extrapolated to a human PBPK model for projection of the PK profile of PFHxA in humans. The external and reference dose were predicted by the developed human PBPK model through various dosing scenarios. The external dose and point of departure of PFHxA were 2.99 μg/kg/day and 5.30 mg/kg/day, respectively. Summary / Conclusions: The developed PBPK model of PFHxA in rats fitted well the observation values and successfully extrapolated to the human situation. Our study provides valuable information about health risk assessment for PFHxA		1					1	A	A	PBPKモデルの構築に関する知見	
D1091	ADME	Aas, CB; Fuglei, E; Herzke, D; Yoccoz, NG; Routti, H	Effect of Body Condition on Tissue Distribution of Perfluoroalkyl Substances (PFASs) in Arctic Fox (Vulpes lagopus)	2014	Environ. Sci. Technol. 2014 Oct:48(19):11654-11661. doi: 10.1021/es503147n.	Arctic animals undergo large seasonal fluctuations in body weight. The effect of body condition on the distribution and composition of 16 perfluoroalkyl substances (PFASs) was investigated in liver, blood, kidney, adipose tissue, and muscle of Arctic foxes (Vulpes lagopus) from Svalbard (n = 18, age 13 years). PFAS concentrations were generally highest in liver, followed by blood and kidney, while lowest concentrations were found in adipose tissue and muscle. Concentrations of summed perfluorocarboxylic acids and perfluoroalkyl sulfonates were five and seven times higher, respectively, in adipose tissue of lean compared to fat foxes. In addition, perfluorodecanoate (PFDA) and perfluoroheptanesulfonate (PFHpS) concentrations in liver, kidney, and blood, and, perfluorononanoate (PFNA) in liver and blood, were twice as high in the lean compared to the fat foxes. The ratio between perfluorooctane sulfonamide (FOSA) and its metabolite perfluorooctanesulfonate (PFOS) was lowest in liver, muscle, and kidney, while significantly higher proportions of FOSA were found in adipose tissue and blood. The results of the present study suggest, that toxic potential of exposure to PFAS among other pollutants in Arctic mammals may increase during seasonal emaciation. The results also suggest that body condition should be taken into account assessing temporal trends of PFASs.			1					C	C		
D1092	PBPK	Qin, WP; Henneberger, L; Huchthausen, J; Konig, M; Escher, BI	Role of bioavailability and protein binding of four anionic perfluoroalkyl substances in cell-based bioassays for quantitative in vitro to in vivo extrapolations	2023	Environ. Int. 2023 Mar:173:107857. doi: 10.1016/j.envint.2023.107857.	Perfluoroalkyl substances (PFAS) are persistent and pose a risk to human health. High throughput screening (HTS) cell-based bioassays may inform risk assessment of PFAS provided that quantitative in vitro to in vivo extrapolation (QIVIVE) can be developed. The QIVIVE ratio is the ratio of nominal (Cnom) or freely dissolved concentration (Cfree) in human blood to Cnom or Cfree in the bioassays. Considering that the concentrations of PFAS in human plasma and in vitro bioassays may vary by orders of magnitude, we tested the hypothesis that anionic PFAS bind to proteins concentration-dependently and therefore the binding differs substantially between human plasma and bioassays, which has an impact on QIVIVE. Solid phase microextraction (SPME) with C18-coated fibers served to quantify the Cfree of four anionic PFAS (perfluorobutanoate (PFBA), perfluorooctanoate (PFOA), perfluorohexane sulfonate (PFHxS) and perfluorooctane sulfonate (PFOS)) in the presence of proteins and lipid, medium components, cells and human plasma over five orders of magnitude in concentrations. The C18-SPME method was used to quantify the non-linear binding to proteins, human plasma and medium, and the partition constants to cells. These binding parameters were used to predict Cfree of PFAS in cell bioassays and human plasma by a concentration-dependent mass balance model (MBM). The approach was illustrated with a reporter gene assay indicating activation of the peroxisome proliferator-activated receptor gamma (PPAR gamma- GeneBLAzer). Blood plasma levels were collected from literature for occupational exposure and the general population. The QIVIVEnom ratios were higher than the QIVIVEfree ratios due to the strong affinity to proteins and large differences in protein contents between human blood and bioassays. For human health risk assessment, the QIVIVEfree ratios of many in vitro assays need to be combined to cover all health relevant endpoints. If Cfree cannot be measured, they can be estimated with the MBM and concentration-dependent distribution ratios.	1							B	B		
D1093	ADME	Hong, AB; Zhuang, LL; Cui, WX; Lu, Q; Yang, P; Su, S; Wang, B; Zhang, GH; Chen, D	Per- and polyfluoroalkyl substances (PFAS) exposure in women seeking in vitro fertilization-embryo transfer treatment (IVF-ET) in China: Blood-follicular transfer and associations with IVF-ET outcomes	2022	Sci. Total Environ.2022 Sep;838(Pt 3):156323. doi: 10.1016/j.scitotenv.2022.156323.	As follicular fluid constitutes a critical microenvironment for the development of oocytes, investigation of environmental contaminants in follicular fluid may facilitate a better understanding of the influence of environmental exposure on reproductive health. In the present study, we aimed to investigate per-and polyfluoroalkyl substances (PFAS) exposure in women receiving in vitro fertilization-embryo transfer (IVF-ET) treatment, determine the blood-follicle transfer efficiencies (BFTE) of PFAS, and explore potential associations between PFAS exposure and selected IVF-ET outcomes. Our results revealed that n-PFOA was the most abundant PFAS in both serum and follicular fluid (FF) (median = 5.85 and 5.56 ng/mL, respectively), followed by n-PFOS (4.95 and 4.28 ng/mL), 6:2 Cl-PFESA (2.18 and 2.10 ng/mL), PFNA (1.37 and 1.37 ng/mL), PFUdA (0.33 and 0.97 ng/mL), PFDA (0.37 and 0.66 ng/mL), PFHxS (0.42 and 0.39 ng/mL), and PFHpS (0.11 and 0.10 ng/mL). The median BFTE ranged from 0.65 to 0.92 for individual PFAS, indicating a relatively high tendency of PFAS to cross the blood-follicle barrier (BFB). An inverted V-shaped trend was observed between the median BFTE and the number of fluorinated carbon atoms or the log K-ow(octanol-water partition coefficient) for individual PFAS, suggesting the influence by physicochemical properties and molecular structures. Although our data did not find any clear pattern in the link between blood or follicular fluid concentrations of PFAS and selected IVF-ET outcomes, our study raises the need for better characterization of exposure to environmental chemicals in follicular fluid together with its potential influence on reproductive health.			1					A	B	ヒト血液、卵胞液濃度に関する知見	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1094	ADME	Moro, G; Liberi, S; Vascon, F; Linciano, S; De Felice, S; Fasolato, S; Foresta, C; De Toni, L; Di Nisio, A; Cendron, L; Angelini, A	Investigation of the Interaction between Human Serum Albumin and Branched Short-Chain Perfluoroalkyl Compounds	2022	Chem. Res. Toxicol. 2022 Sep:35(11):2049-2058. doi: 10.1021/acs.chemrestox.2c00211.	The current trend dealing with the production of per-and polyfluoroalkyl substances (PFASs) involves the shifting toward branched short-chain fluorinated compounds known as new-generation PFASs. A key aspect to be clarified, to address the adverse health effects associated with the exposure to PFASs, is their binding mode to human serum albumin (hSA), the most abundant protein in plasma. In this study, we investigated the interaction between hSA and two representative branched short-chain PFASs, namely, HPFO-DA and C6O4. In-solution studies revealed that both compounds bind hSA with affinities and stoichiometries lower than that of the legacy long-chain perfluoroalkyl compound PFOA. Competition experiments using hSA-binding drugs with known site-selectivity revealed that both HPFO-DA and C6O4 bound to pockets located in subdomain IIIA. The crystal structure of hSA in complex with HPFO-DA unveiled the presence of two binding sites. The characterization and direct comparison of hSA interactions with new-generation PFASs may be key elements for the understanding of the toxicological impact of these compounds.								C	C		
D1095	ADME	Liu, Y; Cao, ZZ; Zong, WS; Liu, RT	Interaction rule and mechanism of perfluoroalkyl sulfonates containing different carbon chains with human serum albumin	2017	RSC Adv. 2017;7(40):24781-24788. doi: 10.1039/c7ra02963b.	In this study, the toxic mechanism and effects of perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHS), and perfluorobutane sulfonate (PFBS) were investigated via spectroscopy, molecular modeling, and calorimetry techniques. Results showed that all three perfluoroalkyl sulfonates (PFASs) bound to human serum albumin (HSA) mainly through electrostatic forces and hydrogen bonds. The backbone and secondary structure of HSA did not significantly change after exposure to PFASs. It may be proposed that the binding changed the local structure around the active site and affected the esterase activity of HSA. Compared with the control group, the inhibited esterase activity of HSA decreased to 28.6%, 43.2%, and 54.4% under the exposure of PFOS, PFHS, and PFBS at 1.3 x 10(-4) mol L-1, respectively. The ITC result reflected that the binding ability increased after lengthening of the carbon chain, which also explained the decreased esterase activity with the increased lengthening of carbon chain. The fluorescence spectra also indicated that the influence on the microenvironment of HSA decreased with the shortening of the carbon chain. This study provided evidence regarding the interaction mechanism and toxicity of PFASs towards HSA in vitro.				1				C	B		
D1096	ADME	Li, WT; Hu, YH; Bischel, HN	In-Vitro and In-Silico Assessment of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous Film-Forming Foam (AFFF) Binding to Human Serum Albumin	2021	Toxics. 2021 Mar;9(3):63. doi: 10.3390/toxics9030063.	Drinking water contaminated by fluorosurfactant-based aqueous film-forming foams (AFFF) is a source of human exposure to poly- and perfluoroalkyl substances (PFAS). However, assessment of bioaccumulation potentials of diverse PFAS in commercial products such as AFFF have been insufficient and challenging, especially due to a lack of analytical standards. Here we explore the value of suspect screening, equilibrium dialysis, and molecular-docking simulations to identify potentially bioaccumulative PFAS. We exposed human serum albumin (HSA) protein to dilutions of a legacy AFFF produced by 3M in 1999 using equilibrium dialysis and screened in-vitro protein-binding affinities using high-resolution mass spectrometry (HRMS). Through suspect screening, we identified 32 PFAS and 18 hydrocarbon surfactants in the AFFF that bound to HSA. Quantification of noncovalent association constants for 26 PFAS standards confirmed that many PFAS, including the short-chain perfluoropropane sulfonic acid (log K-a= 4.1 +/- 0.2 M-1), exhibit strong binding affinities with HSA. At least five PFAS in AFFF (including three PFAS with less than five perfluorocarbons) remained bound to the precipitated HSA pellet after extensive solvent washing-an indication of high PFAS binding potential. Three PFAS (PFBS, PFOS, and PFOA) were confirmed in the protein pellet with analytical standards and quantified after acid digestion-this sample fraction accounted for 5 to 20% of each compound mass in the sample. We calculated pseudo-bioconcentration factors (BCFpseudo) for PFAS that suspect screening flagged as noncovalently bound or potentially covalently bound. Most PFAS exhibiting high BCFpseudo, especially those with seven perfluorocarbons, contained a carboxylic acid or a sulfonic acid. Finally, we used molecular docking to simulate HSA binding affinities for 62 ligands (26 PFAS targets, 18 PFAS qualified in AFFF, and 18 hydrocarbon surfactants qualified in AFFF). We found that molecular docking can effectively separate HSA-binding and -nonbinding compounds in AFFF. In-vitro and in-silico approaches described in this study provide replicable, high-throughput workflows for assessing bioaccumulation potentials of diverse PFAS in commercial products.				1				C	C		
D1097	ADME	Sait, STL; Rino, SF; Gonzalez, SV; Pastukhov, MV; Poletaeva, VI; Farkas, J; Jenssen, BM; Ciesielski, TM; Asimakopoulos, AG	Occurrence and tissue distribution of 33 legacy and novel per- and polyfluoroalkyl substances (PFASs) in Baikal seals (Phoca sibirica)	2023	Sci. Total Environ. 2023 Sep:889:164096. doi: 10.1016/j.scitotenv.2023.164096.	Per- and polyfluoroalkyl substances (PFASs) are bioaccumulative and associated with adverse effects in both wildlife and humans. The occurrence of 33 PFASs was assessed in the plasma, liver, blubber, and brain of 18 Baikal seals (Phoca sibirica) (16 pups and 2 adult females) from Lake Baikal, Russia (in 2011). Of the 33 congeners analysed for: perfluorooctanosulfonic acid (PFOS), 7 long chain perfluoroalkyl carboxylic acids (C8-C14 PFCAs) and 1 branched PFCA (perfluoro-3,7-dimethyloctanoic acid; P37DMOA) were most frequently detected. The PFASs in plasma and liver with the highest median concentrations were legacy congeners: perfluoroundecanoic acid (PFUnA; plasma: 11.2 ng/g w.w.; liver: 7.36 ng/g w.w.), PFOS (plasma: 8.67 ng/g w.w.; liver: 9.86 ng/g w.w.), perfluorodecanoic acid (PFDA; plasma: 5.13 ng/g w.w.; liver: 6.69 ng/g w.w.), perfluorononanoic acid (PFNA; plasma: 4.65 ng/g w. w.; liver: 5.83 ng/g w.w.) and perfluorotridecanoic acid (PFTriDA; plasma: 4.29 ng/g w.w.; liver: 2.55 ng/g w.w.). PFASs were detected in the brain of Baikal seals, indicating that PFASs cross through the blood-brain barrier. In blubber, the majority of PFASs were detected in low abundance and concentrations. In contrast to legacy PFASs, novel con-geners (e.g., Gen X) were either detected infrequently or not found in Baikal seals. The worldwide occurrence of PFASs in pinnipeds was compared and lower median concentrations of PFOS were observed in Baikal seals relative to other pinnipeds. Conversely, similar concentrations of long chain PFCAs were found in Baikal seals compared to other pin-nipeds. Furthermore, human exposure was assessed by estimating weekly intakes (EWI) of PFASs through Baikal seal consumption. Although PFASs concentrations were comparatively low relative to other pinnipeds, consumption of Baikal seal could exceed current regulatory guidelines.								C	C		
D1098	ADME	Kimura, O; Fujii, Y; Haraguchi, K; Kato, Y; Ohta, C; Koga, N; Endo, T	Effects of perfluoroalkyl carboxylic acids on the uptake of sulfobromophthalein via organic anion transporting polypeptides in human intestinal Caco-2 cells	2020	Biochem. Biophys. Rep. 2020 Dec:24:100807. doi: 10.1016/j.bbrep.2020.100807.	We performed a detailed investigation of the uptake of sulfobromophthalein (BSP) from the apical membrane of Caco-2 cells, which is a substrate for organic anion transporting polypeptides (OATPs), and calculated the kinetic parameters of BSP uptake as follows: K-m = 13.9 +/- 1.3 mu M, V-max = 1.15 +/- 0.07 nmol (mg protein)(-1) (5 min)(-1), and k(d) = 38.2 +/- 0.53 mu L (mg protein)(-1) (5 min)(-1). Coincubation with medium-chain (C7-C11) perfluoroalkyl carboxylic acids (PFCAs), such as perfluoroheptanoic acid (PFHpA, C7), perfluorooctanoic acid (PFOA, C8), perfluorononanoic acid (PFNA, C9), perfluorodecanoic acid (PFDA, C10) and perfluoroundecanoic acid (PFUnDA, C11), significantly decreased BSP uptake by 27-55%, while coincubation with short- (C3-C6) and long-chain (C12-C14) PFCAs decreased the uptake only slightly. Dixon plotting suggested that PFOA, PFNA and PFDA competitively inhibited the BSP uptake with inhibition constant (K-i) values of 62.2 +/- 1.3 mu M, 35.3 +/- 0.1 mu M and 43.2 +/- 0.3 mu M, respectively. PFCAs with medium-chains could be substrates for OATPs, probably OATP2B1, which is the most abundantly expressed OATP isoform in Caco-2 cells.			1					B	B		
D1099	ADME	Cheng, WX; Doering, JA; LaLone, C; Ng, C	Integrative Computational Approaches to Inform Relative Bioaccumulation Potential of Per- and Polyfluoroalkyl Substances Across Species	2021	Toxicol. Sci. 2021 Apr:180(2):212-223. doi: 10.1093/toxsci/kfab004.	Predictive toxicology is increasingly reliant on innovative computational methods to address pressing questions in chemicals assessment. Of importance is the evaluation of contaminant impact differences across species to inform ecosystem protection and identify appropriate model species for human toxicity studies. Here we evaluated 2 complementary tools to predict cross-species differences in binding affinity between per- and polyfluoroalkyl substances (PFAS) and the liver fatty acid-binding protein (LFABP): the Sequence Alignment to Predict Across Species Susceptibility (SeqAPASS) tool and molecular dynamics (MD). SeqAPASS determined that the structure of human LFABP, a key determinant of PFAS bioaccumulation, was conserved in the majority of vertebrate species, indicating these species would have similar PFAS bioaccumulation potentials. Level 3 SeqAPASS evaluation identified several potentially destabilizing amino acid differences across species, which were generally supported by DUET stability change predictions. Nine single-residue mutations and 7 whole species sequences were selected for MD evaluation. One mutation (F50V for PFNA) showed a statistically significant difference with stronger affinity than wild-type human LFABP. Predicted binding affinities for 9 different PFAS across 7 species showed human, rat, chicken, and rainbow trout had similar binding affinities to one another for each PFAS, whereas Japanese medaka and fathead minnow had significantly weaker LFABP-binding affinity for some PFAS. Based on these analyses, the combined use of SeqAPASS and MD provides rapid screening for potential species differences with deeper structural insight. This approach can be easily extended to other important biological receptors and potential ligands.				1				C	C		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1100	ADME	Hu, TY; Huang, F; Zhou, SS; Liu, Y	Studies on the Interaction of Perfluorononanoic Acid with Human Serum Albumin by Multi-Spectroscopic, Molecular Docking and Isothermal Titration Calorimetry Techniques	2016	Spectrosc. Spectr. Anal. 2016 Dec:36(12):4141-4147. doi: 10.3964/j.issn.1000-0593(2016)12-4141-07.	Perfluorononanoic acid (PFNA) is the third most frequently detected in serum among all perfluoroalkyl acids (PFAAs) which is a kind of toxic emerging environmental contaminant. The influence of PFNA on the conformation and even function of human serum albumin (HSA) is still just at the beginning of research. The attempt of this paper was to completely elucidate the interaction mechanism of PFNA with HSA by means of multi-spectroscopic, molecular docking and isothermal titration calorimetry (ITC) techniques. The inner filter effect of all fluorescence data in the paper was eliminated to get accurate binding parameters. The results showed that the fluorescence of HSA was quenched by PFNA through a combined quenching procedure of dynamic and static quenching. Through site marker competitive experiments, subdomain IIA. of HSA had been assigned to possess the high-affinity binding site of PFNA. Furthermore, molecular docking reconfirmed that PFNA was bound in subdomain IIA mainly through polar force, hydrophobic interaction and halogen-bond, and the calculated free energy was -26.54 kJ.mol(-1) which indicated that the PFNA molecule exhibited large binding affinity towards HSA. The thermodynamic characterizations of two different classes of binding sites by ITC displayed that the first class with a higher affinity constant was dominated by an enthalpic contribution due to electrostatic interactions and halogen-bond, whereas the second class with a lower affinity constant was preponderated by hydrophobic interaction. The three-dimensional fluorescence revealed that the conformation of HSA was changed and the hydrophobicity of the Trp and Tyr residues microenvironment increased after formation of PFNA-HSA complex. The alterations of the protein secondary structure were quantitatively calculated from circular dichroism (CD) spectroscopy with reduction of a-helix content about 14.3%, beta-sheet 5.3%, beta-turn 3.5%, and augment in random content from 14.4% to 37.5%. Above results revealed that the binding of PFNA with HSA can alter the secondary structure of HSA, further probably affecting HSA physiological function. The results can provide insights with the binding mechanism of PFNA with HSA and salient biophysical and biochemical clues on elucidating the transport and distribution of PFNA in vivo.			1					C	C		
D1101	ADME	Gao, Y; Song, BY; He, AE; Liu, C; Lu, Y; Li, J; Fu, JJ; Liang, Y; Wang, YW	Isomer-specific perfluoroalkyl acids accumulation, excretion and maternal transfer to eggs in chickens around a fluorochemical manufactory in China	2023	Sci. Total Environ. 2023 Mar:865:161125. doi: 10.1016/j.scitotenv.2022.161125.	The co-existing of multiple Per- and polyfluoroalkyl substances (PFASs) might pose more complicated situation for the exposure risk of environment and biota, especially for the surrounding area of the contaminated communities. In this study, tissues and organs of free-ranged chickens, paired eggs, corresponding feces, water, soil/dust, and feed samples around a fluorochemical manufactory were collected to investigate the tissue-isomer-specific accumulation, elimina-tion and maternal transfer to eggs of PFASs. Free-ranged chickens had much higher n-ary sumation PFASs concentrations than farm chickens, and PFBA and PFOS were the predominant PFASs in tissues and organs, which is consistence with the electrochemical fluorination (ECF) production pattern of this manufactory. This result implied that PFASs released from manufactory production is a direct exposure source to the chickens. n-ary sumation PFASs concentrations in yolk samples were higher than other tissues and organs, while the concentrations in albumen were lowest. Isomer profiles analysis indi-cated that n-PFOS proportions in tissues, organs, yolk, and albumen ranged from 85.3 %-98.1 %, whereas in the feces with the percentage of 72.9 %, indicating that the branched PFOS isomers showed faster excretion rate than n-PFOS for chickens. Resident's estimated daily intakes (EDIs) of n-ary sumation PFASs via chicken were in the range of 6.41 to 107.18 ng/kg center dot bw/d. Notably, the EDIs of the sum of four PFASs were higher than the TDI of EFSA in 2020, indicating potential health risks.	1							B	C		
D1102	PBPK	Billat, PA; Vogs, C; Blassiau, C; Brochot, C; Wincent, E; Brion, F; Beaudouin, R	PBTK modeled perfluoroalkyl acid kinetics in zebrafish eleutheroembryos suggests impacts on bioconcentrations by chorion porosity dynamics	2023	Toxicol. Vitro. 2023 Jun:89:105588. doi: 10.1016/j.tiv.2023.105588.	The zebrafish eleutheroembryo (zfe) is widely used as a model to characterize the toxicity of chemicals. However, analytical methods are still missing to measure organ concentrations. Therefore, physiologically-based toxicokinetic (PBTK) modeling may overcome current limitations to help understand the relationship between toxic effects and internal exposure in various organs.A previous PBTK model has been updated to include the chorionic transport barrier and its permeabilization, hatching dynamics within a zfe population over development, and active mediated transport mechanisms. The zfe PBTK model has been calibrated using measured time-dependent internal concentrations of PFBA, PFHxS, PFOA, and PFOS in a zfe population and evaluated using external datasets from the literature.Calibration was successful with 96% of the predictions falling within a 2-fold range of the observed concentrations. The external dataset was correctly estimated with about 50% of the predictions falling within a factor of 3 of the observed data and 10% of the predictions are out of the 10-fold error. The calibrated model suggested that active mediated transport differs between PFAS with a sulfonic and carboxylic acid functional end groups.This PBTK model predicts well the fate of PFAS with various physicochemical properties in zfe. Therefore, this model may improve the use of zfe as an alternative model in toxicokinetic-toxicodynamic studies and help to refine and reduce zfe-based experiments, while giving insights into the internal kinetics of chemicals.	1							C	C		
D1103	ADME	Wen, Y; Kong, Y; Peng, Y; Cui, XY	Uptake, distribution, and depuration of emerging per- and polyfluoroalkyl substances in mice: Role of gut microbiota	2022	Sci. Total Environ. 2022 Dec:853:158372. doi: 10.1016/j.scitotenv.2022.158372.	The bioaccumulation and fate in mammals of hexafluoropropylene oxide trimer acid (HFPO-TA) and hexafluoropropylene oxide dimer acid (HFPO-DA), as major alternatives for perfluorooctanoate (PFOA), have rarely been reported. In addition, the role of gut microbiota was greatly understudied. In this study, the uptake, distribution, and depuration of HFPO-TA, HFPO-DA, and PFOA were investigated by exposure to mice for 14 days, followed by a clear-ance period of 7 days. The patterns of tissue distribution and depuration kinetics of HFPO-TA and PFOA were similar, but different from HFPO-DA. Liver was the main deposition organ for HFPO-TA and PFOA, making contributions of 58.8 % and 59.1 % to the total mass recovered on day 14. Depuration of HFPO-DA was more rapid than HFPO-TA and PFOA. Approximately 95.3 % of HFPO-DA in liver was eliminated on day 21 compared with day 14. While the clearance rates of HPFO-TA and PFOA were only 6.1 % and 13.9 % on day 21. The comparison between normal and pseudo germ-free mice (GM) was also conducted to investigate the effect of gut microbial on in vivo absorption of the three per-and polyfluoroalkyl substances (PFASs). Significantly higher ($p < 0.05$) concentrations of all the three PFASs were observed in most organs and tissues of GM compared with NC group. An analysis of gut microbiota showed that the higher absorp-tion of PFASs in GM group may be attributed to the increase of intestinal permeability (as indicated by the decrease of tight junction protein expression), which were induced by the change of lachnospiraceae abundance. The result highlighted the importance of gut microbiota in absorption and health risk evaluation of emerging PFASs.						1		B	B		
D1104	ADME	Jain, RB	Variabilities in concentrations of selected perfluoroalkyl acids among normotensives and hypertensives across various stages of glomerular function	2021	Arch. Environ. Occup. Health 2021 Jan:76(1):12-22. doi: 10.1080/19338244.2020.1732856.	Data (N = 10643) from National Health and Nutrition Examination Survey for US adults aged > = 20 years for 2003-2016 were analyzed to evaluate how concentrations of selected perfluoroalkyl acids (PFAA) vary among normotensives and hypertensives across various stages of glomerular function (GF) namely from stage 1 to stage 3B/4. Regression models stratified by GF stages and hypertension status were fitted for each of the five PFAAs, namely, PFOA, PFOS, PFDA, PFHxS, and PFNA. For the total population, hypertensives had higher adjusted levels than normotensives for GF-1, GF-2, and GF-3A with highest differences being at GF-3A for every PFAA. At GF-3B/4, hypertensives had lower adjusted geometric means (AGM) than normotensives. While AGMs for PFAA for hypertensives followed inverted U-shaped distributions with points of inflections at GF-3A, for normotensives the points of inflections were at GF-2 or GF-3A.			1					A	B	糸球体機能の高血圧者のPFAS濃度に関する知見	
D1105	ADME	Zhu, YM; Jia, YB; Liu, ML; Yang, LP; Yi, SJ; Feng, XM; Zhu, LY	Mechanisms for tissue-specific accumulation and phase I/II transformation of 6:2 fluorotelomer phosphate diester in earthworm (M. guillelmi)	2021	Environ. Int. 2021 Jun:151:106451. doi: 10.1016/j.envint.2021.106451.	Polyfluoroalkyl phosphate esters (PAPs) are high production volume surfactants used in the food contact paper and packaging industries. They are prone to partition to soil due to their strong hydrophobicity and may biotransform into recalcitrant perfluoroalkyl carboxylic acids (PFCAs); little is known about their fate and behaviors in terrestrial organisms. Here, geophagous earthworms (M. guillelmi) were exposed to 6:2 fluorotelomer phosphate diester (6:2 diPAP)-contaminated soil to examine tissue-specific accumulation and biotransformation. 6:2 diPAP quickly accumulated in M. guillelmi with the highest biota-soil-accumulation factor (BSAF) in the gut, followed by the organs, skin, and body fluid. The total amount of 6:2 diPAP accumulated in the skin was the highest due to its high mass content. These results indicated that skin absorption and gut processes were two major pathways for earthworms to accumulate 6:2 diPAP from soil. In vitro desorption experiments indicated that the gut digestion fluid greatly promoted the desorption of 6:2 diPAP from the soil and enhanced its bioavailability. Degradation of 6:2 diPAP in the soil was stimulated when the earthworm appeared. In contrast to the soil, a more extensive transformation occurred in the earthworm. Perfluorohexanoic acid (PFHxA) was the primary phase I product, followed by perfluoropentyl propanoic acid (FPePA), perfluoropentanoic acid (PFPeA), 2-perfluorohexyl ethanoic acid (FHEA), and perfluoroheptanoic acid (PFHpA), which confirmed the occurrence of ?-and ?-oxidation in earthworms. For the first time, a new phase II product, namely, a 6:2 fluorotelomer alcohol sulfate conjugate, was identified in earthworms at unexpectedly high levels, which might be the primary way earthworms eliminate 6:2 diPAP. Both in vivo and in vitro experiments suggested that 6:2 diPAP experienced faster and more extensive biotransformation in the gut than in the organs. This work sheds light on the bioaccumulation and biotransformation of 6:2 diPAP in terrestrial invertebrates, providing strong evidence of indirect sources of PFCAs in the environment.		1						C	C		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1106	ADME	Mertens, JJWM; Sved, DW; Marit, GB; Myers, NR; Stetson, PL; Murphy, SR; Schmit, B; Shinohara, M; Farr, CH	Subchronic Toxicity of S-111-S-WB in Sprague Dawley Rats	2010	Int. J. Toxicol. 2010 Jul:29(4):358-371. doi: 10.1177/1091581810370372.	S-111-S-WB, a mixture of perfluoro fatty acid ammonium salts (C(6)-C(13)), was administered orally to Crl:CD (SD)IGS-BR rats. Higher hepatic b-oxidation and liver weights with hepatocellular hypertrophy were present at the 0.125 and 0.6 mg/kg/d dosage. The 0.6 mg/kg/d males developed hepatocellular degeneration and necrosis. Lower serum protein and higher bilirubin and BUN were seen in the 0.6 mg/kg/d males and lower globulin and higher alkaline phosphatase in the 0.125 mg/kg/d males and 0.6 mg/kg/d animals. After 2 weeks, serum concentrations of pentadecafluorooctanoic acid (C(8)), heptadecafluorononanoic acid (C(9)), perfluoroundecanoic acid (C(11)), and perfluorotridecanoic acid (C(13)) were constant for at least 8 hours. After 90 days, only C(9) in the 0.025 mg/kg/d females had reached steady state. Serum C(8) and C(9) concentrations in the males were 10-fold higher than in the females, whereas C(11) and C(13) were similar for both genders. The main elimination was via the urine for C(8) (males) and C(9) (females), and via the feces for C(11) and C(13). The no-observed-effect level (NOEL) was 0.025 mg/kg/d for the males and 0.125 mg/kg/d for the females.			1				1	A	A	ラットにおける動態に関する知見	S-111-S-WB（主要成分PFNA）のラット体内動態
D1107	ADME	Khazaee, M; Christie, E; Cheng, WX; Michalsen, M; Field, J; Ng, C	Perfluoroalkyl Acid Binding with Peroxisome Proliferator-Activated Receptors alpha, gamma, and delta, and Fatty Acid Binding Proteins by Equilibrium Dialysis with a Comparison of Methods	2021	Toxics. 2021 Mar;9(3):45. doi: 10.3390/toxics9030045.	The biological impacts of per- and polyfluorinated alkyl substances (PFAS) are linked to their protein interactions. Existing research has largely focused on serum albumin and liver fatty acid binding protein, and binding affinities determined with a variety of methods show high variability. Moreover, few data exist for short-chain PFAS, though their prevalence in the environment is increasing. We used molecular dynamics (MD) to screen PFAS binding to liver and intestinal fatty acid binding proteins (L- and I-FABPs) and peroxisome proliferator activated nuclear receptors (PPAR-alpha, -delta and -gamma) with six perfluoroalkyl carboxylates (PFCAs) and three perfluoroalkyl sulfonates (PFSAs). Equilibrium dissociation constants, K(D)s, were experimentally determined via equilibrium dialysis (EqD) with liquid chromatography tandem mass spectrometry for protein-PFAS pairs. A comparison was made between K(D)s derived from EqD, both here and in literature, and other in vitro approaches (e.g., fluorescence) from literature. EqD indicated strong binding between PPAR-delta and perfluorobutanoate (0.044 +/- 0.013 mu M) and perfluorohexane sulfonate (0.035 +/- 0.0020 mu M), and between PPAR-alpha and perfluorohexanoate (0.097 +/- 0.070 mu M). Unlike binding affinities for L-FABP, which increase with chain length, K(D)s for PPARs showed little chain length dependence by either MD simulation or EqD. Compared with other in vitro approaches, EqD-based K(D)s consistently indicated higher affinity across different proteins. This is the first study to report PPARs binding with short-chain PFAS with K(D)s in the sub-micromolar range.		1						C	C		
D1108	ADME	Bruno, S; Bersani, M; Astore, S; Chiabotto, G; Barge, A; Binello, A; Spyrakis, F	Lack of interaction of the fluorosurfactant C604 with human renal transporters: In vitro/in silico analysis	2022	Toxicology. 2022 Jun:476:153257. doi: 10.1016/j.tox.2022.153257.	C6O4 is a water soluble perfluoroether carboxylic acid ammonium salt used as surfactant in the synthesis of fluompolymers. Available experimental data in rats exposed by the oral route indicate it is eliminated in urine. Previous studies with various linear perfluomcarboxylic acids have suggested that these compounds are substrates of renal membrane transporters in rats and humans, and that the interaction with basal and apical membrane transporters can influence the elimination kinetic by these organisms and explain, in part, the observed differences in the respective half-lives. In particular, apical transporters may contribute to the reuptake of these exogenous compounds from the tubule lumen. The present study was designed to investigate the uptake of C6O4 in two renal cell lines transiently transfected with the human apical membrane transporters, organic anion transporter 4 (OAT4), and urate transporter 1 (URAT1). The uptake of the linear perfluorohexanoic acid (PFC6) was evaluated in parallel. While the uptake of the conjugated steroid estrone-3-sulfate (E3S), a known substrate for renal transporters, and of PFC6 was clearly observed in both cell types transfected with either OAT4 or URAT1, no significant uptake of C6O4 was measured under the same test conditions. The results of the transporter's functionality measured in vitro were consistent with molecular docking simulations. Both outward and inward models of the transporters showed a reduced interaction between C6O4 and URAT1 or OAT4. In contrast, more stable interactions were predicted for PFC6 and PFOA, as well as for the E3S substrate, as shown by the respective docking scores reflecting the binding strength and by the poses assumed in the transporter channels. Altogether, the in vitro and in silico modeling results showed a low reuptake potential and limited interactions of C6O4 molecule with two human apical membrane transporters, contrasting with the more efficient reuptake of PFC6 from the tubule lumen. These results suggest reabsorption from the proximal tubule by apical renal transporters is not likely to interfere with the elimination pathway of C6O4 in humans.		1						C	C		
D1109	PBPK	Kamiya, Y; Yanagi, M; Hina, S; Shigeta, K; Miura, T; Yamazaki, H	Plasma, liver, and kidney exposures in rats after oral doses of industrial chemicals predicted using physiologically based pharmacokinetic models: A case study of perfluorooctane sulfonic acid	2020	J. Toxicol. Sci. 2020;45(12):763-767. doi: 10.2131/jts.45.763.	A simplified physiologically based pharmacokinetic (PBPK) model consisting of chemical receptor, metabolizing and/or excreting, and central compartments was recently proposed. In the current study, this type of PBPK model was set up for perfluorooctane sulfonate, an environmental toxicant with liver effects, as a model compound; the model was then used to estimate tissue concentrations. The pharmacokinetic parameter input values for the model were calculated to give the best fit to reported/measured blood substrate concentrations in rats. The maximum concentrations and areas under the concentration versus time curves in plasma, liver, and kidney extrapolated using PBPK models for perfluorobutane sulfonic acid, perfluorohcxane sulfonic acid, and perfluorooctane sulfonic acid were consistent with the reported mean values in rats. Using the rat models and scaled-up human PBPK models, some accumulation of perfluorooctane sulfonic acid in plasma and liver was seen after repeated doses. The reported 50th and 95th percentile concentrations of perfluorooctane sulfonic acid in human blood (0.0048 and 0.0183 ng/mL, respectively) in the general population underwent reverse dosimetry analysis using our PBPK models. These human blood concentrations potentially imply exposures of 0.041 and 0.16 mu g/kg/day, respectively, for 90 days, values that are roughly similar to the reference dose (0.02 mu g/kg/day) with an uncertainty factor of 30. These results indicate the relatively good estimates for tissue and blood exposures of chemical substrates after oral doses generated using the latest PBPK models.			1			1		A	C	PBPKモデルを用いたラット組織分布に関する知見	PBPK models for perfluorobutane sulfonic acid, perfluorohexane sulfonic acid, and perfluorooctane sulfonic acid
D1110	ADME	Kato, K; Wong, LY; Basden, BJ; Calafat, AM	Effect of temperature and duration of storage on the stability of polyfluoroalkyl chemicals in human serum	2013	Chemosphere. 2013 Apr:91(2):115-117. doi: 10.1016/j.chemosphere.2012.11.013.	We assessed the potential impact of temperature on the long-term stability of several polyfluoroalkyl chemicals in serum. We evaluated the concentrations of perfluorooctane sulfonate, perfluorohexane sulfonate, perfluorooctanoate and perfluorononanoate in 16 human serum samples stored at room temperature, 5 degrees C, -20 degrees C and -70 degrees C at several time points during an eight month period. Concentrations of the target analytes remained unchanged under all studied conditions, even when serum was kept at room temperature for 10 days.			1					C	C		
D1111	ADME	Lu, RC; Cao, AN; Lai, LH; Xiao, JX	Protein-surfactant interaction: Differences between fluorinated and hydrogenated surfactants	2008	Colloid Surf. B-Biointerfaces. 2008 Jun:64(1):98-103. doi: 10.1016/j.colsurfb.2008.01.009.	The interactions of proteins with fluorinated/hydrogenated surfactants were investigated by circular dichroism and turbidity measurement. Pairs of fluorinated and hydrogenated surfactants with similar critical micelle concentrations (cmc), including sodium perfluorooctanoate/sodium decylsulfate and lithium perfluorononanoate/sodium dodecylsulfate were compared in view of their interactions with proteins including BSA, lysozyme, beta-lactoglobulin and ubiquitin. It was found that fluorinated surfactants exhibited stronger interactions with proteins than hydrogenated ones, which, however, depended on the structures of both proteins and surfactant molecules. If the proteins are very stable, or the surfactant-protein interactions are very strong, such differences between the two kinds of surfactants might be indistinguishable.			1					C	C		
D1112	PBPK	Bernstein, AS; Kapraun, DF; Schlosser, PM	A Model Template Approach for Rapid Evaluation and Application of Physiologically Based Pharmacokinetic Models for Use in Human Health Risk Assessments: A Case Study on Per- and Polyfluoroalkyl Substances	2021	Toxicol. Sci. 2021 Aug:182(2):215-228. doi: 10.1093/toxsci/kfab063.	Physiologically based pharmacokinetic (PBPK) models are commonly used in risk assessments to perform inter- and intraspecies extrapolations as well as to extrapolate between different dosing scenarios; however, they must first undergo quality assurance review, which can be a time-consuming process, especially when model code is not readily available. We developed and implemented (using R and MCSim) a PBPK model template capable of replicating published model results for several chemical-specific PBPK models. This model template allows for faster quality assurance review because the general model equations only need to be reviewed once, and application to a specific chemical then only requires reviewing input parameters. The model template can implement PBPK models with oral and intravenous exposure routes, varying numbers of tissue compartments, renal reabsorption, and multiple elimination pathways, including fecal, urinary, and biliary. Using the model template, we reproduced published model simulation results for perfluorohexanesulfonic acid, perfluorononanoic acid, perfluorodecanoic acid, perfluorooctanoate, and perfluouorooctane sulfonate. We also show that the template can be a useful tool for identifying potential model errors. Thus, the model template allows for faster evaluation and review of published PBPK models and provides a proof of concept for using this approach with broader classes of chemical-specific PBPK models.			1					A	B	PBPKモデル構築に関する知見	
D1113	ADME	Ma, J; Zhu, HK; Kannan, K	Fecal Excretion of Perfluoroalkyl and Polyfluoroalkyl Substances in Pets from New York State, United States	2020	Environ. Sci. Technol. Lett. 2020 Mar:7(3):135-142. doi: 10.1021/acs.estlett.9b00786.	Human exposure to per- and polyfluoroalkyl substances (PFASs) continues to be a concern. Little is known about their toxicokinetics, particularly with regard to fecal excretion of PFASs. Because pets are sentinels of human exposure to environmental contaminants, analysis of PFASs in pet feces can provide information about rates of excretion of these chemicals. In this study, 15 PFASs were measured in cat and dog feces collected from the Albany area of New York State. All PFASs except perfluorodecanesulfonate and perfluoroheptanoic acid were found in cat and dog feces. The sum concentrations of 13 PFASs (Sigma PFAS) varied between 21.6 and 474 (mean: 85.4 +/- 94.5) ng/g dry weight for dogs, which were slightly higher than those found for cats (range: 18.0-165 ng/g dry weight, mean: 54.7 +/- 26.9 ng/g dry weight). Long-chain perfluorocarboxylic acids with 9-12 carbons (perfluorononanoic acid, perfluorodecanoic acid, perfluoroundecanoic acid, and perfluorododecanoic acid) were predominant in pet feces. Perfluorooctanesulfonate and its precursors were found at low concentrations. Fecal excretion rates of PFASs in cats and dogs were found to be similar. The estimated daily fecal excretion suggested that both dogs and cats are exposed to some PFASs at doses above the provisional minimum risk level recommended for humans.			1					C	C		

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D1114	ADME	Bartels, JL; Fernandez, SR; Aweda, TA; Alford, A; Peaslee, GF; Garbow, JR; Lapi, SE	Comparative Uptake and Biological Distribution of [F-18]-Labeled C6 and C8 Perfluorinated Alkyl Substances in Pregnant Mice via Different Routes of Administration	2020	Environ. Sci. Technol. Lett. 2020 Sep;7(9):665-671. doi: 10.1021/acs.estlett.0c00367.	Elevated blood sera concentrations of perfluorinated and polyfluorinated alkyl substances (PFAS) are associated with many adverse human health effects, including lower birth weight children. Yet the biodistribution of PFAS between mother and fetus remains unknown. The first comparative uptake and in vivo biodistribution study of long-chain and short-chain PFAS was performed on healthy, pregnant mice via two routes of administration, tail vein injection and oral gavage ingestion. Two F-18 radiolabeled PFAS, [F-18]PFOA (C8) and [F-18]PFHxA (C6), were administered to pregnant mice, and real-time distribution was investigated by dynamic positron emission tomography (PET). Post imaging, the biodistribution of the radio-labeled PFAS compounds were quantified by ex vivo gamma counting. Imaging following tail vein administration showed rapid uptake of both [F-18]PFAS in placentae followed by transport into fetuses. Oral gavage showed a slower uptake but still exhibited transport across the placenta. PFAS uptake was found in all tissues examined, with the highest uptake being exhibited in the blood for both [F-18]C8 and [F-18]C6 via tail vein and the lungs via oral gavage. These initial results provide insight into the link between PFAS exposure in pregnant mammals and offspring health.		1						1	A	A	妊娠マウスにおける組織分布に関する研究	
D1115	ADME	Guo, PF; Furnary, T; Vasiliou, V; Yan, Q; Nyhan, K; Jones, DP; Johnson, CH; Liew, Z	Non-targeted metabolomics and associations with per- and polyfluoroalkyl substances (PFAS) exposure in humans: A scoping review	2022	Environ. Int. 2022 Apr:162:107159. doi: 10.1016/j.envint.2022.107159.	Objective: To summarize the application of non-targeted metabolomics in epidemiological studies that assessed metabolite and metabolic pathway alterations associated with per- and polyfluoroalkyl substances (PFAS) exposure. Recent Findings: Eleven human studies published before April 1st, 2021 were identified through database searches (PubMed, Dimensions, Web of Science Core Collection, Embase, Scopus), and citation chaining (Citationchaser). The sample sizes of these studies ranged from 40 to 965, involving children and adolescents (n = 3), nonpregnant adults (n = 5), or pregnant women (n = 3). High-resolution liquid chromatography-mass spectrometry was the primary analytical platform to measure both PFAS and metabolome. PFAS were measured in either plasma (n = 6) or serum (n = 5), while metabolomic profiles were assessed using plasma (n = 6), serum (n = 4), or urine (n = 1). Four types of PFAS (perfluorooctane sulfonate (n = 11), perfluorooctanoic acid (n = 10), perfluorohexane sulfonate (n = 9), perfluorononanoic acid (n = 5)) and PFAS mixtures (n = 7) were the most studied. We found that alterations to tryptophan metabolism and the urea cycle were most reported PFAS-associated metabolomic signatures. Numerous lipid metabolites were also suggested to be associated with PFAS exposure, especially key metabolites in glycerophospholipid metabolism which is critical for biological membrane functions, and fatty acids and carnitines which are relevant to the energy supply pathway of fatty acid oxidation. Other important metabolome changes reported included the tricarboxylic acid (TCA) cycle regarding energy generation, and purine and pyrimidine metabolism in cellular energy systems. Conclusions: There is growing interest in using non-targeted metabolomics to study the human physiological changes associated with PFAS exposure. Multiple PFAS were reported to be associated with alterations in amino acid and lipid metabolism, but these results are driven by one predominant type of pathway analysis thus require further confirmation. Standardizing research methods and reporting are recommended to facilitate result comparison. Future studies should consider potential differences in study methodology, use of prospective design, and influence from confounding bias and measurement errors.			1						B	C		
D1116	ADME	Schwarz R, Schuurmans M, Seelig J, Künnecke B.	19F-MRI of perfluorononane as a novel contrast modality for gastrointestinal imaging	1999	Magn Reson Med. 1999 Jan;41(1):80-6. doi: 10.1002/(sici)1522-2594(199901)41:1<80::aid-mrm12>3.0.co;2-6.	19F-Magnetic resonance imaging in conjunction with perfluorononane provides a new modality for gastrointestinal (GI) imaging as is demonstrated here with an animal model. Perfluorononane was found to be an ideal oral contrast agent since it is biologically inert, immiscible with water, and since it has a low viscosity and surface tension. Furthermore, its high fluorine content, together with the high sensitivity of 19F-MRI, allowed highly selective MR images of the GI tract of mice to be acquired. Due to the lack of 19F background signals, the contrast of the GI tract was only limited by the signal-to-noise ratio of the 19F-MR images. 19F-RARE images of 1-mm slices with an in-plane resolution of 0.23 x 0.23 mm2 were obtained from the GI tract after oral perfluorononane administration. The passage of perfluorononane through the entire GI tract was monitored by repetitive MR measurements with a maximal time resolution of 38 s. The three-dimensional surfaces of the GI tract were reconstructed and superimposed on corresponding 1H-MR images, which provided complementary anatomical information.									B	C		
D1117	ADME	Gannon SA, Fasano WJ, Mawn MP, Nabb DL, Buck RC, Buxton LW, Jepson GW, Frame SR.	Absorption, distribution, metabolism, excretion, and kinetics of 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)propanoic acid ammonium salt following a single dose in rat, mouse, and cynomolgus monkey	2016	Toxicology. 2016 Jan 18;340:1-9. doi: 10.1016/j.tox.2015.12.006. Epub 2015 Dec 29.	Ammonium, 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate has been developed as a processing aid used in the manufacture of fluoropolymers. The absorption, distribution, elimination, and distribution (ADME) and kinetic behavior of this substance has been evaluated in rats, mice, and cynomolgus monkeys by oral and intravenous routes of exposure and studied in both plasma and urine. The test substance is rapidly and completely absorbed in both rats and mice and both in vivo and in vitro experiments indicate that it is not metabolized. The test substance is rapidly eliminated exclusively in the urine in both rats and mice, with rats eliminating it more quickly than mice (approximately 5h elimination half-life in rats, 20 h half-life in mice). Pharmacokinetic analysis in monkeys, rats, and mice indicate rapid, biphasic elimination characterized by a very fast alpha phase and a slower beta phase. The beta phase does not contribute to potential accumulation after multiple dosing in rats or monkeys. Comparative pharmacokinetics in rats, mice, and monkeys indicates that the rat is more similar to the monkey and is therefore a more appropriate rodent model for pharmacokinetics in primates.									D	A	各動物種における体内動態に関する知見であるが対象PFASについては不明	GenX?
D1118	ADME	Rosen EM, Brantsæter AL, Carroll R, Haug L, Singer AB, Zhao S, Ferguson KK.	Maternal Plasma Concentrations of Per- and polyfluoroalkyl Substances and Breastfeeding Duration in the Norwegian Mother and Child Cohort	2018	Environ Epidemiol. 2018 Sep;2(3):e027. doi: 10.1097/EE9.0000000000000027.	Background: Per- and polyfluoroalkyl substances (PFASs) have been widely produced, many of them persist in the environment, and have been associated with various health effects. Previous studies have identified inverse associations between perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS) and breastfeeding duration, but have been limited in investigation of other PFASs. Methods: We measured the associations between plasma concentrations of 9 different PFASs and cessation of breastfeeding before 3 and 6 complete months using women from the Norwegian Mother and Child Cohort Study (MoBa). The study population includes 1716 primarily nulliparous women from two previous studies of MoBa participants, enrolled from 2003-2007. The association was measured using Cox proportional hazards model. Mixtures analyses were performed using Elastic net regularization to identify interactive effects and control for co-pollutant confounding. Results: Concentrations of PFASs in this population were lower than concentrations in the previous studies on this topic. We found associations between increasing concentrations of perfluorononanoic acid (PFNA), perfluorodecaconic acid (PFDA), perfluoroundecanoic acid (PFUnDA) and decreased breastfeeding cessation (increased duration). The strongest associations were seen between PFDA and PFUnDA and cessation before 3 months: (both hazard ratios = 0.73, 95% confidence intervals: 0.62, 0.86). In our population, the other PFASs appeared to be unassociated with breastfeeding cessation. The mixtures analyses identified meaningful interactions between PFUnDA:PFDA, perfluorohexane sulfonate (PFHXS):PFOA and PFOA:PFOS. Conclusions: The identification of associations between previously unexamined PFASs concentrations and increased breastfeeding duration is novel and may be explained by differences in transplacental transfer rates.			1					1	A	A	母体血漿中濃度に関する知見	
D1119	ADME	Ducatman A, Luster M, Fletcher T.	Perfluoroalkyl substance excretion: Effects of organic anion-inhibiting and resin-binding drugs in a community setting	2021	Environ Toxicol Pharmacol. 2021 Jul;85:103650. doi: 10.1016/j.etap.2021.103650. Epub 2021 Apr 2.	Background: Longer serum half-lives of perfluoroalkyl substances (PFAS) in humans compared to other species has been attributed to differences in the activity of organic anion transporters (OAT). Methods: Among 56,175 adult participants in the community-based C8 Health Project, 23 subjects were taking the uricosuric OAT-inhibitor probenecid, and 36 subjects were taking the bile acid sequestrant cholestyramine. In regression models of log transformed serum PFAS, medication effects were estimated in terms of mean ratios, adjusting for age, gender, BMI, estimated glomerular filtration rate (eGFR) and water-district of residence. Results: Probenecid was associated with modest, but not statistically significant increases in serum PFAS concentrations. In contrast, cholestyramine significantly lowered serum PFAS concentrations, notably for perfluorooctane sulfonic acid (PFOS). Conclusions: The effectiveness of cholestyramine in a community setting supports the importance of gastrointestinal physiology for PFAS excretion kinetics, especially for PFOS. We did not find clear evidence that probenecid, an inhibitor of OAT, affects PFAS clearance.									D	D	薬剤との併用に関する知見であるが対象PFASについて不明	

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D1120	ADME	Ruggiero MJ, Miller H, Idowu JY, Zitzow JD, Chang SC, Hagenbuch B.	Perfluoroalkyl Carboxylic Acids Interact with the Human Bile Acid Transporter NTCP	2021	Livers. 2021 Dec;1(4):221-229. doi: 10.3390/livers1040017. Epub 2021 Oct 18.	Na+/taurocholate cotransporting polypeptide (NTCP) is important for the enterohepatic circulation of bile acids, which has been suggested to contribute to the long serum elimination half-lives of perfluoroalkyl substances in humans. We demonstrated that some perfluoroalkyl sulfonates are transported by NTCP; however, little was known about carboxylates. The purpose of this study was to determine if perfluoroalkyl carboxylates would interact with NTCP and potentially act as substrates. Sodium-dependent transport of [3H]-taurocholate was measured in human embryonic kidney cells (HEK293) stably expressing NTCP in the absence or presence of perfluoroalkyl carboxylates with varying chain lengths. PFCAs with 8 (PFOA), 9 (PFNA), and 10 (PFDA) carbons were the strongest inhibitors. Inhibition kinetics demonstrated competitive inhibition and indicated that PFNA was the strongest inhibitor followed by PFDA and PFOA. All three compounds are transported by NTCP, and kinetics experiments revealed that PFOA had the highest affinity for NTCP with a Km value of 1.8 ± 0.4 mM. The Km value PFNA was estimated to be 5.3 ± 3.5 mM and the value for PFDA could not be determined due to limited solubility. In conclusion, our results suggest that, in addition to sulfonates, perfluorinated carboxylates are substrates of NTCP and have the potential to interact with NTCP-mediated transport.			1					B	C		
D1121	ADME	Goodrich JA, Walker D, Lin X, Wang H, Lim T, McConnell R, Conti DV, Chatzi L, Setiawan VW.	Exposure to perfluoroalkyl substances and risk of hepatocellular carcinoma in a multiethnic cohort	2022	JHEP Rep. 2022 Aug 8;4(10):100550. doi: 10.1016/j.jhepr.2022.100550. eCollection 2022 Oct.	Background & aims: Exposure to poly- and perfluoroalkyl substances (PFAS), a class of persistent organic pollutants, is ubiquitous. Animal studies suggest that PFAS may increase risk of fatty liver and hepatocellular carcinoma (HCC) via impacts on hepatic lipid, amino acid, and glucose metabolism, but human data is lacking. We examined associations between PFAS exposure, altered metabolic pathways, and risk of non-viral HCC. Methods: In this nested case-control study, pre-diagnostic plasma PFAS and metabolomics were measured in 50 incident HCC cases and 50 individually matched controls from the Multiethnic Cohort (MEC) study. Cases/controls were matched by age, sex, race, and study area. PFAS exposure and risk of HCC were examined using conditional logistic regression. A metabolome-wide association study and pathway enrichment analysis was performed for PFAS exposure and HCC risk, and key metabolites/metabolic pathways were identified using a meet in the middle approach. Results: High perfluorooctane sulfonic acid (PFOS) levels (90th percentile from NHANES; >55 μg/L) were associated with 4.5-fold increased risk of HCC (odds ratio 4.5, 95% CI 1.2-16.0). Pathway enrichment analysis showed that PFOS exposure was associated with alterations in amino acid and glycan biosynthesis pathways, which were also associated with HCC risk. We identified 4 metabolites linking PFOS exposure with HCC, including glucose, butyric acid (a short-chain fatty acid), α-ketoisovaleric acid (a branched-chain α-keto acid), and 7α-hydroxy-3-oxo-4-cholestenoate (a bile acid), each of which was positively associated with PFOS exposure and risk of HCC. Conclusion: This proof-of-concept analysis shows that exposure to high PFOS levels was associated with increased risk of non-viral HCC, likely via alterations in glucose, amino acid, and bile acid metabolism. Larger studies are needed to confirm these findings. Lay summary: Per- and polyfluoroalkyl substances (PFAS), often referred to as "forever chemicals" because they are difficult to break down and stay in the human body for years, are extremely common and can cause liver damage. In a first of its kind study, we found that exposure to high levels of perfluorooctanesulfonic acid, one of the most common PFAS chemicals, was linked to increased risk of hepatocellular carcinoma in								D	C	PFAS曝露と肝細胞がんリスクに関する知見であるが対象PFASについて不明	
D1122	ADME	Zhang M, Yu CH, Wang G, Buckley JP, Hong X, Pearson C, Adams WG, Fan ZT, Wang X.	Longitudinal trajectories and determinants of plasma per- and polyfluoroalkyl substance (PFAS) levels from birth to early childhood and metabolomic associations: A pilot study in the Boston Birth Cohort	2022	Precis Nutr. 2022 Jun;1(1):e00004. Epub 2022 Jun 13.doi: 10.1097/PN9.0000000000000003	Background: Per- and polyfluoroalkyl substances (PFAS) are a major public health concern worldwide due to their ubiquitous exposures, environmental persistence, maternal-to-fetal transfer, and multi-organ toxicity. This pilot study aimed to generate preliminary data to inform future studies to address data gaps in the field, including early life PFAS exposure levels, longitudinal changes, determinants, and associated metabolomic alterations in understudied Black and Hispanic children in the United States (U.S.). Methods: This study leveraged existing biosamples and data in the Boston Birth Cohort and measured 12 legacy and emerging PFAS, including Me-PFOSA-AcOH, PFDA, PFDoA, PFHxS, PFNA, PFOA, PFOS, PFUnA, GenX, ADONA, 9Cl-PF3ONS, and PFHpS, in paired cord and early childhood plasma samples. Summary statistics and graphic plots were used to depict PFAS levels at the two time points and their longitudinal changes. Linear regression models were used to identify the early-life factors associated with cord and early childhood PFAS levels. Associations of cord PFAS with cord metabolites were explored using a metabolome-wide association approach and a targeted approach. Results: This study included 39 children, of whom 25 (64%) were Black, 14 (36%) were Hispanic, and 15 (38%) were female. PFOA, PFOS, PFNA, and PFHpS were detectable in all cord and early childhood plasma samples, while GenX and ADONA were not detectable in any sample. Cord PFAS levels were weakly-to-moderately correlated with early childhood PFAS levels (r = -0.03 to 0.40). Several maternal and child factors, including gestational age, year at blood collection, and race/ethnicity, were associated with cord and early childhood PFAS levels. The metabolome-wide association study and the targeted study identified several cord metabolites that may have been affected by in utero PFAS exposure. Conclusions: This pilot study found ubiquitous exposure to multiple PFAS in cord plasma (reflects in utero exposure) and in early childhood plasma (reflects both prenatal and postnatal exposure) among U.S. Black and Hispanic children. Metabolomic analysis suggests that in utero PFAS exposures may alter fetal metabolism. Future large-scale studies are needed to replicate the findings and further examine the associations of fetal PFAS exposure with long-term health outcomes and underlying metabolic pathways.			1		1		1	A	A	出生から幼児期にかけての血漿中PFAS濃度に関する知見	
D1123	ADME	Yukiko Fujii, Tamon Niisoe, Kouji H. Harada, Shinji Uemoto, Yasuhiro Ogura, Katsunobu Takenaka, Akio Koizumi	Toxicokinetics of perfluoroalkyl carboxylic acids with different carbon chain lengths in mice and humans	2015	Journal of Occupational Health, 2015年 57 巻 1 号 1-12. doi: 10.1539/joh.14-0136-OA.	Objectives: Perfluoroalkyl carboxylic acids (PFCAs) consist of analogs with various carbon chain lengths. Their toxicokinetics have remained unexplored except in the case of perfluorooctanoic acid (8 carbon chemicals). This study aimed to investigate the toxicokinetics of PFCAs with six to fourteen carbon atoms (C6 to C14) in mice and humans. Methods: We applied a two-compartment model to mice administered PFCAs intravenously or by gavage. The time courses of the serum concentration and tissue distribution and elimination were evaluated for 24 hours after treatment. For human samples, urine from healthy volunteers, bile from patients who underwent biliary drainage, and cerebral spinal fluid (CSF) from brain drainage were collected. Results: The mouse experiment showed that short-chained PFCAs (C6 and C7) were rapidly eliminated in the urine, whereas long-chain PFCAs (C8 to C14) accumulated in the liver and were excreted slowly in feces. Urinary clearance of PFCAs in humans also decreased with increasing alkyl chain lengths, while biliary clearances increased. C9 to C10 had the smallest total clearance for both mice and humans. However, disparities existed in the magnitude of the total clearance between mice and humans. A slightly higher partition ratio (brain/serum) was observed for long-chained PFCAs in mice, but this was not observed in the corresponding partition ratio in humans (CSF/serum). Conclusions: The large sequestration volumes of PFCAs in the liver seem to be attributable to the liver's large binding capacity in both species. This will be useful in evaluating PFCA bioaccumulation in other species.								1	A	A	マウス、ヒトにおけるPFASのTKに関する知見	
D1124	ADME	Iwabuchi Katsumi(Iwate Institute of Environmental Health Sciences), Senzaki Norimasa, Mazawa Daichi, Sato Itaru, Hara Michihiro, Ueda Fukiko, Liu Wei, Tsuda Shuji	雄ラットにおける単回および慢性の低用量投与でのペルフルオロ化合物の組織トキシコキネティクス(Tissue toxicokinetics of perfluoro compounds with single and chronic low doses in male rats)(英語)	2017	The Journal of Toxicological Sciences(0388-1350)42巻3号 Page301-317(2017.06). doi: 10.2131/jts.42.301.	各種ペルフルオロ化合物の低用量をラットへ単回投与または長期投与し、血液や各主要臓器への分布を調べた。被験ペルフルオロ化合物には、ペルフルオロヘキサン酸(C6A)、ペルフルオロオクタン酸、ペルフルオロノナン酸、ペルフルオロオクタンスルホン酸を用意した。雄Wistarラットに上記4種の混合物を強制経口単回投与し、5分後～28日後時点での血液、脳、心、肝、脾、腎臓の各検体を採取した。また4種混合物の水溶液を飲み水として1または3ヵ月飼育して屠殺し各検体を得た。これらの4種の単回投与における分布を調べたところ、C6Aは組織において非常に急速に吸収、分布、消失し、その半減期は2～3時間と、どの臓器組織でもほぼ同じであった。血清の分布容積と組織送達を考慮した結果、C6Aは主に血清中に分布し脳への送達量は低いことが示された。また慢性投与でもC6Aの蓄積は認められなかった。他の3種の化合物については、ラット生体を独立した1-コンパートメントの組み合わせとみなすことができ、その肝での半減期は血清の半減期よりも長かった。ヒトに関する既報のデータと今回の結果とを突き合わせると、ヒトの場合でもC6Aが脳や肝へ著明に高度蓄積しうる可能性が示唆された。								No. 485と重複		A	A	ラットにおけるPFASのTKに関する知見	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1125	細胞毒性	Amstutz, VH; Cengo, A; Gehres, F; Sijm, DTHM; Vrolijk, MF	Investigating the cytotoxicity of per- and polyfluoroalkyl substances in HepG2 cells: A structure-activity relationship approach	2022	Toxicology. 2022 Oct:480:153312. doi: 10.1016/j.tox.2022.153312.	Per-and polyfluoroalkyl substances (PFAS) are a family of man-made chemicals with currently over 4'700 compounds identified. While toxicological data are available for some of the legacy PFAS, such as PFOA and PFOS, a knowledge gap remains concerning both emerging and legacy PFAS' toxicity due to the diversity of the PFAS. Therefore, a better understanding of the PFAS structure-activity relationship may prove helpful. The present study investigated a potential structure-activity relationship between PFAS and hepatotoxicity. As such, the effects of thirteen PFAS with varying carbon chain-length and functional head-groups (in a concentration range of 0-800 mu M) on the cell viability of HepG2 cells and intracellular reactive oxygen species formation have been tested using the MTT and DCFH assay, respectively. The exposure times were either 3 or 24 h. In addition, intracellular PFAS levels were determined in HepG2 after 24 h exposure. The present study demonstrated that the cytotoxicity of PFAS is dependent on their chain-length as cell viability decreased with increasing chain -length at both exposure times. Calculated Relative Potency Factors (RPF), based on the TC50 values, were used for a tentative ranking of PFAS regarding their hepatotoxicity: PFNA > PFDA > PFOS >= PFOA > PFHxS > PFBS >> PFHpA = PFHxA = PFBA = PFPrA = 6:2 FTOH = 4:2 = FTOH = 3:1 FTOH. Similar results were observed regarding intracellular reactive oxygen species generation at both exposure times, with a tentative ranking of: PFNA > PFOS > PFOA >= PFDA > PFHxS > PFBS > PFBA > PFHpA >= PFHxA > PFPrA > 6:2 FTOH = 4:2 FTOH = 3:1 FTOH. Moreover, a concentration-dependent reactive oxygen species generation has been observed for all PFSAs and PFCAs, but not for the FTOHs. In conclusion, the carbon chain-length and functional head -group of a PFAS determine their in vitro toxicity for the two toxicological endpoints assessed in the present study. Moreover, no effects were observed for the tested FTOHs. As such, the present study established a po-tential structure-activity relationship that opens the possibility of developing a predictive model to help with the risk assessment of PFAS in the future.	1	1	1	1			1	A	-	PFOAやPFOSのようなレガシーPFASは豊富な毒性学的データが入手可能であるが、PFASの構造は多様であり、毒性情報入手困難な新しいPFASについても評価を行う必要がある。本研究では、PFASと肝毒性との潜在的な構造活性相関を調査しており、情報の少ないPFASの毒性評価に有用。	
D1126	細胞毒性	Gorrochategui, E; Lacorte, S; Tauler, R; Martin, FL	Perfluoroalkylated Substance Effects in Xenopus laevis A6 Kidney Epithelial Cells Determined by ATR-FTIR Spectroscopy and Chemometric Analysis	2016	Chem. Res. Toxicol. 2016 May:29(5):924-932. doi: 10.1021/acs.chemrestox.6b00076.	The effects of four perfluoroalkylated substances (PFASs), namely, perfluorobutanesulfonate (PFBS), perfluorooctanoic acid (PFOA), perfluorooctanesulfonate (PFOS), and perfluorononanoic acid (PFNA) were assessed in Xenopus laevis A6 kidney epithelial cells by attenuated total reflection Fourier-transform infrared (ATR-FTIR) spectroscopy and chemometric analysis. Principal component analysis linear discriminant analysis (PCA-LDA) was used to visualize wavenumber-related alterations and ANOVA-simultaneous component analysis (ASCA) allowed data processing considering the underlying experimental design. Both analyses evidenced a higher impact of low-dose PFAS-treatments (10(-9) M) on A6 cells forming monolayers, while there was a larger influence of high-dose PFAS-treatments (10(-5) M) on A6 cells differentiated into dome structures. The observed dose response PFAS-induced effects were to some extent related to their cytotoxicity: the EC50-values of most influential PFAS-treatments increased (PFOS < PFNA < PFOA << PFBS), and higher-doses of these, chemicals induced a larger impact. Major spectral alterations were mainly attributed to DNA/RNA, secondary protein structure, lipids, and fatty acids. Finally, PFOS and PFOA. caused a decrease in A6 cell numbers compared to controls, whereas PFBS and PFNA did not significantly change cell population levels. Overall, this work highlights the ability of PFASs to alter A6 cells, whether forming monolayers or differentiated into dome structures, and the potential of PFOS and PFOA to induce cell death.			1	1				C	-		
D1127	細胞毒性	Otero-Sabio, C; Giacomello, M; Centelleghe, C; Caicci, F; Bonato, M; Venerando, A; Graic, JM; Mazzariol, S; Finos, L; Corain, L; Peruffo, A	Cell cycle alterations due to perfluoroalkyl substances PFOS, PFOA, PFBS, PFBA and the new PFAS C6O4 on bottlenose dolphin (Tursiops truncatus) skin cell	2022	Ecotox. Environ. Safe. 2022 Oct:244:113980. doi: 10.1016/j.ecoenv.2022.113980.	Per-and polyfluoroalkyl substances (PFAS) have become ubiquitous environmental contaminants in aquatic ecosystems worldwide. Marine mammals, as top predators, are constantly exposed to several PFAS compounds that accumulate in different tissues. As a proxy to assess cytotoxicity of PFAS in the bottlenose dolphin (Tursiops truncatus), we generated a new immortalized cell line derived from skin samples of bottlenose dolphin. Using high content imaging, we assessed the effects of increasing concentrations of PFOS, PFOA, PFBS, PFBA and C6O4 on cell viability and cell cycle phases. In particular, we classified all cells based on multiple morphometric differences of the nucleus in three populations, named respectively Normal (nuclei in G0, S and M phase); Large (nuclei showing characteristics of senescence) and Small (nuclei with fragmentation and condensed chromatin). Combining this approach with cell cycle analysis we determined which phases of the cell cycle were influenced by PFAS. The results revealed that the presence of PFOS, PFBS and PFBA could increase the number of cells in G0+G1 phase and decrease the number of those in the S phase. Moreover, PFOS and PFBS lowered the fraction of cells in the M phase. Interestingly PFOS, PFBS and PFBA reduced the prevalence of the senescence phenotype (large nuclei), suggesting a potential tumorigenic effect. Besides, the presence of PFOS and PFBS correlated also with a significant decrease in the number of small nuclei. The C6O4 exposure did not high-lighted morphometric alteration or cell cycle modification bottlenose dolphin skin cell nuclei. While the effects of PFAS on cell cycle was clear, no significant change was detected either in term of cell proliferation or of viability. This study fosters the overall knowledge on the cellular effects of perfluoroalkyl substances in marine mammals.	1			1				C	-		
D1128	細胞毒性	Mahapatra, CT; Damayanti, NP; Guffey, SC; Serafin, JS; Irudayaraj, J; Sepulveda, MS	Comparative in vitro toxicity assessment of perfluorinated carboxylic acids	2017	J. Appl. Toxicol. 2017 Jun:37(6):699-708. doi: 10.1002/jat.3418.	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are synthetic fluorinated compounds that are highly bioaccumulative and persistent organic pollutants. Perfluorooctanoic acid (PFOA), an eight-carbon chain perfluorinated carboxylic acid, was used heavily for the production of fluoropolymers, but concerns have led to its replacement by shorter carbon chain homologues such as perfluorohexanoic acid (PFHxA) and perfluorobutanoic acid (PFBA). However, limited toxicity data exist for these substitutes. We evaluated the toxicity of PFOA, PFHxA and PFBA on a zebrafish liver cell line and investigated the effects of exposure on cell metabolism. Gross toxicity after 96 h of exposure was highest for PFOA and PFO-, while PFHxA and PFBA exhibited lower toxicity. Although the structural similarity of these compounds to fatty acids suggests the possibility of interference with the transport and metabolism of lipids, we could not detect any differential expression of peroxisome proliferator-activated receptor (ppar-, - and -), fabp3 and crot genes after 96 h exposure to up to 10 ppm of the test compounds. However, we observed localized lipid droplet accumulation only in PFBA-exposed cells. To study the effects of these compounds on cell metabolism, we conducted fluorescence lifetime imaging microscopy using naturally fluorescent biomarkers, NADH and FAD. The fluorescence lifetimes of NADH and FAD and the bound/free ratio of each of these coenzymes decreased in a dose- and carbon length-dependent manner, suggesting disruption of cell metabolism. In sum, our study revealed that PFASs with shorter carbon chains are less toxic than PFOA, and that exposure to sublethal dosage of PFOA, PFHxA or PFBA affects cell metabolism.	1	1						B	-		
D1129	細胞毒性	Ojo, AF; Xia, Q; Peng, C; Ng, JC	Evaluation of the individual and combined toxicity of perfluoroalkyl substances to human liver cells using biomarkers of oxidative stress	2021	Chemosphere. 2021 Oct:281:130808. doi: 10.1016/j.chemosphere.2021.130808.	Although human exposure is to mixtures of per- and polyfluoroalkyl substances (PFAS), their combined effects and underlying mechanisms remain largely unknown. In this study, the combined effects of PFAS was investigated by treating human liver cells (HepG2) with various concentrations of perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorodecanoic acid (PFDA), perfluorononanoic acid (PFNA), and perfluorohexanoic acid (PFHxS) individually or in binary combinations (PFOS + PFOA, PFOS PFDA, PFOS PFNA, PFOS PFHxS, PFOA PFDA, PFOA PFNA, and PFOA PFHxS) for 24 h using an orthogonal design. The individual and binary combination effects of PFAS on the cytotoxicity, intracellular reactive oxygen species (ROS) production, and glutathione (GSH) levels were determined by MTS assay, dichlorofluorescein diacetate assay, and GSH-Glo (TM) Glutathione assay, respectively. The results showed that exposure to PFOA, PFOS, PFDA, PFNA, and PFHxS individually and in binary combinations caused concentration-dependent cytotoxicity to HepG2 cells. Also, intracellular ROS production was not significantly induced in both the individual and co-treatment groups, indicating that ROS production may not be likely influencing the combined cytotoxicity of PFAS to HepG2 cells. However, the depletion of the intracellular glutathione levels was correlated with cytotoxicity. Moreover, the factorial analysis results showed no significant interactive effects between PFOS + PFOA, PFOS + PFDA, PFOS + PFNA, PFOS + PFHxS, PFOA + PFDA, PFOA + PFNA, and PFOA + PFHxS. Taken together, the results showed that both individual and combined PFAS could induce concentration-dependent cytotoxicity and depletion of GSH levels, but could not induce significant increases in ROS production at the concentration range tested. Overall, these results provided valuable toxicological data on the combined effects of mixed PFAS that may help to better assess their human health risk.		1	1				1	A	-	混合PFASの複合効果に関する貴重な毒性学的データを提供し、ヒトの健康リスクをより適切に評価するのに役立つ可能性がある	
D1130	細胞毒性	Jabeen, M; Fayyaz, M; Irudayaraj, J	Epigenetic Modifications, and Alterations in Cell Cycle and Apoptosis Pathway in A549 Lung Carcinoma Cell Line upon Exposure to Perfluoroalkyl Substances	2020	Toxics. 2020 Dec;8(4):112. doi: 10.3390/toxics8040112.	Per- and polyfluoroalkyl substances (PFAS) are a group of human-made compounds with strong C-F bonds, and have been used in various manufacturing industries for decades. PFAS have been reported to deleterious effect on human health, which has led to studies identifying the possible toxicity and toxicity routes of these compounds. We report that these compounds have the potential to cause epigenetic modifications, and to induce dysregulation in the cell proliferation cycle as well as apoptosis in A549 lung cancer cells when exposed to 10-, 200- and 400 mu M concentrations of each compound. Our studies show that exposure to perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) may cause hypomethylation in the epigenome, but changes in the epigenetic makeup are not evident upon exposure to GenX. We establish that exposure to lower doses of these compounds causes the cells' balance to shift to cell proliferation, whereas exposure to higher concentrations shifts the balance more towards apoptosis. Furthermore, the apoptosis pathway upon exposure to GenX, PFOA, and PFOS has also been identified. Our findings suggest that exposure to any of these compounds may have profound effects in patients with pre-existing lung conditions or could trigger lung cancinogenesis.					1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1131	遺伝毒性	Ojo, AF; Peng, C; Ng, JC	Genotoxicity assessment of per- and polyfluoroalkyl substances mixtures in human liver cells (HepG2)	2022	Toxicology. 2022 Dec:482:153359. doi: 10.1016/j.tox.2022.153359.	Per- and polyfluoroalkyl substances (PFAS) are ubiquitous, toxic, and persistent environmental chemicals of concern that have been widely detected in all environmental matrices including human biological fluids. Although humans are exposed to complex mixtures of PFAS, it remains uncertain whether the co-exposure to PFAS mixtures could induce genotoxic damage in humans. Hence, this study evaluated the combined genotoxicity of PFAS mixtures in a human cell line system. To assess the possible genotoxic damage caused by human exposure to PFAS and their mixtures, we investigated their potential to induce cytotoxicity (cell viability) and genotoxicity (DNA damage) in a human liver cell line (HepG2). The selected PFAS include perfluorononanoic acid (PFNA), perfluorooctane sulfonic acid (PFOS), perfluorodecanoic acid (PFDA), perfluorooctanoic acid (PFOA), and perfluorohexane sulfonic acid (PFHxS). The interaction toxicities of these PFAS in binary mixtures were also determined using the additive index approach. The results revealed that exposure to PFNA, PFOS, PFDA, PFOA, and PFHxS singly and in binary mixtures induced a concentration-dependent decrease in cell viability. The additive index values indicated that the binary mixtures of PFOS + PFNA, PFOS + PFDA, and PFOS + PFOA displayed synergistic interaction, whereas the binary mixtures of PFOS + PFHxS, PFOA + PFNA, PFOA + PFDA, and PFOA + PFHxS behaved additively. Using the alkaline Comet assay, the potential of PFAS and their mixtures to induce DNA damage was evaluated based on a 1:1 ratio of the concentration of respective compounds required to produce a 1/10th of effective concentrations causing 50 % inhibition in cell viability (EC50). The results revealed that exposure to PFNA, PFOS, PFDA, PFOA, and PFHxS singly and in binary mixtures (PFOS + PFNA, PFOS + PFDA, PFOS + PFOA, PFOS + PFHxS, PFOA + PFNA, PFOA + PFDA, and PFOA + PFHxS) caused a moderate increase in cellular DNA damage, but no dose-response relationship was observed. Overall, this study indicates that the tested PFAS causes a concentration-dependent decrease in cell viability and only a modest increase in cellular DNA damage under these conditions.			1				1	A	-	PFASとその混合物暴露による遺伝毒性の可能性を評価するため、ヒト肝細胞株（HepG2）において、細胞毒性（細胞生存率）と遺伝毒性（DNA損傷）を誘発する可能性を調べており、有用。	
D1132	細胞毒性	Yoo, HJ; Pyo, MC; Park, Y; Kim, BY; Lee, KW	Hexafluoropropylene oxide dimer acid (GenX) exposure induces apoptosis in HepG2 cells	2021	Heliyon. 2021 Nov;7(11):e08272. doi: 10.1016/j.heliyon.2021.e08272.	Hexafluoropropylene oxide dimer acid, also known as GenX, is a poly- and perfluoroalkyl substance (PFAS). PFASs are nonvolatile synthetic substances that can be readily disseminated into the environment during processing and use, making them easy to implement in the soil, drinking water, and air. Compared to other PFASs, GenX has a comparatively short carbon chain length and is expected to have a lower tendency to accumulate in humans; therefore, GenX has recently been used as a substitute to other PFASs. However, the mechanisms underlying GenX action and intoxication in humans remains unclear. In this study, the apoptotic capacity of GenX in human liver cells was investigated. When representative human-derived liver cells (HepG2 cells) were treated with GenX for 12 h, cell viability was reduced, and apoptosis was greatly increased. In addition, GenX increased the generation of intracellular reactive oxygen species (ROS), indicating the induction of oxidative stress in a dose-dependent manner. GenX treatment increased the expression of major apoptosis-related genes relative to the untreated control group. This research indicates that GenX causes apoptosis through ROS mediation in HepG2 cells, which may expand our knowledge of the molecular and toxicological mechanisms of GenX.					1		1	A	-	GenXは、他のPFASと比較して炭素鎖長が比較的短く、ヒトへの蓄積傾向が低いと予想されるため、最近では他のPFASの代替物質として使用されている。しかしながら、ヒトにおけるGenXの作用および中毒メカニズムは、依然として不明である。本研究では、ヒト肝細胞におけるGenXのアポトーシス能について検討しており、これらの問題を解決する糸口になるかもしれない。	
D1133	遺伝毒性	Liu, CY; Chen, PC; Lien, PC; Liao, YP	Prenatal Perfluorooctyl Sulfonate Exposure and Alu DNA Hypomethylation in Cord Blood	2018	Int. J. Environ. Res. Public Health. 2018 Jun;15(6):1066. doi: 10.3390/ijerph15061066.	Background: Perfluoroalkyl substances (PFASs) are stable and persistent in the environment, animals, and humans. PFASs can penetrate placenta and affect fetal growth. We investigated associations between prenatal exposure to perfluorooctanoic acid (PFOA), perfluorooctyl sulfonate (PFOS), perfluorononanoic acid (PFNA), and perfluoroundecanoic acid (PFUA) and global methylation levels. Specific Aims and Methods: The study used the subjects from Taiwan Birth Panel birth cohort study, including all pregnant women who gave birth between July 2004 and June 2005 in four hospitals in Taipei city and New Taipei City. A total of 363 mother-infant pairs were included in the final analyses. PFOA, PFOS, PFNA, and PFUA were measured by UPLC-MS/MS in cord blood. LINE-1 and Alu repeated elements from cord blood was used to represent global DNA methylation levels. Multivariable regression models were used to adjust potential confounders. Results: After controlling for potential confounders, each unit increase in the natural log-transformed PFOS exposure was associated with an adjusted OR of 1.72 (95% CI: 1.03, 2.88) for low Alu methylation level when dichotomized methylation level by medium. No significant effects between PFOA, PFNA, PFUA and methylation levels in the multivariable regression models were observed. Conclusions: Our findings suggest that prenatal PFOS exposure may be associated with low Alu methylation level.			1					B	-		
D1134	細胞毒性	Ojo, AF; Peng, C; Ng, JC	Combined effects and toxicological interactions of perfluoroalkyl and polyfluoroalkyl substances mixtures in human liver cells (HepG2)	2020	Environ. Pollut.2020 Aug;263(Pt B):114182. doi: 10.1016/j.envpol.2020.114182.	The combined effects and toxicological interactions of perfluoroalkyl and polyfluoroalkyl substances (PFAS) mixtures remain largely unknown even though they occur as complex mixtures in the environment. This study investigated the toxicity of individual and combined PFAS to human liver cell line (HepG2). The Combination Index (CI)-isobologram equation method was used to determine the toxicological interactions of PFAS in binary, ternary and multi-component mixtures. The results indicated that the cytotoxicity of individual PFAS to HepG2 cells increased with increasing carbon chain lengths when separated into non-sulfonated and sulfonated groups. The respective cytotoxicity of PFAS is in the order of PFDA > PFNA > PFOA > PFHpA for perfluoroalkyl carboxylic acids and in the order of PFOS > PFHxS for perfluoroalkane sulfonic acids. The toxicological interaction of PFOS and PFOA with other PFAS clearly showed a different pattern of combined toxicity in HepG2 Cells. The binary, ternary, and multi-component combinations of PFOS with PFOA, PFNA, PFDA, PFHxS, and PFHpA displayed synergistic interactions for almost all inhibitory effect levels tested, whereas, either synergistic or antagonistic effect was observed in mixtures with PFOA. Overall, the pattern of interactions of PFAS mixtures is predominated by synergism, especially at low to medium effect levels; the exceptions to this were the antagonistic interactions found in mixture with PFOA, PFHxS, and PFHpA. These cytotoxicity results may have an implication on the health risk assessment of PFAS mixtures.			1					B	-		
D1135	遺伝毒性	Liu, Y; Eliot, MN; Papandonatos, GD; Kelsey, KT; Fore, R; Langevin, S; Buckley, J; Chen, AM; Lanphear, BP; Cecil, KM; Yolton, K; Hivert, MF; Sagiv, SK; Baccarelli, AA; Oken, E; Braun, JM	Gestational Perfluoroalkyl Substance Exposure and DNA Methylation at Birth and 12 Years of Age: A Longitudinal Epigenome-Wide Association Study	2022	Environ. Health Perspect. 2022 Mar;130(3):37005. doi: 10.1289/EHP10118.	BACKGROUND: DNA methylation alterations may underlie associations between gestational perfluoroalkyl substances (PFAS) exposure and later-life health outcomes. To the best of our knowledge, no longitudinal studies have examined the associations between gestational PFAS and DNA methylation. OBJECTIVES: We examined associations of gestational PFAS exposure with longitudinal DNA methylation measures at birth and in adolescence using the Health Outcomes and Measures of the Environment (HOME) Study (2003-2006; Cincinnati, Ohio). METHODS: We quantified serum concentrations of perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), perfluorononanoate (PFNA), and perfluorohexane sulfonate (PFHxS) in mothers during pregnancy. We measured DNA methylation in cord blood (n =266) and peripheral leukocytes at 12 years of age (n =160) using the Illumina HumanMethylation EPIC BeadChip. We analyzed associations between log(2) -transformed PFAS concentrations and repeated DNA methylation measures using linear regression with generalized estimating equations. We included interaction terms between children's age and gestational PFAS. We performed Gene Ontology enrichment analysis to identify molecular pathways. We used Project Viva (1999-2002; Boston, Massachusetts) to replicate significant associations. RESULTS: After adjusting for covariates, 435 cytosine-guanine dinucleotide (CpG) sites were associated with PFAS (false discovery rate, $q < 0.05$). Specifically, we identified 2 CpGs for PFOS, 12 for PFOA, 8 for PFHxS, and 413 for PFNA; none overlapped. Among these, 2 CpGs for PFOA and 4 for PFNA were replicated in Project Viva. Some of the PFAS-associated CpG sites annotated to gene regions related to cancers, cognitive health, cardiovascular disease, and kidney function. We found little evidence that the associations between PFAS and DNA methylation differed by children's age. DISCUSSION: In these longitudinal data, PFAS biomarkers were associated with differences in several CpGs at birth and at 12 years of age in or near genes linked to some PFAS-associated health outcomes. Future studies should examine whether DNA methylation mediates associations between gestational PFAS exposure and health.			1				1	A	-	妊娠期のPFAS曝露と出生時および青年期の縦断的DNAメチル化測定との関連を調べた研究で、妊娠期のPFAS曝露と健康との関連を考察する上で重要	
D1136	細胞毒性	Shen, ZQ; Ge, J; Ye, HL; Tang, S; Li, Y	Cholesterol-like Condensing Effect of Perfluoroalkyl Substances on a Phospholipid Bilayer	2020	J. Phys. Chem. B. 2020 Jul:124(26):5415-5425. doi: 10.1021/acs.jpcb.0c00980.	To understand the potential cytotoxicity of perfluoroalkyl substances (PFAS), we study their interactions with a model phospholipid bilayer membrane using molecular dynamics (MD) simulations. Four typical PFAS molecules are investigated, including perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorooctanesulfonic acid (PFOS), and perfluorohexane sulfonate (PFHxS). All of these PFAS molecules are found to spontaneously penetrate the lipid bilayer within a short simulation time (a few nanoseconds). During the penetration process, further free-energy analysis reveals that a PFAS molecule encounters an energy barrier at the bilayer/water interface. To overcome this free-energy barrier, the PFAS molecule flips itself at the interface. We further investigate the influence of embedded PFAS molecules on the membrane properties. All of the embedded PFAS molecules are found to produce a cholesterol-like condensing effect on the lipid bilayer, which includes increases of the order parameters of lipid tails and the thickness of the lipid bilayer and a decrease of area per lipid. Moreover, the PFAS molecules are found to form hydrogen bonds with oxygen atoms at three different positions of a lipid molecule. Our work reveals the penetration pathway of PFAS molecules entering into a lipid bilayer. In addition, the cholesterol-like condensing effect induced by embedded PFAS molecules on model membranes is systematically investigated and discussed. Our simulations can help understand the physical mechanisms of PFAS cytotoxicity.			1					C	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1137	遺伝毒性	Coperchini, F; Croce, L; Denegri, M; Pignatti, P; Agozzino, M; Netti, GS; Imbriani, M; Rotondi, M; Chiovato, L	Adverse effects of in vitro GenX exposure on rat thyroid cell viability, DNA integrity and thyroid-related genes expression	2020	Environ. Pollut. 2020 Sep:264:114778. doi: 10.1016/j.envpol.2020.114778.	The hexafluoropropylene-oxide-dimer-acid (GenX) is a short-chain perfluoroalkyl substance that was recently introduced following the phase out of PFOA, as an alternative for the process of polymerization. GenX was detected at high concentrations in rivers, drinking water and in sera of exposed workers and recent findings suggested its potential dangerousness for human health. Aim of the study was to assess the consequences of GenX exposure on in vitro thyroid cells with particular attention to the effects on cell-viability, proliferation, DNA-damage and in the thyroid-related genes expression. FRTL-5 rat-thyroid cell line were incubated with increasing concentrations of GenX for 24 h, 48 h and 72 h to assess cell viability by WST-1. DNA-damage was assessed by comet assay and further confirmed by micronucleus assay. The proliferation of survived cells was measured by staining with crystal violet and evaluation of its optical density after incubation with SDS. Changes in TTF-1, Pax8, Tg, TSH-R, NIS and TPO genes expression were evaluated by RT-PCR. GenX exposure reduced FRTL-5 viability in a time and dose-dependent manner (24 h: ANOVA F = 22.286; p < 0.001; 48 h: F = 43.253, p < 0.001; 72 h: F = 49.708, p < 0.001). Moreover, GenX exerted a genotoxic effect, as assessed by comet assay (significant increase in tail-length, olive-tail-moment and percentage of tail-DNA) and micronucleus assay, both at cytotoxic and non-cytotoxic concentrations. Exposure to GenX at concentrations non-cytotoxic exerted a significant lowering of the expression of the regulatory gene TTF-1 (p < 0.05 versus untreated) and higher expression of Pax-8 (p < 0.05 versus untreated) and a down-regulation of NIS (p < 0.05 versus untreated). In addition, cells survived to GenX exposure showed a reduced re-proliferation ability (24 h: ANOVA F = 11,941; p < 0,001; 48 h: F = 93.11; p < 0.001; 72 h F = 21.65; p < 0.001). The exposure to GenX produces several toxic effects on thyroid cells in vitro. GenX is able to promote DNA-damage and to affect the expression of thyroid transcription-factor genes.					1		1	A	-	PFOAの段階的廃止に伴い、導入されたGenXは、河川、飲料水、暴露された労働者の血清から高濃度で検出され、人体に対する潜在的な危険性が示唆されている。本研究の目的は、試験管内甲状腺細胞におけるGenX暴露の影響を評価することであり、これらの遺伝毒性試験データはPFOA関連化合物の評価に極めて重要。	
D1138	遺伝毒性	Watkins, DJ; Wellenius, GA; Butler, RA; Bartell, SM; Fletcher, T; Kelsey, KT	Associations between serum perfluoroalkyl acids and LINE-1 DNA methylation	2014	Environ. Int. 2014 Feb:63:71-76. doi: 10.1016/j.envint.2013.10.018	Perfluoroalkyl acids (PFAAs) are persistent, synthetic compounds that are used in a number of consumer products. Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) have been associated with cardiovascular risk factors, and changes in gene expression and DNA methylation in animals and cellular systems. However, whether PFAA exposure is associated with LINE-1 DNA methylation, a potential marker of cardiovascular risk, in humans remains unknown. We sought to evaluate the cross-sectional associations between serum PFAAs and LINE-1 DNA methylation in a population highly exposed to PFOA. We measured serum PFAAs twice four to five years apart in 685 adult participants (47% male, mean age +/- SD = 42 +/- 11 years): We measured percent LINE-1 DNA methylation in peripheral blood leukocytes at the second time point (follow-up), and estimated absolute differences in LINE-1 methylation associated with an interquartile (IQR) shift in mean PFAA serum levels. IQR increases in mean serum PFOA, PFOS, perfluorononanoic acid (PFNA), and perfluorohexane sulfonate (PFHxS) were associated with differences of -0.04 (p = 0.16), 020 (p = 0.001), 0.06 (p = 0.19), and 0.02 (p = 0.57), respectively, in % LINE-1 methylation at follow-up after adjustment for potential confounders. We observed a monotonic increase in LINE-1 DNA methylation across tertiles of PFOS and PFNA (p(trend) = 0.02 for both associations), but not across tertiles of PFOA or PFHxS (p(trend) = 0.71 and 0.44, respectively). In summary, serum PFOS was associated with LINE-1 methylation, while serum PFOA, PFHxS, and PFNA were not. Additional research is needed to more precisely determine whether these compounds are epigenetically active.								B	-		
D1139	細胞毒性	Kleszczynski, K; Gardzielewski, P; Mulkiewicz, E; Stepnowski, P; Skladanowski, AC	Analysis of structure-cytotoxicity in vitro relationship (SAR) for perfluorinated carboxylic acids	2007	Toxicol. Vitro. 2007 Sep:21(6):1206-1211. doi: 10.1016/j.tiv.2007.04.020.	Perfluorinated carboxylic acids (PFAs) represent derivatives of naturally occurring compounds and have been widely used in various industrial fields for decades. They are known to be environmentally persistent. Thus far numerous reports have been focused on reproductive toxicity of PFAs in animals but few studies have been carried out on toxicity towards human cells. Viability tests were performed here at varying time-exposures on C-6-C-18 PFAs with human colon carcinoma (HCTI 16) cells. These cells were found earlier as the most useful line for in vitro assays. A chain length-EC50 dependence has been clearly observed. Estimated values of EC50 decreased with elongation of fluorocarbon chain (PFHxA > PFHpA > PFOA > PFNA > PFDA > PFDoA > PFTeDA). Further elongation (C-16 and C-18) did not deepen the effect but even partially reversed it. The effect was intensified after longer exposure (72 h); at relatively low 40 mu M PFTeDA, the viability decreased to similar to 50%. It seems that PFAs are not acutely toxic at the cellular level. Even so, however, they can trigger cell apoptosis, which is prominent in the case of myristic acid perfluorinated analogue.		1	1					B	-		
D1140	細胞毒性	Oldham, ED; Xie, W; Farnoud, AM; Fiegel, J; Lehmler, HJ	Disruption of Phosphatidylcholine Mono layers and Bilayers by Perfluorobutane Sulfonate	2012	J. Phys. Chem. B. 2012 Aug:116(33):9999-10007. doi: 10.1021/jp304412p.	Perfluoroalkyl acids (PFAAs) are persistent environmental contaminants resistant to biological and chemical degradation due to the presence of carbon fluorine bonds. These compounds exhibit developmental toxicity in vitro and in vivo. The mechanisms of toxicity may involve partitioning into lipid bilayers. We investigated the interaction between perfluorobutane sulfonate (PFBS), an emerging PFAA, and model phosphatidylcholine (PC) lipid assemblies (i.e., dimyristoyl-, and dipalmitoyl- and distearoylphosphatidylcholine) using fluorescence anisotropy and Langmuir monolayer techniques. PFBS decreased the transition temperature and transition width of PC bilayers. The apparent membrane partition coefficients ranged from 4.9 X 10(2) to 8.2 X 10(2). The effects on each PC were comparable. The limiting molecular area of PC monolayers increased, and the surface pressure at collapse decreased in a concentration dependent manner. The compressibility of all three PCs was decreased by PFBS. In summary, PFBS disrupted different model lipid assemblies, indicating potential for PFBS to be a human toxicant. However, the effects of PFBS are not as pronounced as those seen with longer chain PFAAs.			1	1				C	-		
D1141	遺伝毒性	Petroff, RL; Cavalcante, RG; Langen, ES; Dolinoy, DC; Padmanabhan, V; Goodrich, JM	Mediation effects of DNA methylation and hydroxymethylation on birth outcomes after prenatal per- and polyfluoroalkyl substances (PFAS) exposure in the Michigan mother-infant Pairs cohort	2023	Clin. Epigenetics. 2023 Mar;15(1):49. doi: 10.1186/s13148-023-01461-5.	BackgroundPer- and polyfluoroalkyl substances (PFAS) are chemicals that are resistant to degradation and ubiquitous in our environments. PFAS may impact the developing epigenome, but current human evidence is limited to assessments of total DNA methylation. We assessed associations between first trimester PFAS exposures with newborn DNA methylation, including 5-methylcytosine (5-mC) and 5-hydroxymethylcytosine (5-hmC). DNA methylation mediation of associations between PFAS and birth outcomes were explored in the Michigan Mother Infant Pairs cohort. Nine PFAS were measured in maternal first trimester blood. Seven were highly detected and included for analysis: PFHxS, PFOA, PFOS, PFNA, PFDA, PFUnDA, and MeFOSAA. Bisulfite-converted cord blood DNA (n = 141) and oxidative-bisulfite-converted cord blood (n = 70) were assayed on Illumina MethylationEPIC BeadChips to measure total DNA methylation (5-mC + 5-hmC) and 5-mC/5-hmC. Correcting for multiple comparisons, beta regressions were used to assess associations between levels of PFAS and total methylation, 5-mC, or 5-hmC. Nonlinear mediation analyses were used to assess the epigenetic meditation effect between PFAS and birth outcomes.ResultsPFAS was significantly associated with total methylation (q < 0.05: PFHxS-12 sites; PFOS-19 sites; PFOA-2 sites; PFNA-3 sites; PFDA-4 sites). In 72 female infants and 69 male infants, there were sex-specific associations between five PFAS and DNA methylation. 5-mC and 5-hmC were each significantly associated with thousands of sites for PFHxS, PFOS, PFNA, PFDA, PFUnDA, and MeFOSAA (q < 0.05). Clusters of 5-mC and 5-hmC sites were significant mediators between PFNA and PFUnDA and decreased gestational age (q < 0.05).ConclusionsThis study demonstrates the mediation role of specific types of DNA methylation on the relationship between PFAS exposure and birth outcomes. These results suggest that 5-mC and 5-hmC may be more sensitive to the developmental impacts of PFAS than total DNA methylation.			1				1	A	-	ヒトにおいて、PFAS曝露と、5-メチルシトシン（5-mC）および5-ヒドロキシメチルシトシン（5-hmC）を含む新生児のDNAメチル化との関連を評価しており、重要。	
D1142	遺伝毒性	Wang, HX; Li, WY; Yang, JQ; Wang, YP; Du, HY; Han, MH; Xu, LJ; Liu, SP; Yi, JP; Chen, Y; Jiang, QW; He, GS	Gestational exposure to perfluoroalkyl substances is associated with placental DNA methylation and birth size	2023	Sci. Total Environ.2023 Feb;858(Pt 1):159747. doi: 10.1016/j.scitotenv.2022.159747.	DNA methylation is one potential mechanism for the effects of gestational exposure to perfluoroalkyl substances (PFASs) on fetal growth. We investigated 180 pregnant women who participated in a cohort study conducted in Tangshan City, Northern China, and determined the concentrations of 11 PFASs and the methylation of two genes re-lated to fetal growth [insulin-like growth factor 2 (IGF2) and nuclear receptor subfamily 3 group C member 1 (NR3C1)] and one surrogate marker for global methylation [long interspersed nuclear element-1 (LINE-1)] in placenta tissue. Multiple linear regression analysis was performed to examine the associations of log transformed PFASs with the DNA methylation and birth size. Weighted quantile sum regression was used to determine the mixture effect of PFASs. After adjusting for potential confounders, perfluorooctane sulfonate (PFOS) was negatively associated with the overall methylation of LINE-1. PFASs mixture was negatively associated with the methylation of all CpG loci of LINE-1 and overall methylation of NR3C1. Perfluorootanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), and the PFASs mixture showed negative associations with head circumference. After stratified by newborns' sex, PFOA, PFNA and the PFASs mixture was negatively associated with overall methyl-ation of LINE-1 only in the male subgroup and the methylation of all CpG loci of LINE-1 was negatively associated with ponderal index only in the female subgroup. The interaction of newborns' sex with PFOS and PFOA on overall methylation of IGF2 was statistically significant and so was the interaction of sex with PFOS on overall methylation of LINE-1. These findings suggested that intrauterine exposure to PFASs affected placental DNA methylation and reduced fetal growth, which might be modified by sex.			1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1143	細胞毒性	Hu, JY; Li, J; Wang, JS; Zhang, AQ; Dai, JY	Synergistic effects of perfluoroalkyl acids mixtures with J-shaped concentration-responses on viability of a human liver cell line	2014	Chemosphere 2014 Feb:96:81-88. doi: 10.1016/j.chemosphere.2013.07.033	Some perfluoroalkyl acids (PFAAs) are highly persistent and bioaccumulative, resulting in their broad coexisting distribution in humans and the environment. Our aim was to investigate the individual and joint effects of PFAAs on cellular viability of a human liver cell line (HL-7702) using the MTT assay. Equipartition ray design and equivalent-effect concentration ratio (EECR) mixtures were used to investigate the binary and multiple effects of PFAAs, respectively. All tested PFAAs mixtures and the individuals (except perfluorododecanoic acid (PFDoDA) and perfluorotetradecanoic acid (PFTeDA)) showed obvious non-monotonic J-shaped concentration-response curves (CRC) on HL-7702. The inhibitory effect of individual PFAAs increased with the elongation of the carbon chain and was dominated by their molecular volume. The three binary mixtures (PFOA/S, PFHxA/S and PFBA/S) showed that synergistic effects occurred under effective inhibitory concentrations (IC) of IC0, IC10, and IC50 in mixtures, while for IC-20 the synergistic effect only occurred under higher PFSA proportion in mixtures. Furthermore, EECR mixtures of the nine individual PFAAs with J-shaped CRC also showed synergistic effects. However, mixtures of the eleven individual PFAAs including those with S-shaped CRC resulted in partial addition effects on HL-7702. Our results indicated that the individual stimulatory responses of HL-7702 to PFAA may produce adverse effects in mixtures at relevant dose levels.	1	1						C	-		
D1144	細胞毒性	Mulkiewicz, E; Jastorff, B; Skladanowski, AC; Kleszczynski, K; Stepnowski, P	Evaluation of the acute toxicity of perfluorinated carboxylic acids using eukaryotic cell lines, bacteria and enzymatic assays	2007	Environ. Toxicol. Pharmacol. 2007 May:23(3):279-285. doi: 10.1016/j.etap.2006.11.002.	The acute biological activity of a homologous series of perfluorinated carboxylic acids - perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PENA) and perfluorodecanoic acid (PFDA) - was studied. To analyze the potential risk of the perfluorinated acids to humans and the environment, different in vitro toxicity test systems were employed. The cytotoxicity of the chemicals towards two different types of mammalian cell lines and one marine bacteria was investigated. The viability of cells from the promyelocytic leukemia rat cell line (IPC-81) and the rat glioma cell line (C6) was assayed calorimetrically with WST-1 reagent. The evaluation was combined with the Vibrio fischeri acute bioluminescence inhibition assay. The biological activity of the compounds was also determined at the molecular level with acetylcholinesterase and glutathione reductase inhibition assays. This is the first report of the effects of perfluorinated acids on the activity of purified enzymes. The results show these compounds have a very low acute biological activity. The observed effective concentrations lie in the millimole range, which is well above probable intracellular concentrations. A relationship was found between the toxicity of the perfluorinated carboxylic acids and the perfluorocarbon chain length: in every test system applied, the longer the perfluorocarbon chain, the more toxic was the acid. The lowest effective concentrations were thus recorded for perfluorononanoic and perfluorodecanoic acids.		1	1					B	-		
D1145	細胞毒性	Hoover, G; Kar, S; Guffey, S; Leszczynski, J; Sepulveda, MS	In vitro and in silico modeling of perfluoroalkyl substances mixture toxicity in an amphibian fibroblast cell line	2019	Chemosphere 2019 Oct:233:25-33. doi: 10.1016/j.chemosphere.2019.05.065	Poly and perfluoroalkyl substances (PFAS) are a large group of emerging organic pollutants that can persist in the environment and bioaccumulate in biota. They are found in complex mixtures, and although the exact number of PFAS is unknown, it has been estimated to be in the thousands. The objective of this study was two-fold. First, we examined the cytotoxicity of PFAS singly and in binary mixtures using an amphibian fibroblast cell line. Second, we used this experimental data to develop quantitative structure-activity relationship (QSAR) models for single and binary mixtures. We tested the cytotoxicity of four common PFAS: perfluorooctane sulfonate (PFOS); perfluorooctanoic acid (PFOA); perfluorohexane sulfonate (PFHxS); and perfluorohexanoic acid (PFHxA). PFOS was the most toxic and PFHxA the least cytotoxic. Binary mixtures allowed for the construction of isobolograms to test for additivity, synergism, or antagonism. Using this data, QSAR modeling was used for predicting the toxicity of 24 single and 1380 binary mixtures (theoretically generated). Overall, our experimental and modeling results showed that mixtures were approximately additive, with the exception of PFOS and PFOA, which were found to be weakly synergistic. This data shows that certain mixtures of PFAS may have increased toxicity potential above what the simple sum of PFAS concentrations would suggest. More studies are needed that test the toxicity of PFAS mixtures.		1						C	-		
D1146	遺伝毒性	Qin, C; Lu, YX; Borch, T; Yang, LL; Li, YW; Zhao, HM; Hu, XJ; Gao, YZ; Xiang, L; Mo, CH; Li, QX	Interactions between Extracellular DNA and Perfluoroalkyl Acids (PFAAs) Decrease the Bioavailability of PFAAs in Pakchoi (Brassica chinensis L.)	2022	J. Agric. Food Chem. 2022 Nov:70(46):14622-14632. doi: 10.1021/acs.jafc.2c04597.	Perfluoroalkyl acids (PFAAs) are emerging ionic organic pollutants worldwide. Great amounts of extracellular DNA (similar to mg/kg) coexist with PFAAs in the environment. However, PFAA-DNA interactions and effects of such interactions have not been well studied. Herein, we used isothermal titration calorimetry (ITC), spectroscopy, and computational simulations to investigate the PFAA-DNA interactions. ITC assays showed that specific binding affinities of PFHxA-DNA, PFOA-DNA, PFNA- DNA, and PFOS-DNA were 5.14 x 105, 3.29 x 105, 1.99 x 105, and 2.18 x 104 L/mol, respectively, which were about 1-2 orders of magnitude stronger than those of PFAAs with human serum albumin. Spectral analysis suggested interactions of PFAAs with adenine (A), cytosine (C), guanine (G), and thymine (T), among which grooves associated with thymine were the major binding sites. Molecular dynamics simulations and quantum chemical calculations suggested that hydrogen bonds and van der Waals forces were the main interaction forces. Such a PFAA-DNA binding decreased the bioavailability of PFAAs in plant seedlings. The findings will help to improve the current understanding of the interaction between PFAAs and biomacromolecules, as well as how such interactions affect the bioavailability of PFAAs.		1	1					C	-		
D1147	細胞毒性	Kasuya, MC; Hatanaka, K	Cytotoxicity and cellular uptake of perfluorocarboxylic acids	2016	J. Fluor. Chem. 2016 Aug:188:1-4. doi: 10.1016/j.jfluchem.2016.05.006	To address the health and environmental concerns associated with perfluorocarboxylic acids, the assessment of cytotoxicity and bioaccumulation of perfluorocarboxylic acids is essential. This study investigated the effect of perfluorocarboxylic acids having various chain lengths on mouse melanoma B16 cells. The extent of cytotoxicity of perfluorohexanoic acid (C6), perfluoroheptanoic acid (C7), perfluorooctanoic acid (C8), perfluorononanoic acid (C9) and perfluorodecanoic acid (C10) within a concentration range of 0.25-1600 mu g/ml was determined. Based on results, the viability of cells was 90% or higher in the presence of C6, C7, C8 at a concentration of up to 200 mu g/ml, indicating that B16 cells are safe in the presence of C6, C7 and C8. On the other hand, moderate cytotoxicity was observed with C9 or C10, even at a relatively low concentration of 25 mu g/ml. When cells were incubated in the presence of the same concentration (100 or 200 mu g/ml) of perfluorocarboxylic acids, the number of live cells decreased as the perfluoroalkyl chain length increased suggesting that long-chained perfluorocarboxylic acids are more cytotoxic than short-chained perfluorocarboxylic acids. The correlation between cellular uptake and perfluoroalkyl chain length was also investigated. The presence of C6 in the cells was not detected probably because of poor uptake. On the other hand, the presence of C7-C10 in the cells was confirmed and quantified by LC ESI MS. Results showed that cellular uptake of long-chained perfluorocarboxylic acids were significantly higher than short-chained perfluorocarboxylic acids.		1	1				1	A	-	様々な鎖長を持つペルフルオロカルボン酸のマウスメラノーマB16細胞に対する影響を調べており、長鎖ペルフルオロカルボン酸の細胞内取り込みは、短鎖ペルフルオロカルボン酸よりも有意に高いことが示された。	
D1148	細胞毒性	Rusiecka, I; Skladanowski, AC	Induction of the multixenobiotic/multidrug resistance system in various cell lines in response to perfluorinated carboxylic acids	2008	Acta Biochim. Pol. 2008 ;55:329-337. doi: 10.18388/abp.2008_3080	The multixenobiotic resistance (closely related to multidrug resistance) system controls transport across the plasma membrane as a defense against toxic molecules. Multixenobiotic resistance system consists of an efflux pump, ABCB1 (also named P-glycoprotein, P-gp), and/or a molecule of the ABCC family (also named multiple resistance associated protein, MRP). ABCB1 is able to increase efflux of many low-molecular foreign molecules. Measuring system induction may be used as a biomarker of cell/organism exposure to foreign substances. Various established cell lines were tested for constitutive and induced multixenobiotic resistance proteins by Western blotting immunodetection. The pumping function was indirectly assayed with Rhodamine B by visualization of cell fluorescence in the presence of verapamil. Changes in ABC proteins were measured by flow cytometry after exposition to various perfluorinated carboxylic acids. MCF7 and HeLa cells were found to contain the highest constitutive level of both ABCB1 and ABCC1. HEK293 exhibited much less ABCB1 and no activity of pumping out Rhodamine B. The pumping activity was found to be related to the amount of the cell-type specific 170 kDa ABCB1 protein. An 8-day exposure to 10(-4) M perfluorononanoic acid resulted in about 2-2.5-fold increase of ABCB1 level. That was confirmed also for short times by flow cytometry of cells exposed to perfluorinated acids and its natural congeners. Both ABCB1- and ABCC1-related fluorescence increased along with the carbon chain in acids from C-6 up to C-9 and decreased for C-10. Measuring of multixenobiotic resistance changes in vitro induced by chemicals may be a convenient test for screening for their potential toxicity.			1					C	-		
D1149	in vitro（PPAR）	Evans, N; Conley, JM; Cardon, M; Hartig, P; Medlock-Kakaley, E; Gray, LE	In vitro activity of a panel of per- and polyfluoroalkyl substances (PFAS), fatty acids, and pharmaceuticals in peroxisome proliferator-activated receptor (PPAR) alpha, PPAR gamma, and estrogen receptor assays	2022	Toxicol. Appl. Pharmacol. 2022 Aug:449:116136. doi: 10.1016/j.taap.2022.116136.	Data demonstrate numerous per- and polyfluoroalkyl substances (PFAS) activate peroxisome proliferator-activated receptor alpha (PPAR alpha), however, additional work is needed to characterize PFAS activity on PPAR gamma (PPAR gamma) and other nuclear receptors. We utilized in vitro assays with either human or rat PPAR alpha or PPAR gamma ligand binding domains to evaluate 16 PFAS (HFPO-DA, HFPO-DA-AS, NBP2, PFMOAA, PFHxA, PFOA, PFNA, PFDA, PFOS, PFBS, PFHxS, PFOSA, EtPFOSA, and 4:2, 6:2 and 8:2 FTOH), 3 endogenous fatty acids (oleic, linoleic, and octanoic), and 3 pharmaceuticals (WY14643, clofibrate, and the metabolite clofibric acid). We also tested chemicals for human estrogen receptor (hER) transcriptional activation. Nearly all compounds activated both PPAR alpha and PPAR gamma in both human and rat ligand binding domain assays, except for the FTOH compounds and PFOSA. Receptor activation and relative potencies were evaluated based on effect concentration 20% (EC20), top percent of max fold induction (pmax(top)), and area under the curve (AUC). HFPO-DA and HFPO-DA-AS were the most potent (lowest EC20, highest pmax(top) and AUC) of all PFAS in rat and human PPAR alpha assays, being slightly less potent than oleic and linoleic acid, while NBP2 was the most potent in rat and human PPAR gamma assays. Only PFHxS, 8:2 and 6:2 FTOH exhibited hER agonism >20% pmax. In vitro measures of human and rat PPAR alpha and PPAR gamma activity did not correlate with oral doses or serum concentrations of PFAS that induced increases in male rat liver weight from the National Toxicology Program 28-d toxicity studies. Data indicate that both PPAR alpha and PPAR gamma activation may be molecular initiating events that contribute to the in vivo effects observed for many PFAS.		1	1	1	1			A	B	PPARαを介した毒性発現機序の参考になる。	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1150	生態毒性（PPAR）	Soderstrom, S; Lille-Langoy, R; Yadetie, F; Rauch, M; Milinski, A; Dejaegere, A; Stote, RH; Goksoyr, A; Karlsen, OA	Agonistic and potentiating effects of perfluoroalkyl substances (PFAS) on the Atlantic cod (Gadus morhua) peroxisome proliferator-activated receptors (Ppars)	2022	Environ. Int. 2022 May:163:107203. doi: 10.1016/j.envint.2022.107203.	Toxicity mediated by per-and polyfluoroalkyl substances (PFAS), and especially perfluoroalkyl acids (PFAAs), has been linked to activation of peroxisome proliferator-activated receptors (Ppar) in many vertebrates. Here, we present the primary structures, phylogeny, and tissue-specific distributions of the Atlantic cod (Gadus morhua) gmPpara1, gmPpara2, gmPparb, and gmPparg, and demonstrate that the carboxylic acids PFHxA, PFOA, PFNA, as well as the sulfonic acid PFHxS, activate gmPpara1 in vitro, which was also supported by in silico analyses. Intriguingly, a binary mixture of PFOA and the non-activating PFOS produced a higher activation of gmPpara1 compared to PFOA alone, suggesting that PFOS has a potentiating effect on receptor activation. Supporting the experimental data, docking and molecular dynamics simulations of single and double-ligand complexes led to the identification of a putative allosteric binding site, which upon binding of PFOS stabilizes an active conformation of gmPpara1. Notably, binary exposures of gmPpara1, gmPpara2, and gmPparb to model-agonists and PFAAs produced similar potentiating effects. This study provides novel mechanistic insights into how PFAAs may modulate the Ppar signaling pathway by either binding the canonical ligand-binding pocket or by interacting with an allosteric binding site. Thus, individual PFAAs, or mixtures, could potentially modulate the Pparsignaling pathway in Atlantic cod by interfering with at least one gmPpar subtype.		1	1					C	D		今回の選定された5種のPFASについては要約では言及されていない。
D1151	PPAR	Ishibashi, H; Iwata, H; Kim, EY; Tao, L; Kannan, K; Tanabe, S; Batoev, VB; Petrov, EA	Contamination and effects of perfluorochemicals in Baikal Seal (Pusa sibirica). 2. Molecular characterization, expression level, and transcriptional activation of peroxisome proliferator-activated receptor alpha	2008	Environ. Sci. Technol. 2008 Apr:42(7):2302-2308. doi: 10.1021/es0720558.	To investigate the biological effects of perfluorochemicals (PFCs) and to identify biomarkers of exposure to PFCs, this study focused on the effects mediated by peroxisome proliferator-activated receptor alpha (PPAR alpha) in Baikal seals (Pusa sibirica). We cloned a full-length cDNA encoding PPAR alpha from the liver of Baikal seal, which has a deduced open reading frame of 468-amino acid residues with a predicted molecular mass of 52.2 kDa. Comparison of the amino-acid sequence of Baikal seal PPAR alpha with that of other mammalian PPAR alpha showed considerable similarities with PPAR alpha of dog (97%), human (95%), rat (92%), and mouse (91%). The quantitative real-time RTPCR analyses of tissues from Baikal seals revealed that PPAR alpha mRNAs were primarily expressed in the liver, kidney, heart, and muscle. The hepatic expression levels of PPAR alpha mRNA showed a positive correlation with the expression levels of immunochemically detected cytochrome P450 (CYP) 4A-like protein, indicating that the PPAR alpha-CYP4A signaling pathway in Baikal seal is likely conserved. This study also developed an in vitro PPAR alpha reporter gene assay using African green monkey kidney CV-1 cells transiently transfected with Baikal seal PPAR alpha cDNA expression vector and a reporter vector containing a peroxisome proliferator-responsive element. The in vitro reporter gene assay displayed significant response to clofibrate, which is a known PPAR alpha agonist in humans and rodents. Treatment with perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA), or perfluorooctane sulfonate (PFOS) induced PPAR alpha-mediated transcriptional activity in a dose-dependent manner, showing the lowest-observed-effect concentrations of 62.5, 125, 125, 62.5, and 125 mu M, respectively. In the livers of wild Baikal seals, expression levels of PPAR alpha mRNA showed a significant positive correlation with PFNA levels. Moreover, expression of hepatic CYP4A-like protein was significantly correlated with the hepatic concentrations of PFNA and PFDA. These results suggest modulation of the PPAR alpha-CYP4A signaling pathway by PFCs in the wild Baikal seals. Our study demonstrates that the PPAR alpha-mediated response may be a useful biomarker to evaluate potential biological effects of PFCs in wildlife.			1					C	B		
D1152	PPAR	Ishibashi, H; Hirano, M; Kim, EY; Iwata, H	In Vitro and In Silico Evaluations of Binding Affinities of Perfluoroalkyl Substances to Baikal Seal and Human Peroxisome Proliferator-Activated Receptor alpha	2019	Environ. Sci. Technol. 2019 Feb:53(4):2181-2188. doi: 10.1021/acs.est.8b07273.	In this study, we assessed the binding affinities of perfluoroalkyl substances (PFASs), including perfluoroalkyl carboxylates (PFCAs) and perfluoroalkyl sulfonates (PFSAs), to the ligand-binding domains (LBDs) of Baikal seal (Pusa sibirica; bs) and human (h) peroxisome proliferator-activated receptor alpha (PPAR alpha). An in vitro competitive binding assay showed that six PFCAs and two PFSAs could bind to recombinant bs and hPPAR alpha LBD proteins in a dose dependent manner. The relative binding affinities (RBAs) of PFASs to bsPPAR alpha were as follows: PFOS > PFDA > PFNA > PFUnDA > PFOA > PFHxS > PFHpA > PFHxA. The RBAs to bsPPAR alpha showed a significant positive correlation with those to hPPAR alpha. In silico PPAR alpha homology modeling predicted that there were two ligand-binding pockets (LBPs) in the bsPPAR alpha and hPPAR alpha LBDs. Structure-activity relationship analyses suggested that the binding potencies of PFASs to PPAR alpha might depend on LBP binding cavity volume, hydrogen bond interactions, the number of perfluorinated carbons, and the hydrophobicity of PFASs. Interspecies comparison of the in vitro binding affinities revealed that bsPPAR alpha had higher preference for PFASs with long carbon chains than hPPAR alpha. The in silico docking simulations suggested that the first LBP of bsPPAR alpha had higher affinities than that of hPPAR alpha; however, the second LBP of bsPPAR alpha had lower affinities than that of hPPAR alpha. To our knowledge, this is the first evidence showing interspecies differences in the binding of PFASs to PPAR alpha s and their structure activity relationships.		1	1					C	B		
D1153	in vitro（肺毒性）	Xin, Y; Wan, B; Yang, Y; Cui, XJ; Xie, YC; Guo, LH	Perfluoroalkyl acid exposure induces protective mitochondrial and endoplasmic reticulum autophagy in lung cells	2018	Arch. Toxicol. 2018 Oct:92(10):3131-3147. doi: 10.1007/s00204-018-2266-0.	Wide application of perfluoroalkyl acids (PFAAs) has raised great concerns on their side-effects on human health. PFAAs have been shown to accumulate mainly in the liver and cause hepatotoxicity. However, PFAAs can also deposit in lung tissues through air-borne particles and cause serious pulmonary toxicity. But the underlying mechanisms are still largely unknown. Autophagy is a type of programmed cell death parallel to necrosis and apoptosis, and may be involved in the lung toxicity of PFAAs. In this study, lung cancer cells, A549, were employed as the model to investigate the effects of three PFAAs with different carbon chain lengths on cell autophagy. Through Western blot analysis on LC3-I/II ratio of cells exposed to non-cytotoxic concentration (200 mu M) and cytotoxic concentration (350 mu M), we found concentration-dependent increase of autophagosomes in cells, which was further confirmed by TEM examination on ultra-thin section of cells and fluorescence imaging on autophagosomes in live cells. The abundance of p62 increased with the PFAAs concentration indicating the blockage of autophagy flux. Furthermore, we identified the mitochondrial autophagy (mitophagy) and endoplasmic reticulum autophagy (ER-phagy) morphologically as the major types of autophagy, suggesting the disruption on mitochondria and ERs. These organelle damages were confirmed by the overgeneration of ROS, hyperpolarization of mitochondrial membrane potential, as well as the up-regulation of ER-stress-related proteins, ATF4 and p-IRE1. Further analysis on the signaling pathways showed that PFAAs activated the MAPK pathways and inhibited the PI3K/Akt pathway, with potencies following the order of PFDA > PFNA > PFOA. Anti-oxidant (NAC) treatment did not rescue cells from death, indicating that oxidative stress is not the reason of cytotoxicity. Inhibition of autophagy by Atg5 siRNA and chloroquine even increased the toxicity of PFAAs, suggesting that PFAAs-autophagy was induced as the secondary effects of organelle damages and played a protective role during cell death.			1					C	B		
D1154	in vitro（PPAR）	Qin, H; Niu, YX; Luan, HY; Li, MH; Zheng, L; Pan, YF; Liu, W	Effects of legacy and emerging per- and polyfluoroalkyl substances on PPAR alpha/beta/gamma regulation and osteogenic/adipogenic differentiation	2022	Environ. Int. 2022 Dec:170:107584. doi: 10.1016/j.envint.2022.107584.	As the primary molecular target, there is still a gap between the peroxisome proliferator-activated receptors (PPARs) regulation and the adverse health effects caused by per- and polyfluoroalkyl substances (PFASs). The effects of PFASs on cellular differentiation regulated by PPARs is likely significant given the association of PFASs exposure with obesity and decreased bone density. Human mesenchymal stem cells (hMSCs) were used as an in vitro model to assess the roles of PPAR subtypes in the multipotent differentiation of hMSCs affected by perfluorooctanesulfonate (PFOS), perfluorooctanoic acid (PFOA) and their replacement compounds. PFASs increased the expression of three PPAR subtypes in proliferating and differentiating hMSCs. Meanwhile, PFOS and PFOA decreased osteogenesis, enhanced adipogenesis, and increased bone turnover in hMSCs. Similarly, PFOA alternatives, hexafluoropropylene oxide dimer acid (HFPO-DA) and hexafluoropropylene oxide trimer acid (HFPO-TA), exhibited similar or even higher potency in affecting stem cell differentiation compared with PFOA. Perfluorohexanesulfonate (PFHxS) inhibited osteogenesis with comparable potency to PFOS. In contrast, 6:2 chlorinated poly-fluoroalkyl ether sulfonate (6:2Cl-PFESA) enhanced osteogenesis. PPAR beta expression is significantly positively correlated with osteogenesis and osteoprotegerin (OPG) secretion in 6:2Cl-PFESA treated cells. shRNA knockdown of PPAR beta remarkably reversed the osteogenic effects of 6:2Cl-PFESA and enhanced the adipogenic effects of the six chemicals. The results suggested that the adverse effects and relative potency of PFASs on the multipotent differentiation of hMSCs were dependent on the integrated action of the three PPAR subtypes, which facilitates a better understanding of the molecular initiating events of PFASs. The present study may well explain the mechanism of the decreased bone density and increased obesity incidence among those exposed to legacy PFASs, and indicates the necessity of further health risk assessment for the alternatives.					1			C	B		
D1155	in vitro（PPAR）	Routti, H; Berg, MK; Lille-Langoy, R; Oygarden, L; Harju, M; Dietz, R; Sonne, C; Goksoyr, A	Environmental contaminants modulate the transcriptional activity of polar bear (Ursus maritimus) and human peroxisome proliferator-activated receptor alpha (PPARA)	2019	Sci Rep. 2019 May:9:6918. doi: 10.1038/s41598-019-43337-w.	Peroxisome proliferator-activated receptor alfa (PPARA/NR1C1) is a ligand activated nuclear receptor that is a key regulator of lipid metabolism in tissues with high fatty acid catabolism such as the liver. Here, we cloned PPARA from polar bear liver tissue and studied in vitro transactivation of polar bear and human PPARA by environmental contaminants using a luciferase reporter assay. Six hinge and ligand-binding domain amino acids have been substituted in polar bear PPARA compared to human PPARA. Perfluorocarboxylic acids (PFCA) and perfluorosulfonic acids induced the transcriptional activity of both human and polar bear PPARA. The most abundant PFCA in polar bear tissue, perfluorononanoate, increased polar bear PPARA-mediated luciferase activity to a level comparable to that of the potent PPARA agonist WY-14643 (similar to 8-fold, 25 mu M). Several brominated flame retardants were weak agonists of human and polar bear PPARA. While single exposures to polychlorinated biphenyls did not, or only slightly, increase the transcriptional activity of PPARA, a technical mixture of PCBs (Aroclor 1254) strongly induced the transcriptional activity of human (similar to 8-fold) and polar bear PPARA (similar to 22-fold). Polar bear PPARA was both quantitatively and qualitatively more susceptible than human PPARA to transactivation by less lipophilic compounds.			1					C	D		今回の選定された5種のPFASについては要約では言及されていない。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1156	in vitro（肝毒性）	Amstutz, VH; Cengo, A; Sijm, DTHM; Vrolijk, MF	The impact of legacy and novel perfluoroalkyl substances on human cytochrome P450: An in vitro study on the inhibitory potential and underlying mechanisms	2022	Toxicology. 2022 Feb:468:153116. doi: 10.1016/j.tox.2022.153116.	Per- and polyfluomalkyl substances (PFASs) are a group of synthetic compounds with a wide range of industrial applications. PFOA and PFOS have been the most extensively studied and have been associated with hepatotoxicity. Recently, the interaction with cytochrome P450 (CYP) has been proposed as a potential key molecular event leading to PFAS-induced hepatotoxicity. In the present study, we aimed to determine a structure-activity relationship between thirteen PFASs and their inhibitory potential on the activities of four CYPs (CYP2E1, CYP2D6, CYP3A4 and CYP2C19). The influence of PFASs (5-3200 mu M) on CYP enzyme activities was measured using the Vivid (R) P450 metabolism assays. Using the same assays, Michaelis-Menten saturation curves were determined to explore the type of PFAS-induced CYP inhibition. Most PFASs were capable of inhibiting activity of the tested CYPs, as shown by their IC50 values. CYP2E1 is particularly inhibited by 3:1 FTOH, PFOA, and PFOS, whereas CYP2D6 is inhibited by PFHxS, PFHpA, PFOA, PFOS, PFNA, and PFDA. Additionally, CYP3A4 is most strongly inhibited by PFHxS, PFOA, PFOS, PFNA, and PFDA. Finally, CYP2C19 is inhibited by PFBS, PFHxS, PFHpA, PFOA, PFOS, PFNA, and PFDA. Interestingly, PFHxA and PFHxS induced an increase in CYP2E1 activity, whereas 4:2 FTOH strongly induced CYP2D6 activity. The mechanism of inhibition of CYPs by PFASs differed per CYP isoenzyme. CYP3A4 was competitively inhibited by PFBS, PFHxS, PFOS, PFNA and PFDA and non-competitively by PFOA. Additionally, CYP2C19 was competitively inhibited by PFHxA, PFOS and PFNA, whereas PFBS and PFHxS induced a mixed inhibition. Inhibition of CYP2C19 by PFHpA was atypical with an increased Vmax and a decreased Km. Finally, PFHxS competitively inhibited CYP2D6, whereas PFBS, PFOA, PFOS, PFDA and PFNA induced an atypical inhibition. Our results show that CYP inhibition by PFASs appears to be structure-dependent as well as CYP dependent. Inhibition of CYP2D6, CYP2C19 and CYP3A4 increased with increasing chain-lengths between six and nine carbons. The PFTOHs were only able to inhibit CYP2E1 and did not affect any of the other CYPS. Some PFASs remarkably induced the enzyme activity of CYPs. These results indicate that in addition to PFOA and PFOS, multiple novel PFASs may alter drug metabolism by the interference with CYPs.		1		1				B	B		
D1157	in vitro（肝毒性）	Marques, E; Pfohl, M; Wei, W; Tarantola, G; Ford, L; Amaeze, O; Alesio, J; Ryu, S; Jia, XL; Zhu, H; Bothun, GD; Slitt, A	Replacement per- and polyfluoroalkyl substances (PFAS) are potent modulators of lipogenic and drug metabolizing gene expression signatures in primary human hepatocytes	2022	Toxicol. Appl. Pharmacol. 2022 May:442:115991. doi: 10.1016/j.taap.2022.115991.	Per- and polyfluoroalkyl substances (PFAS) are a class of environmental toxicants, and some, such as per-fluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), have been associated with hepatic steatosis in rodents and monkeys. It was hypothesized that perfluorosulfonic acids (C4, 6, 8), perfluorocarboxylic acids (C4-14), perfluoro(2-methyl-3-oxahexanoic) acid (HFPO-DA), 1H, 1H, 2H, 2H-perfluorooctanesulfonic acid (6:2 FTS) along with 3 PFOS precursors could induce expression of lipid metabolism genes and lipid deposition in human hepatocytes. Five-donor pooled cryopreserved human hepatocytes were cultured and treated with 0.1% DMSO vehicle or various PFAS (0.25 to 25 mu M) in media. After a 48-h treatment, mRNA transcripts related to lipid transport, metabolism, and synthesis were measured using a Quantigene Plex assay. After 72-h treatments, hepatocytes were stained with Nile Red dye to quantify intracellular lipids. Overall, PFAS were transcriptionally active at 25 mu M. In this model, lipid accumulation was not observed with C8-C12 treatments. Shorter chain PFAS (C4-C5), 6:2 FTS, and PFOS precursor, metFOSA, induced significant liver lipid accumulation, and gene acti-vation at lower concentrations than legacy PFAS. In summary short chain PFAS and other alternative PFAS were more potent gene inducers, and potential health effects of replacement PFAS should be critically evaluated in humans.					1			B	B		
D1158	in vitro（肝毒性）	Bjork, JA; Dawson, DA; Krogstad, JO; Wallace, KB	Transcriptional effects of binary combinations of PFAS in FaO cells	2021	Toxicology. 2021 Dec:464:152997. doi: 10.1016/j.tox.2021.152997.	Per- and polyfluoroalkyl substances (PFAS) represent a large class of structurally diverse chemicals of increasing public concern, mostly due to their chemical stability and undetermined toxicity profiles. In laboratory animals, adverse effects implicated for certain PFAS, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) in particular, include liver toxicity and the associated metabolic dysregulation, immune and thyroid alterations, reproductive toxicity, and selected tumors. The broad commercialization and environmental distribution of PFAS has drawn attention to the need for understanding risks associated with combined exposure to multiple PFAS in complex mixtures. The purpose of this investigation is to determine whether binary combinations of PFAS elicit a molecular response that is either greater than or less than the sum of the individual responses. Exposure of FaO rat hepatoma cells for 24 h to 25 mu M-200 mu M of the 4- and 8-carbon perfluorocarboxylic acids (PFBA and PFOA) or the 4, 6, and 8-carbon perfluorosulfonic acids (PFBS, PFHxS, and PFOS, respectively) individually caused a dose-dependent increase in PPAR alpha-regulated expression of peroxisomal bifunctional enzyme (Ehhadh). Potency increased with carbon number, with the carboxylates eliciting a greater transcriptional response than the corresponding sulfonates. Combined exposure to PFOA and PFBA produced an effect that was significantly less than the sum of the individual responses. The response to the combination of PFOA and PFOS produced a summative effect at concentrations that were not cytotoxic. Combined exposures to PFOS and either PFBS or PFHxS at low noncytotoxic concentrations produced a transcriptional effect that was significantly less than the sum of the individual effects. The results demonstrate that among the five structurally related perfluoroalkyl acids included in this investigation, PPAR alpha transcriptional activation in response to combined binary exposures is consistently at or below that predicted by the sum of the individual effects.	1			1				A	B	PPARαを介した毒性発現機序の参考になる。	
D1159	実験動物（PPAR）	Heintz, MM; Chappell, GA; Thompson, CM; Haws, LC	Evaluation of Transcriptomic Responses in Livers of Mice Exposed to the Short-Chain PFAS Compound HFPO-DA	2022	Front. Toxicol. 2022 Jun:4:937168. doi: 10.3389/ftox.2022.937168.	HFPO-DA (ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate; CASRN 62037-80-3) is a component of the GenX technology platform used as a polymerization aid in the manufacture of some types of fluoropolymers. The liver is the primary target of toxicity for HFPO-DA in rodents and previous examination of hepatic transcriptomic responses inmice following oral exposure to HFPO-DA for 90 days showed induction of peroxisome proliferator-activated receptor signaling pathways, predominantly by PPAR alpha, as well as increased gene expression of both peroxisomal and mitochondrial fatty acidmetabolism. To further investigate themechanism of liver toxicity, transcriptomic analysis was conducted on liver tissue frommice orally exposed to 0, 0.1, 0.5 or 5mg/kg-bw/day HFPO-DA in a reproduction/developmental toxicity study. Hepatic gene expression changes demonstrated activation of the PPAR alpha signaling pathway. Peroxisomal and mitochondrial fatty acid beta-oxidation gene sets were enriched at lower HFPO-DA concentrations, and complement cascade, cell cycle and apoptosis related gene sets were enriched at higher HFPO-DA concentrations. These results support the reported histopathological findings in livers of mice from this study and indicate that the effects of HFPO-DA are mediated through rodent-specific PPAR alpha signaling mechanisms regardless of reproductive status in mice.					1		1	A	A	GenXの肝トランスクリプトーム解析を行っており、メカニズムの参考になる。	in vivoにおいて、GenXの複数用量で実験が行われており、生殖・発達毒性についても検討されている。
D1160	実験動物（肝毒性）	Heintz, MM; Haws, LC; Klaunig, JE; Cullen, JM; Thompson, CM	Assessment of the mode of action underlying development of liver lesions in mice following oral exposure to HFPO-DA and relevance to humans	2023	Toxicol. Sci. 2023 Mar:192(1):15-29. doi: 10.1093/toxsci/kfad004.	HFPO-DA (ammonium, 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)propanoate) is a short-chain polyfluorinated alkyl substance (PFAS) used in the manufacture of some types of fluorinated polymers. Like many PFAS, toxicity studies with HFPO-DA indicate the liver is the primary target of toxicity in rodents following oral exposure. Due to the structural diversity of PFAS, the mode of action (MOA) can differ between PFAS for the same target tissue. There is significant evidence for involvement of peroxisome proliferator-activated receptor alpha (PPAR alpha) activation based on molecular and histopathological responses in the liver following HFPO-DA exposure, but other MOAs have also been hypothesized based on limited evidence. The MOA underlying the liver effects in mice exposed to HFPO-DA was assessed in the context of the Key Events (KEs) outlined in the MOA framework for PPAR alpha activator-induced rodent hepatocarcinogenesis. The first 3 KEs (ie, PPAR alpha activation, alteration of cell growth pathways, and perturbation of cell growth/survival) are supported by several lines of evidence from both in vitro and in vivo data available for HFPO-DA. In contrast, alternate MOAs, including cytotoxicity, PPAR gamma and mitochondrial dysfunction are generally not supported by the scientific literature. HFPO-DA-mediated liver effects in mice are not expected in humans as only KE 1, PPAR alpha activation, is shared across species. PPAR alpha-mediated gene expression in humans produces only a subset (ie, lipid modulating effects) of the responses observed in rodents. As such, the adverse effects observed in rodent livers should not be used as the basis of toxicity values for HFPO-DA for purposes of human health risk assessment.					1			A	A	GenXによる病理組織変化について参考になる。	GenXの肝毒性に関して、マウス実験のヒトへの外挿性についても言及している。
D1161	実験動物（肝毒性）	Thompson, CM; Heintz, MM; Wolf, JC; Cheru, R; Haws, LC; Cullen, JM	Assessment of Mouse Liver Histopathology Following Exposure to HFPO-DA With Emphasis on Understanding Mechanisms of Hepatocellular Death	2023	Toxicol. Pathol. 2023 Jan:51(1-2):4-14. doi: 10.1177/01926233231159078.	Ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate (HFPO-DA) is a short chain member of per- and polyfluoroalkyl substances (PFAS). To better understand the relevance of histopathological effects seen in livers of mice exposed to HFPO-DA for human health risk assessment, histopathological effects were summarized from hematoxylin and eosin (H&E)-stained sections in several repeat-dose toxicity studies in mice. Findings across studies revealed histopathological changes consistent with peroxisomal proliferation, whereas two reports of steatosis could not be confirmed in the published figures. In addition, mechanisms of hepatocellular death were assessed in H&E sections as well as with the apoptotic marker cleaved caspase-3 (CCasp3) in newly cut sections from archived liver blocks from select studies. A comparison of serially CCasp3 immunolabeled and H&E-stained sections revealed that mechanisms of hepatocellular death cannot be clearly discerned in H&E-stained liver sections alone as several examples of putatively necrotic cells were positive for CCasp3. Published whole genome transcriptomic data were also reevaluated for enrichment of various forms of hepatocellular death in response to HFPO-DA, which revealed enrichment of apoptosis and autophagy, but not ferroptosis, pyroptosis, or necroptosis. These morphological and molecular findings are consistent with transcriptomic evidence for peroxisome proliferator-activated receptor alpha (PPAR alpha) signaling in HFPO-DA exposed mice.					1			A	B	GenXによる病理組織変化について参考になる。	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1162	in vitro（肝毒性）	Robarts, DR; Venneman, KK; Gunewardena, S; Apte, U	GenX induces fibroinflammatory gene expression in primary human hepatocytes	2022	Toxicology. 2022 Jul:477:153259. doi: 10.1016/j.tox.2022.153259.	The toxicity induced by the persistent organic pollutants per-and polyfluoroalkyl substances (PFAS) is dependent on the length of their polyfluorinated tail. Long-chain PFASs have significantly longer half-lives and profound toxic effects compared to their short-chain counterparts. Recently, production of a short-chain PFAS substitute called ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy) propanoate, also known as GenX, has significantly increased. However, the adverse health effects of GenX are not completely known. In this study, we investigated the dose-dependent effects of GenX on primary human hepatocytes (PHH). Freshly isolated PHH were treated with either 0.1, 10, or 100 mu M of GenX for 48 and 96 h; then, global transcriptomic changes were determined using Human Clariom (TM) D arrays. GenX-induced transcriptional changes were similar at 0.1 and 10 mu M doses but were significantly different at the 100 mu M dose. Genes involved in lipid, monocarboxylic acid, and ketone metabolism were significantly altered following exposure of PHH at all doses. However, at the 100 mu M dose, GenX caused changes in genes involved in cell proliferation, inflammation and fibrosis. A correlation analysis of concentration and differential gene expression revealed that 576 genes positively (R < -0.99) and 375 genes negatively (R <-0.99) correlated with GenX concentration. The upstream regulator analysis indicated HIF1 alpha was inhibited at the lower doses but were activated at the higher dose. Additionally, VEGF, PPAR alpha, STAT3, and SMAD4 signaling was induced at the 100 mu M dose. These data indicate that at lower doses GenX can interfere with metabolic pathways and at higher doses can induce fibroinflammatory changes in human hepatocytes.					1			A	B	GenXの肝トランスクリプトーム解析を行っており、メカニズムの参考になる。	
D1163	実験動物（肝毒性）	Guo, H; Chen, JM; Zhang, HX; Yao, JZ; Sheng, N; Li, Q; Guo, Y; Wu, CY; Xie, WD; Dai, JY	Exposure to GenX and Its Novel Analogs Disrupts Hepatic Bile Acid Metabolism in Male Mice	2022	Environ. Sci. Technol. 2022 May:56(10):6133-6143. doi: 10.1021/acs.est.1c02471.	Due to its wide usage and recent detection inenvironmental matrices, hexafluoropropylene oxide dimer acid(HFPO-DA, commercial name GenX) has attracted considerableattention. Here, we explored and compared the toxicity of GenXand its novel analogs with that of perfluorooctanoic acid (PFOA)to provide guidance on the structural design and optimization ofnovel alternatives to poly- and perfluoroalkyl substances (PFASs).Adult male BALB/c mice were continuously exposed to PFOA,GenX, perfluoro-2-methyl-3,6-dioxo-heptanoic acid (PFMO2H-pA), and perfluoro-2-methyl-3,6,8-trioxo-nonanoic acid (PFMO3-NA; 0, 0.4, 2, or 10 mg/kg/d) via oral gavage for 28 days. ThePFOA, GenX, and PFMO3NA treatment groups showed anincrease in relative liver weight, and bile acid metabolism was the most significantly affected pathway in all treatment groups, asshown via weighted gene coexpression network analysis. The highest total bile acid levels were observed in the 2 and 10 mg/kg/dPFMO3NA groups. The ratios of primary bile acids to all bile acids increased in the high-dose groups, while the ratios of secondarybile acids showed a downward trend. Thus, bile acid metabolism disorder may be a prominent adverse effect induced by exposure toGenX, its analogs, and PFOA. Results also showed that the hepatotoxicity of PFMO2HpA was lower than that of GenX, whereas thehepatotoxicity of PFMO3NA was stronger, suggesting that PFMO2HpA may be a potential alternative to GenX.					1			A	B	胆汁酸に対する影響に関して参考になる。	in vivoにおいて、GenXの複数用量で実験が行われている
D1164	in vitro（肝毒性）	Palazzolo, S; Caligiuri, I; Sfriso, AA; Mauceri, M; Rotondo, R; Campagnol, D; Canzonieri, V; Rizzolio, F	Early Warnings by Liver Organoids on Short- and Long-Chain PFAS Toxicity	2022	Toxics. 2022 Feb;10(2):91. doi: 10.3390/toxics10020091.	Short-chain per-fluoroalkyl substances (PFAS) have replaced long-chains in many applications, however the toxicity and its mode of action and interactions due to the large number of these compounds and their mixtures is still poorly understood. The paper aims to compare the effects on mouse liver organoids (target organ for bioaccumulation) of two long-chain PFAS (perfluorooctane sulfonate -PFOS-, perfluorooctanoic acid -PFOA) and two short-chain PFAS commonly utilized in the industry (heptafluorobutyric acid -HFBA-, Pentafluoropropionic anhydride-PFPA) to identify the mode of action of these classes of contaminants. Cytomorphological aberrations and ALT/GDH enzyme disruption were identified but no acute toxicity endpoint neither apoptosis was detected by the two tested short-chain PFAS. After cytomorphological analysis, it is evident that short-chain PFAS affected organoid morphology inducing a reduction of cytostructural complexity and aberrant cytological features. Conversely, EC50 values of 670 +/- 30 mu M and 895 +/- 7 mu M were measured for PFOS and PFOA, respectively, together with strong ALT/GDH enzyme disruption, caspase 3 and 7 apoptosis activation and deep loss of architectural complexity of organoids in the range of 500-1000 mu M. Eventually, biochemical markers and histology analysis confirmed the sensitivity of organoid tests that could be used as a fast and reproducible platform to test many PFAS and mixtures saving time and at low cost in comparison with in vivo tests. Organoids testing could be introduced as an innovative platform to assess the toxicity to fast recognize potentially dangerous pollutants.								A	D	肝毒性メカニズムの参考になる。	今回の選定された5種のPFASについては要約では言及されていない。
D1165	実験動物（肝毒性）	Blake, BE; Miller, CN; Nguyen, H; Chappell, VA; Phan, TP; Phadke, DP; Balik-Meisner, MR; Mav, D; Shah, RR; Fenton, SE	Transcriptional pathways linked to fetal and maternal hepatic dysfunction caused by gestational exposure to perfluorooctanoic acid (PFOA) or hexafluoropropylene oxide-dimer acid (HFPO-DA or GenX) in CD-1 mice	2022	Ecotox. Environ. Safe. 2022 Dec:248:114314. doi: 10.1016/j.ecoenv.2022.114314.	Per-and polyfluoroalkyl substances (PFAS) comprise a diverse class of chemicals used in industrial processes, consumer products, and fire-fighting foams which have become environmental pollutants of concern due to their persistence, ubiquity, and associations with adverse human health outcomes, including in pregnant persons and their offspring. Multiple PFAS are associated with adverse liver outcomes in adult humans and toxicological models, but effects on the developing liver are not fully described. Here we performed transcriptomic analyses in the mouse to investigate the molecular mechanisms of hepatic toxicity in the dam and its fetus after exposure to two different PFAS, perfluorooctanoic acid (PFOA) and its replacement, hexafluoropropylene oxide-dimer acid (HFPO-DA, known as GenX). Pregnant CD-1 mice were exposed via oral gavage from embryonic day (E) 1.5-17.5 to PFOA (0, 1, or 5 mg/kg-d) or GenX (0, 2, or 10 mg/kg-d). Maternal and fetal liver RNA was isolated (N = 5 per dose/group) and the transcriptome analyzed by Affymetrix Array. Differentially expressed genes (DEG) and differentially enriched pathways (DEP) were obtained. DEG patterns were similar in maternal liver for 5 mg/kg PFOA, 2 mg/kg GenX, and 10 mg/kg GenX (R2: 0.46-0.66). DEG patterns were similar across all 4 dose groups in fetal liver (R2: 0.59-0.81). There were more DEGs in fetal liver compared to maternal liver at the low doses for both PFOA (fetal = 69, maternal = 8) and GenX (fetal = 154, maternal = 93). Upregulated DEPs identified across all groups included Fatty Acid Metabolism, Peroxisome, Oxidative Phosphorylation, Adipogenesis, and Bile Acid Metabolism. Transcriptome-phenotype correlation analyses demonstrated > 1000 maternal liver DEGs were significantly correlated with maternal relative liver weight (R2 >0.92). These findings show shared biological pathways of liver toxicity for PFOA and GenX in maternal and fetal livers in CD-1 mice. The limited overlap in specific DEGs between the dam and fetus suggests the developing liver responds differently than the adult liver to these chemical stressors. This work helps define mechanisms of hepatic toxicity of two structurally unique PFAS and may help predict latent consequences of developmental exposure.					1			D	A	発生毒性であるが、肝臓が含まれているため参考になる可能性が高い。	in vivoにおいて、GenXの複数用量で、胎仔・母動物において実験が行われている
D1166	実験動物（肝毒性）	Guo, H; Sheng, N; Guo, Y; Wu, CY; Xie, WD; Dai, JY	Exposure to GenX and its novel analogs disrupts fatty acid metabolism in male mice	2021	Environ. Pollut. 2021 Dec:291:118202. doi: 10.1016/j.envpol.2021.118202.	Perfluoroalkyl ether carboxylic acids (PFECAs), including hexafluoropropylene oxide dimer acid (HFPO-DA, GenX), have been widely used as alternatives to perfluorooctanoic acid (PFOA) and subsequently detected in various environmental matrices. Despite this, public information regarding their hepatotoxicity remains limited. Here, to compare the hepatotoxicity of PFECAs and identify better alternatives for GenX, adult male mice were exposed to different concentrations (0.4, 2, and 10 mg/kg/d) of PFOA, GenX, and its analogs (PFMO2HpA and PFMO3NA) for 28 d. Results demonstrated increased hepatomegaly and disturbed fatty acid metabolism with increasing treatment doses. After dimensionality reduction analysis, significant differences were observed in the relative liver weights and liver and serum biochemical parameters among the four clusters. Furthermore, when chemical concentrations in the liver were similar, no differences in the indicators of liver injury associated with fatty acid metabolism were observed among groups in the same clusters. Our results suggest that dimensionality reduction analysis is a useful strategy for analyzing samples exposed to multiple compounds at different doses. Furthermore, PFECAs exhibit similar hepatotoxicities at the same cumulative hepatic concentration in mice with constant body weight, while PFMO2HpA exhibits lower hepatotoxicity compared to GenX at the same dose.					1			A	B	肝毒性メカニズムの参考になる。	PFOAとGenXに加えて類似物質（PFMO2HpAとPFMO3NA）の肝毒性を複数用量で検出している。
D1167	実験動物（肝毒性）	Xu, LL; Chen, YK; Zhang, QY; Chen, LJ; Zhang, KK; Li, JH; Liu, JL; Wang, Q; Xie, XL	Gestational exposure to GenX induces hepatic alterations by the gut-liver axis in maternal mice: A similar mechanism as PFOA	2022	Sci. Total Environ. 2022 May:820:153281. doi: 10.1016/j.scitotenv.2022.153281.	GenX is an alternative to perfluorooctanoic acid (PFOA) and was included in the accession list of Substances of Very High Concern in 2019. Gestational GenX exposure induces maternal hepatotoxicity in animals. However, the mecha-nisms of GenX toxicity have not been explored. In the present study, pregnant Balb/c mice were administered with PFOA (1 mg/kg BW/day), GenX (2 mg/kg BW/day), or Milli-Q water by gavage during gestation. Similar hepatic path-ological changes, including enlargement of hepatocytes, cytoplasm loss, nucleus migration, inflammatory cell infiltra-tion, and reduction of glycogen storage, were observed in PFOA and GenX groups. Increased expression levels of indicators of the TLR4 pathway indicated activation of inflammation in the liver of maternal mice after exposure to PFOA or GenX, consistent with the pathological changes. Overexpression of cleaved PARP-1, cleaved caspase 3, Bax and decreased Bcl-2 proteins indicated activation of apoptosis, whereas overexpression of ULK-1, p62, beclin-1, LC3-II proteins and downregulation of p-mTOR implied that PFOA and GenX exposure initiated autophagy. Decreased secretion of mucus, reduced expression levels of tight junction proteins, and higher serum levels of lipopolysaccharide indicated disruption of the intestinal barrier. Translocation of lipopolysaccharide may be recognized by TLR4, thus triggering inflammatory pathway in the maternal liver. In summary, gestational exposure to PFOA or GenX induced maternal hepatic alterations through the gut-liver axis.					1			A	B	肝毒性メカニズムの参考になる。	PFOAとGenXの肝毒性を比較している。単用量で検出している。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1168	実験動物（肝毒性）	Yoo, HJ; Pyo, MC; Rhee, KH; Lim, JM; Yang, SA; Yoo, MK; Lee, KW	Perfluorooctanoic acid (PFOA) and hexafluoropropylene oxide-dimer acid (GenX): Hepatic stress and bile acid metabolism with different pathways	2023	Ecotox. Environ. Safe. 2023 Jul:259:115001. doi: 10.1016/j.ecoenv.2023.115001.	Per-and polyfluoroalkyl substances (PFASs) and perfluoroalkyl ether carboxylic acids (PFECAs) are organic chemicals that are widely used in the manufacture of a wide range of human-made products. Many monitoring findings revealed the presence of PFASs and PFECAs in numerous environmental sources, including water, soil, and air, which drew more attention to both chemicals. Because of their unknown toxicity, the discovery of PFASs and PFECAs in a variety of environmental sources was viewed as a cause for concern. In the present study, male mice were given orally one of the typical PFASs, perfluorooctanoic acid (PFOA), and one of the representative PFECAs, hexafluoropropylene oxide-dimer acid (HFPO-DA). The liver index showing hepatomegaly rose significantly after 90 d of exposure to PFOA and HFPO-DA, respectively. While sharing similar suppressor genes, both chemicals demonstrated unique hepatotoxic mechanisms. In different ways, these two substances altered the expression of hepatic stress-sensing genes as well as the regulation of nuclear receptors. Not only are bile acid metabolism-related genes in the liver altered, but cholesterol metabolism-related genes as well. These results indicate that PFOA and HFPO-DA both cause hepatotoxicity and bile acid metabolism impairment with distinct mechanisms.					1			A	B	肝毒性メカニズムの参考になる。	PFOAとGenXの肝毒性を比較している。
D1169	実験動物（PPAR）	Attema, B; Janssen, AWF; Rijkers, D; van Schothorst, EM; Hooiveld, GJEJ; Kersten, S	Exposure to low-dose perfluorooctanoic acid promotes hepatic steatosis and disrupts the hepatic transcriptome in mice	2022	Mol. Metab. 2022 Dec:66:101602. doi: 10.1016/j.molmet.2022.101602.	Objective: Perfluoroalkyl substances (PFAS) are man-made chemicals with demonstrated endocrine-disrupting properties. Exposure to perfluorooctanoic acid (PFOA) has been linked to disturbed metabolism via the liver, although the exact mechanism is not clear. Moreover, information on the metabolic effects of the new PFAS alternative GenX is limited. We examined whether exposure to low-dose PFOA and GenX induces metabolic disturbances in mice, including NAFLD, dyslipidemia, and glucose tolerance, and studied the involvement of PPARa.Methods: Male C57BL/6J wildtype and PPARa-/- mice were given 0.05 or 0.3 mg/kg body weight/day PFOA, or 0.3 mg/kg body weight/day GenX while being fed a high-fat diet for 20 weeks. Glucose and insulin tolerance tests were performed after 18 and 19 weeks. Plasma metabolite levels were measured next to a detailed assessment of the liver phenotype, including lipid content and RNA sequencing.Results: Exposure to high-dose PFOA decreased body weight and increased liver weight in wildtype and PPARa-/- mice. High-dose but not low-dose PFOA reduced plasma triglycerides and cholesterol, which for triglycerides was dependent on PPARa. PFOA and GenX increased hepatic triglycerides in a PPARa-dependent manner. RNA sequencing showed that the effects of GenX on hepatic gene expression were entirely dependent on PPARa, while the effects of PFOA were mostly dependent on PPARa. In the absence of PPARa, the involvement of PXR and CAR became more prominent.Conclusion: Overall, we show that long-term and low-dose exposure to PFOA and GenX disrupts hepatic lipid metabolism in mice. Whereas the effects of PFOA are mediated by multiple nuclear receptors, the effects of GenX are entirely mediated by PPARa. Our data underscore the potential of PFAS to disrupt metabolism by altering signaling pathways in the liver.					1		1	A	A	肝毒性の変化とメカニズムの参考になる。	PFOAとGenXの長期・低用量暴露によるマウスの肝脂質代謝を比較している。メカニズムとして、PFOAの影響が複数の核内受容体によって媒介されるのに対し、GenXの影響はすべてPPARaによって媒介される。
D1170	実験動物（肝毒性）	Pfohl, M; Marques, E; Auclair, A; Barlock, B; Jamwal, R; Goedken, M; Akhlaghi, F; Slitt, AL	An 'Omics Approach to Unraveling the Paradoxical Effect of Diet on Perfluorooctanesulfonic Acid (PFOS) and Perfluorononanoic Acid (PFNA)-Induced Hepatic Steatosis	2021	Toxicol. Sci. 2021 Apr:180(2):277-294. doi: 10.1093/toxsci/kfaa172.	Perfluoroalkyl substances (PFAS) are a family of toxicants universally detected in human serum and known to cause dyslipidemia in animals and humans. Hepatic steatosis, which is defined as lipid deposition in the liver, is known to be a consequence of poor diet. Similarly, PFAS are known to induce hepatic steatosis in animals on a low-fat chow. This study explored diet-PFAS interactions in the liver and their potential to modulate hepatic steatosis. Male C57BL/6J mice were fed with either a low-fat diet (10% kcal from fat, LFD) or a moderately high-fat diet (45% kcal from fat, HFD) with or without perfluorooctanesulfonic acid (3ppm, PFOS) or perfluorononanoic acid (3ppm, PFNA) in feed for 12weeks. Livers were excised for histology and quantification of PFAS and lipids. The PFOS and PFNA coadministration with HFD reduced the hepatic accumulation of lipid and PFAS relative to the LFD treatment groups. Furthermore, transcriptomic analysis revealed that PFAS administration in the presence of an HFD significantly reduces expression of known hepatic PFAS uptake transporters, organic anion transporter proteins. Transcriptomics and proteomics further revealed several pathways related to lipid metabolism, synthesis, transport, and storage that were modulated by PFAS exposure and further impacted by the presence of dietary fat. Both dietary fat content and the chemical functional head group exerted significant influence on hepatic PFAS accumulation and the resulting biochemical signature, suggesting that diet and structure should be considered in the design and interpretation of research on PFAS induced hepatic steatosis.			1					B	B	一容量のためPODを決定することはできないが毒性の参考になる・	PFOSとPFNAの肝毒性の比較をしている。単用量での実験。
D1171	in vitro（肝毒性）	Rowan-Carroll, A; Reardon, A; Leingartner, K; Gagne, R; Williams, A; Meier, MJ; Kuo, B; Bourdon-Lacombe, J; Moffat, I; Carrier, R; Nong, A; Lorusso, L; Ferguson, SS; Atlas, E; Yauk, C	High-Throughput Transcriptomic Analysis of Human Primary Hepatocyte Spheroids Exposed to Per- and Polyfluoroalkyl Substances as a Platform for Relative Potency Characterization	2021	Toxicol. Sci. 2021 Jun:181(2):199-214. doi: 10.1093/toxsci/kfab039.	Per- and poly-fluoroalkyl substances (PFAS) are widely found in the environment because of their extensive use and persistence. Although several PFAS are well studied, most lack toxicity data to inform human health hazard and risk assessment. This study focused on 4 model PFAS: perfluorooctanoic acid (PFOA; 8 carbon), perfluorobutane sulfonate (PFBS; 4 carbon), perfluorooctane sulfonate (PFOS; 8 carbon), and perfluorodecane sulfonate (PFDS; 10 carbon). Human primary liver cell spheroids (pooled from 10 donors) were exposed to 10 concentrations of each PFAS and analyzed at 4 time points. The approach aimed to: (1) identify gene expression changes mediated by the PFAS, (2) identify similarities in biological responses, (3) compare PFAS potency through benchmark concentration analysis, and (4) derive bioactivity exposure ratios (ratio of the concentration at which biological responses occur, relative to daily human exposure). All PFAS induced transcriptional changes in cholesterol biosynthesis and lipid metabolism pathways, and predicted PPARa activation. PFOS exhibited the most transcriptional activity and had a highly similar gene expression profile to PFDS. PFBS induced the least transcriptional changes and the highest benchmark concentration (ie, was the least potent). The data indicate that these PFAS may have common molecular targets and toxicities, but that PFOS and PFDS are the most similar. The transcriptomic bioactivity exposure ratios derived here for PFOA and PFOS were comparable to those derived using rodent apical endpoints in risk assessments. These data provide a baseline level of toxicity for comparison with other known PFAS using this testing strategy.				1				A	B	肝毒性メカニズムの参考になる。	
D1172	実験動物（肝毒性）	Chen, L; Liu, YF; Mu, HX; Li, H; Liu, S; Zhu, MY; Bu, YQ; Wu, B	Effects of perfluorobutane sulfonate and perfluorooctane sulfonate on lipid homeostasis in mouse liver	2022	Environ. Pollut. 2022 Dec:315:120403. doi: 10.1016/j.envpol.2022.120403.	Perfluorobutane sulfonate (PFBS), an alternative to perfluorooctane sulfonate (PFOS), has been increasingly used in recent years. However, emerging evidence has raised concerns about the potential health risks of PFBS. Here, the toxicityof low-dose PFBS on livers was explored and compared with that of PFOS. Adult C57BL/6 mice were exposed to 10 mu g/L, 500 mu g/L PFBS, or 500 mu g/L PFOS for 28 days through drinking water. At the phenotypic level, no liver damage was observed in the 10 mu g/L PFBS group. The cell apoptosis and decrease of CAT activities were observed in the 500 mu g/L PFBS group, while accumulation of lipid droplets, increase of CAT activities and TAG levels were found in the 500 mu g/L PFOS group. Lipidomics analysis revealed that 138, 238, and 310 lipids were significantly changed in the 10 mu g/L, 500 mu g/L PFBS and 500 mu g/L PFOS groups, respectively. The two PFBS-treated groups induced similar global lipid changes in a dose-dependent manner, which were distinct from PFOS. Overall, PFBS exposure induced an increase in phosphatidylcholines and sphingomyelins, but a decrease in phosphatidylinositol. PFOS exposure caused an increase in triacylglycerols. This study provides more evidence on the health hazards caused by exposure to low-dose PFBS.				1				B	B	PODを決定する研究デザインにはなっていないが毒性の参考になる。	低用量のPFBSへの暴露による肝毒性をPFOSと比較している。
D1173	in vitro（肝毒性）	Qi, Q; Niture, S; Gadi, S; Arthur, E; Moore, J; Levine, KE; Kumar, D	Per- and polyfluoroalkyl substances activate UPR pathway, induce steatosis and fibrosis in liver cells	2023	Environ. Toxicol. 2023 Jan:38(1):225-242. doi: 10.1002/tox.23680.	Per- and polyfluoroalkyl substances (PFAS), which include perfluorooctanoic acid (PFOA), heptafluorobutyric acid (HFBA), and perfluorotetradecanoic acid (PFTA), are commonly occurring organic pollutants. Exposure to PFAS affects the immune system, thyroid and kidney function, lipid metabolism, and insulin signaling and is also involved in the development of fatty liver disease and cancer. The molecular mechanisms by which PFAS cause fatty liver disease are not understood in detail. In the current study, we investigated the effect of low physiologically relevant concentrations of PFOA, HFBA, and PFTA on cell survival, steatosis, and fibrogenic signaling in liver cell models. Exposure of PFOA and HFBA (10 to 1000 nM) specifically promoted cell survival in HepaRG and HepG2 cells. PFAS increased the expression of TNF alpha and IL6 inflammatory markers, increased endogenous reactive oxygen species (ROS) production, and activated unfolded protein response (UPR). Furthermore, PFAS enhanced cell steatosis and fibrosis in HepaRG and HepG2 cells which were accompanied by upregulation of steatosis (SCD1, ACC, SRBP1, and FASN), and fibrosis (TIMP2, p21, TGF beta) biomarkers expression, respectively. RNA-seq data suggested that chronic exposures to PFOA modulated the expression of fatty acid/lipid metabolic genes that are involved in the development of NFALD and fatty liver disease. Collectively our data suggest that acute/chronic physiologically relevant concentrations of PFAS enhance liver cell steatosis and fibrosis by the activation of the UPR pathway and by modulation of NFALD-related gene expression.								B	C	炎症性サイトカインなどの反応に関して参考になる。	
D1174	実験動物（PPAR）	Jiang, LL; Hong, YJ; Xie, GS; Zhang, JH; Zhang, HN; Cai, ZW	Comprehensive multi-omics approaches reveal the hepatotoxic mechanism of perfluorohexanoic acid (PFHxA) in mice	2021	Sci. Total Environ. 2021 Oct:790:148160. doi: 10.1016/j.scitotenv.2021.148160.	Perfluorohexanoic acid (PFHxA), one of the short-chain perfluoroalkyl acids (PFAAs), is considered as a substitute of perfluorooctane sulfonate (PFOS). This emerging organic pollutant is persistent and highly bioavailable to humans, raising concerns about its potential health risks. There are currently few researches on the toxicity of PFHxA. Liver has been suggested to be the main target of PFHxA toxicity, and the mechanism remains unclear. Herein, we investigated the transcriptomic, proteomic, and metabolomic landscape in PFHxA-exposed mice. Using these approaches, we identified several valuable biological processes involved in the process of liver injury, comprising fatty acid biosynthesis and degradation pathways, which might be induced by peroxisome proliferator-activated receptor (PPAR) signaling pathway. These processes further promoted oxidative stress and induced liver injury. Meanwhile, abnormalities in purine metabolism and glutathione metabolism were observed during the liver injury induced by PFHxA, indicating the production of oxidative stress. Finally, our present multi-omics studies provided new insights into the mechanisms involved in PFHxA-induced liver injury.		1						A	B	PFHxAの毒性メカニズムの参考になる。	PFHxAによる肝毒性メカニズムとして、プリン代謝とグルタチオン代謝の異常が観察され、酸化ストレスの産生が示唆された。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1175	in vitro（肝毒性）	Qi, WP; Clark, JM; Timme-Laragy, AR; Park, Y	Perfluorobutanesulfonic acid (PFBS) induces fat accumulation in HepG2 human hepatoma	2020	Toxicol Environ. Chem. 2020;102(10):585-606. doi: 10.1080/02772248.2020.1808894.	Per- and poly-fluoroalkyl substances, especially perfluorooctane-sulfonic acid (PFOS), have been extensively used for over 50 years. A growing body of evidence has emerged demonstrating the potential adverse effects of these substances, including its effect on the development of non-alcoholic fatty liver disease, as one of the most prevalent chronic liver diseases. Nonetheless, there is no report of effects of perfluorobutanesulfonic acid (PFBS), the major replacement for PFOS, on non-alcoholic fatty liver disease. Therefore, the effects of PFBS exposure on fat accumulation in a human hepatoma cell line were examined. Cells were exposed to PFBS with or without 300Imol/L fatty acid mixture (oleic acid-palmitic acid, 2:1) conjugated by bovine serum albumin as an inducer of steatosis for 48 h. PFBS at 200 Imol/L significantly increased the triglyceride level in the presence of fatty acid compared to the control, but not without fatty acid, which was abolished by a specific peroxisome proliferator-activated receptor gamma antagonist. PFBS upregulated key genes controlling lipogenesis and fatty acid uptake. PFBS treatment also promoted the production of reactive oxygen species, an endoplasmic reticulum stress marker and cytosolic calcium. In conclusion, PFBS increased fat accumulation, in part, via peroxisome proliferator-activated receptor gamma-mediated pathway in hepatoma cells.				1				B	B		PFBSはPPARγを介して、肝細胞の脂肪蓄積を部分的に増加させた。
D1176	実験動物（肝毒性）	Chappell, GA; Thompson, CM; Wolf, JC; Cullen, JM; Klaunig, JE; Haws, LC	Assessment of the Mode of Action Underlying the Effects of GenX in Mouse Liver and Implications for Assessing Human Health Risks	2020	Toxicol. Pathol. 2020 Apr:48(3):494-508. doi: 10.1177/0192623320905803.	GenX is an alternative to environmentally persistent long-chain perfluoroalkyl and polyfluoroalkyl substances. Mice exposed to GenX exhibit liver hypertrophy, elevated peroxisomal enzyme activity, and other apical endpoints consistent with peroxisome proliferators. To investigate the potential role of peroxisome proliferator-activated receptor alpha (PPAR alpha) activation in mice, and other molecular signals potentially related to observed liver changes, RNA sequencing was conducted on paraffin-embedded liver sections from a 90-day subchronic toxicity study of GenX conducted in mice. Differentially expressed genes were identified for each treatment group, and gene set enrichment analysis was conducted using gene sets that represent biological processes and known canonical pathways. Peroxisome signaling and fatty acid metabolism were among the most significantly enriched gene sets in both sexes at 0.5 and 5 mg/kg GenX; no pathways were enriched at 0.1 mg/kg. Gene sets specific to the PPAR alpha subtype were significantly enriched. These findings were phenotypically anchored to histopathological changes in the same tissue blocks: hypertrophy, mitoses, and apoptosis. In vitro PPAR alpha transactivation assays indicated that GenX activates mouse PPAR alpha. These results indicate that the liver changes observed in GenX-treated mice occur via a mode of action (MOA) involving PPAR alpha, an important finding for human health risk assessment as this MOA has limited relevance to humans.					1			A	C	作用機序の参考になる。	
D1177	実験動物（PPAR）	Zhang, Y; Le, Y; Bu, PL; Cheng, XG	Regulation of Hox and ParaHox genes by perfluorochemicals in mouse liver	2020	Toxicology. 2020 Aug:441:152521. doi: 10.1016/j.tox.2020.152521.	Homeobox (Hox) genes encode homeodomain proteins, which play important roles in the development and morphological diversification of organisms including plants and animals. Perfluorinated chemicals (PFCs), which are well recognized industrial pollutants and universally detected in human and wildlife, interfere with animal development. In addition, PFCs produce a number of hepatic adverse effects, such as hepatomegaly and dyslipidemia. Homeodomain proteins profoundly contribute to liver regeneration. Hox genes serve as either oncogenes or tumor suppressor genes during target organ carcinogenesis. However, to date, no study investigated whether PFCs regulate expression of Hox genes. This study was designed to determine the regulation of Hox (including Hox-a to -d subfamily members) and paraHox [including GS homeobox (Gsx), pancreatic and duodenal homeobox (Pdx), and caudal-related homeobox (Cdx) family members] genes by PFCs including perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA) in mouse liver. 46.4 mg/kg PFNA induced mRNA expression of Hoxa5, b7, c5, d10 and Pdx1 in wild-type and CAR-null mouse livers, but not in PPAR alpha-null mouse livers, indicating a PPAR alpha-dependent manner. PFOA, PFNA, and PFDA all induced mRNA expression of Hoxa5, b7, c5, d10, Pdx1 and Zeb2 in wild-type but not PPAR alpha-null mouse livers. In addition, in Nrf2-null mouse livers, PFNA continued to increase mRNA expression of Hoxa5 and Pdx1, but not Hoxb7, c5 or d10. Furthermore, Wy14643, a classical PPAR alpha agonist, induced mRNA expression of Hoxb7 and c5 in wild-type but not PPAR alpha-null mouse livers. However, Wy14643 did not induce mRNA expression of Hoxa5, d10 or Pdx1 in either wild-type or PPAR alpha-null mouse livers. TCPOBOP, a classical mouse CAR agonist, increased mRNA expression of Hoxb7, c5 and d10 but not Hoxa5 or Pdx1 in mouse livers. Moreover, PFNA decreased cytoplasmic and nuclear Hoxb7 protein levels in mouse livers. However, PFNA increased cytoplasmic Hoxc5 protein level but decreased nuclear Hoxc5 protein level in mouse livers. In conclusion, PFCs induced mRNA expression of several Hox genes such as Hoxb7, c5 and d10, mostly through the activation of PPAR alpha and/or Nrf2 signaling.								A	B	作用機序の参考になる。	
D1178	実験動物（肝毒性）	Zhang, W; Zhang, YT; Zhang, HX; Wang, JS; Cui, RN; Dai, JY	Sex Differences in Transcriptional Expression of FABPs in Zebrafish Liver after Chronic Perfluorononanoic Acid Exposure	2012	Environ. Sci. Technol. 2012 May:46(9):5175-5182. doi: 10.1021/es300147w.	Perfluorononanoic acid (PFNA), a nine carbon backbone of perfluorinated acids (PFAAs), has wide production applications and is found in environmental matrices as a contaminant. To understand the adverse effects of PFNA, adult male and female zebrafish were exposed to differing PFNA dosages (0, 0.01, 0.1, and 1.0 mg/L) for 180 days using a flow-through exposure system. Results showed body weight, body length, and hepatosomatic index (HSI) decreased in both sexes. The HPLC-MS/MS analysis found that PFNA concentrations were higher in male livers than in female livers with increasing significance in a dose-dependent manner. Total cholesterol levels increased in the livers of both sexes, whereas triglyceride (TG) levels increased in males and decreased in females. With the exception of FABP1b, the transcriptional expression levels of fatty acid binding proteins (FABPs) were up-regulated in males and down-regulated in females. A similar trend between sexes occurred for peroxisome proliferator-activated receptors (PPARs) and Ccaat-enhancer-binding proteins (C/EBPs), which may be the upstream regulatory elements of FABPs. The results indicated that PFNA exposure caused opposite adverse effects on liver TG levels between the sexes in zebrafish possibly due to the opposite expression of FABPs and its upstream genes.				1				C	B		ゼブラフィッシュを用いた複数濃度のPFNAの毒性を検討しており、また雌雄差においても検討をしている
D1179	実験動物（肝毒性）	Gebreab, KY; Eeza, MNH; Bai, TY; Zuberi, Z; Matysik, J; O'Shea, KE; Alia, A; Berry, JP	Comparative toxicometabolomics of perfluorooctanoic acid (PFOA) and next-generation perfluoroalkyl substances	2020	Environ. Pollut.2020 Oct;265(Pt A):114928. doi: 10.1016/j.envpol.2020.114928.	Owing to environmental health concerns, a number of per- and polyfluoroalkyl substances (PFAS) have been phased-out, and increasingly replaced by various chemical analogs. Most prominent among these replacements are numerous perfluoroether carboxylic acids (PFECA). Toxicity, and environmental health concerns associated with these next-generation PFAS, however, remains largely unstudied. The zebrafish embryo was employed, in the present study, as a toxicological model system to investigate toxicity of a representative sample of PFECA, alongside perfluorooctanoic acid (PFOA) as one of the most widely used, and best studied, of the legacy PFAS. In addition, high-resolution magic angle spin (HRMAS) NMR was utilized for metabolic profiling of intact zebrafish embryos in order to characterize metabolic pathways associated with toxicity of PFAS. Acute embryotoxicity (i.e., lethality), along with impaired development, and variable effects on locomotory behavior, were observed for all PFAS in the zebrafish model. Median lethal concentration (LC50) was significantly correlated with alkyl chain-length, and toxic concentrations were quantitatively similar to those reported previously for PFAS. Metabolic profiling of zebrafish embryos exposed to selected PFAS, specifically including PFOA and two representative PFECA (i.e., GenX and PFO3TDA), enabled elaboration of an integrated model of the metabolic pathways associated with toxicity of these representative PFAS. Alterations of metabolic profiles suggested targeting of hepatocytes (i.e., hepatotoxicity), as well as apparent modulation of neural metabolites, and moreover, were consistent with a previously proposed role of mitochondrial disruption and peroxisome proliferator-activated receptor (PPAR) activation as reflected by dysfunctions of carbohydrate, lipid and amino acid metabolism, and consistent with a previously proposed contribution of PFAS to metabolic syndrome. Taken together, it was generally concluded that toxicity of PFECA is quantitatively and qualitatively similar to PFOA, and these analogs, likewise, represent potential concerns as environmental toxicants.					1			C	B		
D1180	実験動物（肝毒性）	Zhang, W; Liu, Y; Zhang, HX; Dai, JY	Proteomic analysis of male zebrafish livers chronically exposed to perfluorononanoic acid	2012	Environ. Int. 2012 Jul:42:20-30. doi: 10.1016/j.envint.2011.03.002	Perfluorononanoic acid (PFNA), a synthetic perfluorinated carboxylic acid and fluorosurfactant, is a known environmental contaminant found in people and wildlife. To understand the hepatotoxicity mechanism of PFNA, male zebrafish (n=200) were exposed to differing concentrations of PFNA (0, 0.1, 0.5, and 1.0 mg/L) for 180 days. A two-dimensional difference gel electrophoresis (2-D DIGE) approach coupled with MALDI-TOF-MS/MS analysis was employed to detect and identify the differential expressed proteins. A total of 57 proteins were successfully identified and categorized into functional classes that included metabolism (amino acid metabolism. TCA cycle and pyruvate metabolism, gluconeogenesis and glycolysis, protein metabolism and modification, and nucleotides metabolism), structure and motility, stress and defense, signal transduction, and cell communication. Our proteomic analyses added new perspective to PFNA hepatotoxicity in zebrafish. Results regarding mRNA levels demonstrated that the involvement of peroxisome proliferator-activated receptors (PPARs) could not sufficiently explain the hepatotoxicity mechanism of PFAAs in zebrafish. The extensive protein variations indicated that multiple cellular pathways were involved in and suggested that multiple protein molecules should be simultaneously targeted as an effective strategy to counter PFNA toxicity. Other potential modes should be further investigated.				1				C	B		ゼブラフィッシュを用いてPFNAの複数濃度を用いて検討を行っている。結果としてPFNA 毒性に対抗する効果的な戦略として複数のタンパク質分子を同時に標的にする必要があると提唱している。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1181	実験動物（PPAR）	Ishibashi, H; Kim, EY; Iwata, H	Transactivation Potencies of the Baikal Seal (Pusa sibirica) Peroxisome Proliferator-Activated Receptor alpha by Perfluoroalkyl Carboxylates and Sulfonates: Estimation of PFOA Induction Equivalency Factors	2011	Environ. Sci. Technol. 2011 Apr:45(7):3123-3130. doi: 10.1021/es103748s.	The present study assessed the transactivation potencies of the Baikal seal (Pusa sibirica) peroxisome proliferator-activated receptor alpha (BS PPAR alpha) by perfluorochemicals (PFCs) having various carbon chain lengths (C4-C12) using an in vitro reporter gene assay. Among the twelve PFCs treated with a range of 7.8-250 mu M concentration, eight perfluoroalkyl carboxylates (PFCAs) and two perfluoroalkyl sulfonates (PFSAs) induced BS PPAR alpha-mediated transcriptional activities in a dose-dependent manner. To compare the BS PPARa. transactivation potencies of PFCs, the present study estimated the PFOA induction equivalency factors (IEFs), a ratio of the 50% effective concentration of PFOA to the concentration of each compound that can induce the response corresponding to 50% of the maximal response of PFOA. The order of IEFs for the PFCs was as follows: PFOA (IEF: 1) > PFHpA (0.89) > PENA (0.61) > PFPeA (0.50) > PFHxS (0.41) > PFHxA (0.38) approximate to PFDA (0.37) > PFBA (0.26) = PFOS (0.26) > PFUnDA (0.15) >> PFDoDA and PFBuS (not activated). The structure-activity relationship analysis showed that PFCAs having more than seven perfluorinated carbons had a negative correlation (r = -1.0, p = 0.017) between the number of perfluorinated carbons and the IEF of PFCAs, indicating that the number of perfluorinated carbon of PFCAs is one of the factors determining the transactivation potencies of the BS PPARa. The analysis also indicated that PFCAs were more potent than PFSAs with the same number of perfluorinated carbons. Treatment with a mixture of ten PFCs showed an additive action on the BS PPARa. activation. Using IEFs of individual PFCs and hepatic concentrations of PFCs in the liver of wild Baikal seals, the PFOA induction equivalents (IEQs, 5.3-58 ng IEQ/g wet weight) were calculated. The correlation analysis revealed that the hepatic total IEQ showed a significant positive correlation with the hepatic expression levels of cytochrome P450 4A-like protein (r = 0.53, p = 0.036). This suggests that our approach may be useful for assessing the potential PPARa-mediated biological effects of complex mixtures of PFCs in wild Baikal seal population.	1	1						C	C		
D1182	実験動物（肝毒性）	Le, Y; Cheng, XG	Perfluorononanoic Acid (PFNA) Suppresses Autophagy and Activates Nrf2 Signaling	2019	Faseb J. 2019 Apr:33:506.12. doi: 10.1096/fasebj.2019.33.1_supplement.506.12	Perfluorinated compounds (PFCs), a group of persistent environmental pollutants, are frequently detected in human blood. Epidemiological and animal studies show that there are positive associations between higher blood levels of PFCs and greater risk of liver disorders, thyroid disorders, reproductive toxicity, and immunotoxicity. Nuclear factor erythroid 2-related factor (Nrf) 2, a transcription factor that can be activated by oxidative stress, electrophiles, and accumulated p62 protein after autophagy repression, plays important anti-inflammatory, anti-oxidative and cytoprotective roles. We previously reported that PFCs increased the expressions of several Nrf2 target genes in mouse liver. However, the underlying mechanism by which PFCs activate Nrf2 signaling remains largely unknown. The present study was designed to determine whether PFNA activates Nrf2 signaling; and if so, the underlying mechanism. PFNA increased mRNA expressions of Nrf2-target genes, including Heme oxygenase (Ho/HO) 1 and NAD(P)H: quinone oxidoreductase (Nqo/NQO) 1, as well as nuclear levels of Nrf2/NRF2 protein in both mouse liver and cultured human Hep3B hepatoma cells. To our surprise, PFNA did not produce apparent oxidative stress in both mouse liver and cultured human Hep3B hepatoma cells. We next determined the impact of PFNA on autophagy progression. In both mouse liver and cultured human Hep3B hepatoma cells, PFNA decreased the conversion of microtubule-associated protein 1 light chain 3 beta (LC3B)-I into LC3B-II, and increased cytosolic levels of p62 protein, indicating that PFNA repressed autophagic flux. In addition, PFNA decreased nuclear levels of transcription factor EB (TFEB) protein, an upstream signaling molecule of autophagy. Morphologically, PFNA caused liver injury in both wide-type and Nrf2-null mouse liver, evidenced by hepatocyte necrosis and hemorrhage. In consistency with histology study, PFNA (0.1mmole/kg) increased serum AST and ALT levels in both wide-type mice and Nrf2-null mice. In addition, PFNA produced clear inflammation foci in Nrf2-null mouse liver, but not in wide-type mouse liver. Furthermore, PFNA induced mRNA expressions of pro-inflammatory cytokines, including IL-1 β, IL-6, and TNF-α only in Nrf2-null mouse liver, but not in wide-type mouse liver. In conclusion, PFNA activates Nrf2 signaling, primarily mediated by accumulated p62 protein after autophagy repression, which significantly attenuated PFNA-induced inflammation.			1					A	B	酸化ストレスメカニズムの参考になる。	in vivoおよびvitroの研究で、PFNAの肝毒性メカニズムについて検討している。その結果、PFNAはNrf2シグナルを活性化し、主にオートファジー抑制後に蓄積したp62タンパク質を介して炎症を抑制すると結論づけている。
D1183	in vitro（肝毒性）	Fragki, S; Louisse, J; Bokkers, B; Luijten, M; Peijnenburg, A; Rijkers, D; Piersma, AH; Zeilmaker, MJ	New approach methodologies: A quantitative in vitro to in vivo extrapolation case study with PFASs	2023	Food Chem. Toxicol. 2023 Feb:172:113559. doi: 10.1016/j.fct.2022.113559.	Per: and polyfluoroalkyl substances (PFASs) have been associated with increased blood lipids in humans. Perfluorooctanoic acid (PFOA) has been also linked with elevated alanine transferase (ALT) serum levels in humans, and in rodents the liver is a main target organ for many PFASs. With the focus on New Approach Methodologies, the chronic oral equivalent effect doses were calculated for PFOA, PFNA (perfluorononanoic acid), PFHxS (perfluorohexanesulfonic acid) and PFOS (perfluorooctane sulfonic acid) based on in vitro effects measured in the HepaRG cell line. Selected in vitro readouts were considered biomarkers for lipid disturbances and hepatotoxicity. Concentration-response data obtained from HepaRG cells on triglyceride (TG) accumulation and expression changes of 12 selected genes (some involved in cholesterol homeostasis) were converted into corresponding human dose-response data, using physiologically based kinetic (PBK) model-facilitated reverse dosimetry. Next to this, the biokinetics of the chemicals were studied in the cell system. The current European dietary PFASs exposure overlaps with the calculated oral equivalent effect doses, indicating that the latter may lead to interference with hepatic gene expression and lipid metabolism. These findings illustrate an in vitro-in silico methodology, which can be applied for more PFASs, to select those that should be prioritized for further hazard characterization.			1					A	D	作用機序の参考になる。	今回の選定された5種のPFASについては要約では言及されていない。
D1184	実験動物（PPAR）	Zhang, Y; Zhang, YC; Klaassen, CD; Cheng, XG	Alteration of Bile Acid and Cholesterol Biosynthesis and Transport by Perfluorononanoic Acid (PFNA) in Mice	2018	Toxicol. Sci. 2018 Mar:162(1):225-233. doi: 10.1093/toxsci/kfx237.	Perfluorochemicals produce hepatotoxic effects via activation of peroxisome proliferator-activated receptor alpha (PPAR alpha) and constitutive androstane receptor (CAR) nuclear receptors in animals. Bile formation is one major liver function. But it remains unknown whether perfluorochemicals alter metabolism of bile acids (BAs) in liver. The present study was designed to determine the impact of perfluorononanoic acid (PFNA) on BA and cholesterol homeostasis in mice. A single dose of PFNA (0.1mmol/kg) was intraperitoneally administered to adult male wild-type (WT), PPAR alpha-null, and CAR-null mice. PFNA caused cholestasis in the WT mice, indicated by increased serum alanine aminotransferase, hyperbilirubinemia, elevated BA concentrations in mouse serum, and appearance of bile plugs in mouse liver. In addition, PFNA decreased total and some individual BAs in mouse liver. PFNA increased the concentrations of total and taurine-conjugated, as well as some individual BAs in the serum of WT and CAR-null mice but not in PPAR alpha-null mice, indicating a PPAR alpha-dependent mechanism. PFNA decreased mRNA expression of most BA-related transporters (sodium-taurocholate cotransporting polypeptide, organic anion transporting polypeptide [Oatp]1a1, Oatp1b2, and bile salt export pump) and BA biosynthetic enzymes (Cyp7a1, 7b1, 8b1, and 27a1) in mouse liver, but increased mRNA expression of some efflux transporters (breast cancer resistance protein, multidrug resistance transporter 2, multidrug resistance-associated protein [Mrp] 2, Mrp3, and Mrp4), primarily via a PPAR alpha-dependent mechanism. Moreover, PFNA increased free and total cholesterol in mouse liver but not in mouse serum. Furthermore, PFNA increased mRNA expression of sterol transporters, namely Abca1, g1, g5/g8, and steroidogenic acute regulatory protein via PPAR alpha. In conclusion, PFNA produced cholestasis in mouse liver, and the activation of PPAR alpha plays a central role in regulating BA and cholesterol metabolism and transport in mouse serum and liver.			1					A	B	作用機序の参考になる。	PFNAは肝臓での胆汁うっ滞を誘発し、PPARαを介してマウス血清および肝臓におけるBAとコレステロールの代謝および輸送の調節に影響を与えている。
D1185	実験動物（肝毒性）	Skov, K; Kongsbak, K; Hadrup, N; Frandsen, HL; Svingen, T; Smedsgaard, J; Audouze, K; Eklund, AC; Vinggaard, AM	Exposure to perfluorononanoic acid combined with a low-dose mixture of 14 human-relevant compounds disturbs energy/lipid homeostasis in rats	2015	Metabolomics. 2015 Oct:11(5):1451-1464. doi: 10.1007/s11306-015-0802-y.	Humans are constantly exposed to a significant number of compounds and many are readily detected in human body fluids. Worryingly, several of these compounds are either suspected to be, or have already been shown to be harmful to humans either individually or in combination. However, the potential consequences of low-dose exposure to complex mixtures remain poorly understood. We have profiled the effects on rat blood plasma and liver homeostasis using metabolomics and transcriptomics following 2-week exposure to either a mixture of 14 common chemicals (Mix), perfluorononanoic acid (PFNA) at low (0.0125 mg/kg/day) or mid (0.25 mg/kg/day) doses, or a combination of Mix and PFNA. In blood plasma, 63 and 64 metabolites were significantly changed upon exposure to Mix alone or PFNA + Mix, respectively. Twelve of the metabolites were identified and comprised mainly lipids, with various lipid classes differentially affected across study groups. In the liver, expression of 182 and 203 genes-mainly related to energy homeostasis and lipid metabolism-were differentially expressed upon exposure to PFNA alone or PFNA + Mix, respectively. In general, Mix alone affected lipid metabolism evident in blood plasma, whereas effects on lipid metabolism in the liver were mainly driven by PFNA. This study verifies that a chemical mixture given at high-end human exposure levels can affect lipid homeostasis and that the combined use of metabolomics and transcriptomics can provide complimentary information allowing for a detailed analysis of affected signaling pathways.			1					A	C	作用機序の参考になる。	
D1186	実験動物（肝毒性）	Zhang, FH; Liu, L; Hu, JL; Fu, HY; Li, HY; Chen, JM; Yang, CY; Guo, QR; Liang, XT; Wang, L; Guo, Y; Dai, JY; Sheng, N; Wang, JS	Accumulation and glucocorticoid signaling suppression by four emerging perfluoroethercarboxylic acids based on animal exposure and cell testing	2023	Environ. Int. 2023 Aug:178:108092. doi: 10.1016/j.envint.2023.108092.	Various perfluoroethercarboxylic acids (PFECA) have emerged as next-generation replacements of legacy per -and polyfluoroalkyl substances (PFAS). However, there is a paucity of information regarding their bio-accumulation ability and hazard characterization. Here, we explored the accumulation and hepatotoxicity of four PFECA compounds (HFPO-DA, HFPO-TA, PFO4DA, and PFO5DoDA) in comparison to perfluorooctanoic acid (PFOA) after chronic low-dose exposure in mice. Except for HFPO-DA, the levels of all tested PFAS in the liver exceeded that in serum. High molecular weight PFECA compounds (PFO5DoDA and HFPO-TA) showed stronger accumulation capacity and longer half-lives (t1/2) than low molecular weight PFECA compounds (HFPO-DA and PFO4DA) and even legacy PFOA. Although hepatomegaly is a common apical end point of PFAS exposure, the differentially expressed gene (DEG) profiles in the liver suggested significant differences between PFOA and the four PFECA compounds. Gene enrichment analysis supported a considerable inhibitory effect of PFECA, but not PFOA, on the glucocorticoid receptor (GR) signaling pathway. Both HFPO-TA and PFO5DoDA demonstrated a more pronounced ability to perturb RNA expression profiles in vivo and to suppress GR signaling in vitro compared to HFPO-DA and PFO4DA. Calculated reference doses (RfDs) emphasized the potential hazard of PFECA to human health. Overall, our findings indicate that PFECA alternatives do not ease the concerns raised from legacy PFAS pollution.					1			A	B	作用機序の参考になる。	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1187	in vitro（核内受容体）	Houck, KA; Patlewicz, G; Richard, AM; Williams, AJ; Shobair, MA; Smeltz, M; Clifton, MS; Wetmore, B; Medvedev, A; Makarov, S	Bioactivity profiling of per- and polyfluoroalkyl substances (PFAS) identifies potential toxicity pathways related to molecular structure	2021	Toxicology. 2021 Jun:457:152789. doi: 10.1016/j.tox.2021.152789.	Per- and polyfluoroalkyl substances (PFAS) are a broad class of hundreds of fluorinated chemicals with environmental health concerns due to their widespread presence and persistence in the environment. Several of these chemicals have been comprehensively studied for experimental toxicity, environmental fate and exposure, and human epidemiology; however, most chemicals have limited or no data available. To inform methods for prioritizing these data-poor chemicals for detailed toxicity studies, we evaluated 142 PFAS using an in vitro screening platform consisting of two multiplexed transactivation assays encompassing 81 diverse transcription factor activities and tested in concentration-response format ranging from 137 nM to 300 mu M. Results showed activity for various nuclear receptors, including three known PFAS targets-specifically estrogen receptor alpha and peroxisome proliferator receptors alpha and gamma. We also report activity against the retinoid X receptor beta, the key heterodimeric partner of type II, non-steroidal nuclear receptors. Additional activities were found against the pregnane X receptor, nuclear receptor related-1 protein, and nuclear factor erythroid 2-related factor 2, a sensor of oxidative stress. Using orthogonal assay approaches, we confirmed activity of representative PFAS against several of these targets. Finally, we identified key PFAS structural features associated with nuclear receptor activity that can inform future predictive models for use in prioritizing chemicals for risk assessment and in the design of new structures devoid of biological activity.								A	D	作用機序の参考になる。	今回の選定された5種のPFASについては要約では言及されていない。
D1188	in vitro（肝毒性）	Lim, JJ; Suh, Y; Faustman, EM; Cui, JY	Perfluorinated Carboxylic Acids with Increasing Carbon Chain Lengths Upregulate Amino Acid Transporters and Modulate Compensatory Response of Xenobiotic Transporters in HepaRG Cells	2022	Drug Metab. Dispos. 2022 Oct:50(10):1396-1413. doi: 10.1124/dmd.121.000477.	Perfluorinated carboxylic acids (PFCAs) are widespread environmental pollutants for which human exposure has been documented. PFCAs at high doses are known to regulate xenobiotic transporters partly through peroxisome proliferator-activated receptor alpha (PPAR alpha) and constitutive androstane receptor (CAR) in rodent models. Less is known regarding how various PFCAs at a lower concentration modulate transporters for endogenous substrates, such as amino acids in human hepatocytes. Such studies are of particular importance because amino acids are involved in chemical detoxification, and their transport system may serve as a promising therapeutic target for structurally similar xenobiotics. The focus of this study was to further elucidate how PFCAs modulate transporters involved in intermediary metabolism and xenobiotic biotransformation. We tested the hepatic transcriptomic response of HepaRGcells exposed to 45 mu M of perfluorooctanoic acid, perfluorononanoic acid, or perfluorodecanoic acid in triplicates for 24 hours (vehicle: 0.1% DMSO), as well as the prototypical ligands for PPARa (WY-14643, 45 mu M) and CAR (6-(4-chlorophenyl) imidazo[2,1-b][1,3]thiazole-5-carbaldehyde O-(3,4-dichlorobenzyl)oxime [CITCO], 2 IM). PFCAs with increasing carbon chain lengths (C8-C10) regulated more liver genes, with amino acid metabolism and transport ranked among the top enriched pathways and PFDA ranked as themost potent PFCA tested. Genes encoding amino acid transporters, which are essential for protein synthesis, were novel inducible targets by all three PFCAs, suggesting a potentially protective mechanism to reduce further toxic insults. None of the transporter regulations appeared to be through PPAR alpha or CAR but potential involvement of nuclear factor erythroid 2-related factor 2 is noted for all 3 PFCAs. In conclusion, PFCAs with increasing carbon chain lengths up-regulate amino acid transporters andmodulate xenobiotic transporters to limit further toxic exposures in HepaRGcells. SIGNIFICANCE STATEMENT Little is known regarding how various perfluorinated carboxylic acids modulate the transporters for endogenous substrates in human liver cells. Using HepaRG cells, this study is among the first to show that perfluorinated carboxylic acids with increasing carbon chain lengths upregulate amino acid transporters, which are essential for protein synthesis, and modulate xenobiotic transporters to limit further toxic exposures at concentrations lower than what was used in the literature.			1					B	D		今回の選定された5種のPFASについては要約では言及されていない。
D1189	実験動物（肝毒性）	Permadi H, Lundgren B, Andersson K, DePierre JW.	Effects of perfluoro fatty acids on xenobiotic-metabolizing enzymes, enzymes which detoxify reactive forms of oxygen and lipid peroxidation in mouse liver	1992	Biochem Pharmacol. 1992 Sep 25;44(6):1183-91. doi: 10.1016/0006-2952(92)90383-t.	Male mice were exposed via their diet to perfluoro fatty acids of various chain-lengths (2-10 carbon atoms) at different doses (0.02 and 0.1% weight) and for different periods of time (2-10 days). Thereafter, we monitored effects on liver and body weights and a number of hepatic parameters, including mitochondrial protein content, microsomal contents of cytochromes P450 and b5, NADPH-cytochrome P450 reductase activity [measured as NADPH-cytochrome c reductase (EC 1.6.2.3)], microsomal and cytosolic epoxide hydrolase (EC 3.3.2.3) activities, cytosolic DT-diaphorase (EC 1.6.99.2), glutathione transferase (EC 2.5.1.18), glutathione peroxidase (EC 1.11.1.9) and superoxide dismutase (EC 1.15.1.1) activities, and levels of thiobarbituric acid-reactive material (as an indicator of lipid peroxidation) in the mitochondrial subfraction. The most dramatic changes observed were a 5-9-fold increase in mitochondrial protein, a 3-6-fold increase in the microsomal content of cytochrome P450, a 3-10-fold increase in cytosolic DT-diaphorase activity, an approximately 2-fold increase in cytosolic epoxide hydrolase activity and as much as a 60% decrease in the level of thiobarbituric acid-reactive compounds in the mitochondrial fraction. Smaller increases in microsomal epoxide hydrolase activity and decreases in cytosolic glutathione peroxidase activity were also observed. Of the perfluoro fatty acids tested, perfluorooctanoic acid caused the largest changes in the parameters examined here. Dietary exposure of mice to a 0.02% dose of this substance for 10 days results in a maximal or near-maximal effect in most cases.								B	D		今回の選定された5種のPFASについては要約では言及されていない。
D1190	実験動物（肝毒性）	Kozuka H, Yamada J, Horie S, Watanabe T, Suga T, Ikeda T.	Characteristics of induction of peroxisomal fatty acid oxidation-related enzymes in rat liver by drugs. Relationships between structure and inducing activity	1991	Biochem Pharmacol. 1991 Feb 15;41(4):617-23. doi: 10.1016/0006-2952(91)90635-i.	To clarify the mechanism of induction of hepatic peroxisome-associated enzymes by drugs, we examined the interrelationship between the structures of fifteen drugs of two types (phenoxyacetic acid derivatives and perfluorinated compounds) and their inducing activities. Male Wistar rats were given the drugs at 150 mg/kg body weight daily for 2 weeks, and then hepatic activities of fatty acid metabolism-related enzymes were determined. The activity of the cyanide-insensitive fatty acyl-CoA oxidizing system located in peroxisomes was increased significantly in the following order: 2,4,5-trichlorophenoxypropionic acid (12.5-fold) greater than 2,4-dichlorophenoxypropionic acid (6.6-fold) greater than clofibrate (4.5-fold) greater than 2-methyl-4-chlorophenoxyacetic acid (2.6-fold) greater than 2,4,5-trichlorophenoxyacetic acid (2.5-fold) greater than p-chlorophenoxypropionic acid (2.4-fold) greater than 2,4-dichlorophenoxyacetic acid (1.7-fold). Treatment with perfluorinated compounds, perfluorobutyric acid, perfluorooctanoic acid, perfluorodecanoic acid and perfluorooctanol, also induced the activity by 2-, 4.3-, 3.1- and 2.0-fold respectively. The profile of the induction of carnitine acetyltransferase by these compounds was quite similar to that of cyanide-insensitive fatty acyl-CoA oxidizing system. Lipophilicity of these drugs was determined by the octanol-water partition method. Among these drugs, 2,4,5-trichlorophenoxypropionic acid showed the largest octanol/water partition coefficient (log P = 0.39). These results show a strong correlation among the number of chlor-substitutions on the phenyl moiety, the methyl-group on the alpha position of the acetic acid moiety, lipophilicity and the inducibility of peroxisomal fatty acid oxidation-related enzymes.	1							B	B	PODを決定する研究デザインにはなっていないが毒性の参考になる。	
D1191	実験動物（肝毒性）	Sun S, Li X, Zhang L, Zhong Z, Chen C, Zuo Y, Chen Y, Hu H, Liu F, Xiong G, Lu H, Chen J, Dai J.	Hexafluoropropylene oxide trimer acid (HFPO-TA) disturbs embryonic liver and biliary system development in zebrafish	2023	Sci Total Environ. 2023 Feb 10;859(Pt 1):160087. doi: 10.1016/j.scitotenv.2022.160087. Epub 2022 Nov 11.	Hexafluoropropylene oxide trimer acid (HFPO-TA), a novel alternative to perfluorooctanoic acid (PFOA), has emerged as a potential environmental pollutant. Here, to investigate the toxic effects of HFPO-TA on liver and biliary system development, zebrafish embryos were exposed to 0, 50, 100, or 200 mg/L HFPO-TA from 6 to 120 h post-fertilization (hpf). Results showed that the 50 % lethal concentration (LC50) of HFPO-TA was 231 mg/L at 120 hpf, lower than that of PFOA. HFPO-TA exposure decreased embryonic hatching, survival, and body length. Furthermore, HFPO-TA exerted higher toxicity at the specification stage than during the differentiation and maturation stages, leading to small-sized livers in Tg(fabp10a: DsRed) transgenic larvae and histopathological changes. Significant decreases in the mRNA expression of genes related to liver formation were observed. Alanine transaminase (ALT), aspartate aminotransferase (AST), total bilirubin (TBIL), and direct bilirubin (DBIL) levels were significantly increased. HFPO-TA decreased total cholesterol (TCHO) and triglyceride (TG) activities, disturbed lipid metabolism through the peroxisome proliferator-activated receptor (PPAR) pathway, and induced an inflammatory response. Furthermore, HFPO-TA inhibited intrahepatic biliary development in Tg(Tp1:eGFP) transgenic larvae and interfered with transcription of genes associated with biliary duct development. HFPO-TA reduced bile acid synthesis but increased bile acid transport, resulting in disruption of bile acid metabolism. Therefore, HFPO-TA influenced embryonic liver and biliary system morphogenesis, caused liver injury, and may be an unsafe alternative for PFOA.					1			C	D		今回の選定された5種のPFASについては要約では言及されていない。
D1192	実験動物（肝毒性）	Zhang X, Du J, Huo S, Li B, Zhang J, Song M, Shao B, Li Y.	Hexafluoropropylene oxide trimer acid causes fibrosis in mice liver via mitochondrial ROS/cGAS-STING/NLRP3-mediated pyroptosis	2023	Food Chem Toxicol. 2023 Apr;174:113706. doi: 10.1016/j.fct.2023.113706. Epub 2023 Mar 5.	Hexafluoropropylene oxide trimer acid (HFPO-TA) causes hepatotoxicity, however, its underlying mechanisms have not been conclusively determined. We investigated the effects of HFPO-TA on mice liver after 28 days of orally administered 0 or 0.5 mg/kg/d HFPO-TA. Administration of HFPO-TA induced mitochondrial ROS (mtROS) overexpression, cGAS-STING signaling activation, pyroptosis and fibrosis in mice liver. To determine the HFPO-TA-associated hepatotoxic mechanisms, mtROS, cGAS-STING signaling and pyroptosis intervention assays were performed in HFPO-TA-exposed mice liver. First, mtROS was found to be an upstream regulatory target of cGAS-STING signaling, pyroptosis and fibrosis. Second, cGAS-STING signaling was established to be an upstream regulatory mechanism of pyroptosis and fibrosis. Finally, pyroptosis was shown to regulate fibrosis. The above results confirm that HFPO-TA causes mice liver fibrosis via mtROS/cGAS-STING/NLRP3-mediated pyroptosis.					1			A	D	作用機序の参考になる。	今回の選定された5種のPFASについては要約では言及されていない。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1193	実験動物（肝毒性）	Yang W, Ling X, He S, Cui H, Yang Z, An H, Wang L, Zou P, Chen Q, Liu J, Ao L, Cao J.	PPARα/ACOX1 as a novel target for hepatic lipid metabolism disorders induced by per- and polyfluoroalkyl substances: An integrated approach	2023	Environ Int. 2023 Aug;178:108138. doi: 10.1016/j.envint.2023.108138. Epub 2023 Aug 8.	Background: Per- and polyfluoroalkyl substances (PFAS) are persistent and ubiquitous environmental contaminants with well-documented hepatotoxicity. However, the mechanistic linkage between PFAS exposure and non-alcoholic fatty liver disease (NAFLD) remains largely elusive. Objectives: This study aimed to explore PFAS-to-NAFLD link and the relevant molecular mechanisms. Methods: The cross-sectional analyses using National Health and Nutrition Examination Survey (NHANES) data were conducted to investigate the association between PFAS exposure and NAFLD. A combination of in silico toxicological analyses, bioinformatics approaches, animal experiments, and in vitro assays was used to explore the molecular initiating events (MIEs) and key events (KEs) in PFAS-induced hepatic lipid metabolism disorders. Results: The cross-sectional analyses with NHANES data revealed the significant association between PFAS exposure and hepatic steatosis/NAFLD. The in silico toxicological analyses showed that PPARα activation induced by perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS), prototypical representatives of PFAS, is the critical MIE associated with NAFLD-predominant liver diseases. Transcriptome-based bioinformatic annotation and analyses identified that transcriptional upregulation of hepatic acyl-CoA oxidase 1 (ACOX1) in PPARα-regulated peroxisomal β-oxidation pathway was the KE involved with PFOA/PFOS-perturbed hepatic lipid metabolic pathways in humans, mice and rats. The in vivo and in vitro assays further verified that ACOX1-mediated oxidative stress contributed to mitochondrial compromise and lipid accumulation in PFOA/PFOS-exposed mouse hepatocytes, which could be mitigated by co-treatment with ACOX1 inhibitor and mitochondria ROS scavenger. Additionally, we observed that besides PFOA and PFOS, hepatic ACOX1 exhibited good-fit response to short-term exposures of long-chain (C7-C10) perfluoroalkyl carboxylic acids (PFHpA, PFNA, PFDA) and perfluoroalkyl sulfonic acids (PFHpS, PFDS) in human hepatocyte spheroids through benchmark dose (BMD) modeling. Conclusion: Our study unveils a novel molecular target for PFAS-induced hepatic lipid metabolic disorders, shedding new light on prediction, assessment, and mitigation of PFAS hepatotoxicity.								A	C	肝毒性の変化とメカニズムの参考になる。	
D1194	実験動物（肝毒性）	池田 敏彦(三共), 相場 君江, 福田 邦昭	パーフルオロ脂肪酸類によるラット肝ペルオキシソーム増殖の誘導(The Induction of Peroxisome Proliferation in Rat Liver by Perfluorinated Fatty Acids, Metabolically Inert Derivatives of Fatty Acids)(英語)	1985	The Journal of Biochemistry(0021-924X)98巻2号 Page475-482(1985.08). doi: 10.1093/oxfordjournals.jbchem.a135302.	SD系雄性ラットを0.02%種々のフッ素化合物混合飼料にて2週間飼育するか,あるいは直接種々のフッ素化合物のコーン油溶液を単回腹腔内注射(100 mg/kg)した後,肝ペルオキシソーム増殖の誘導を調べた.その判定には,肝重量増加ならびに肝カタラーゼ活性増加の測定,SDSポリアクリルアミドゲル電気泳動法による肝ペルオキシソーム由来エノイルCoA水和酵素(分子量8万タンパク質)の検出および電子顕微鏡による観察などの手法を用いた.薬物混合飼料による処理では,脂肪酸誘導体であるパーフルオロオクタン酸(PFOA, C8)およびパーフルオロ酪酸(PFBA, C4)が顕著にペルオキシソームを誘導したが,カルボキシル基を持たない1-H, 1-H,ペンタデカフルオロオクタノール(PFOL, C8)およびパーフルオロオクタン(PFO, C8)はまったく誘導しなかった.単回腹腔内投与では,パーフルオロデカン酸(PFDA, C10), PFOA,およびPFOLが誘導したが,PFBA,PFOおよびパーフルオロドデカン(PFD, C12)は誘導しなかった.アルコール誘導体であるPFOLは,大量単回投与では一部PFOAに代謝されて効果を発揮するが短鎖脂肪酸であるPFBAは体外排泄が速い可能性が高く,このため単回投与では効果があらわれないとみられる.官能基を持たないパラフィン誘導体はまったく誘導能を示さなかった.これらのことから,肝ペルオキシソーム増殖の誘導には脂肪酸構造が必須であることが示唆された.	1							A	B	作用機序の参考になる。	
D1195	実験動物（肝毒性）	Kudo Naomi(城西大学 薬学科), Suzuki-Nakajima Erika, Mitsumoto Atsushi, Kawashima Yoichi	雌雄マウスにおける炭素鎖長の異なるペルフルオロ脂肪酸に対する肝臓の反応　肝肥大、ペルオキシソームβ-酸化およびミクロソーム1-アシルグリセロホスホコリンアシルトランスフェラーゼの誘導に関して(Responses of the Liver to Perfluorinated Fatty Acids with Different Carbon Chain Length in Male and Female Mice: In Relation to Induction of Hepatomegaly, Peroxisomal β-Oxidation and Microsomal 1-Acylglycerophosphocholine Acyltransferase)(英語)	2006	Biological & Pharmaceutical Bulletin(0918-6158)29巻9号 Page1952-1957(2006.09). doi: 10.1248/bpb.29.1952	肝肥大、ペルオキシソームβ-酸化およびミクロソーム1-アシルグリセロホスホコリン(1-アシル-GPC)アシルトランスフェラーゼの誘導力について雌雄マウスの肝臓で6～9炭素鎖長のペルフルオロ脂肪酸(PFCA)間で比較した。比較したPFCAはいずれも肝肥大とペルオキシソームβ酸化を誘導し、その強度はペルフルオロノナン酸(PFNA)、ペルフルオロオクタン酸(PFOA)、ペルフルオロヘプタン酸(PFHA)、ペルフルオロヘキサン酸(PFHeA)の順であった。ミクロソーム1-アシル-GPCアシルトランスフェラーゼは、PFHA、PFOAおよびPFNAにより誘導され、ペルオキシソームβ酸化も同様であった。いずれのPFACによるペルオキシソームβ酸化の誘導においても有意な性差はなかった。PFNAとPFOAの肝臓への蓄積は雌雄共に用量依存的であった。程度は低いがPFHAは肝に蓄積し、PFHeAの肝蓄積は少量であった。PFNA、PFOAおよびPFHAの肝内濃度は雄の方が雌より高かった。雌雄ともペルオキシソームβ酸化活性とPFHeA、PFHA、PFOAおよびPFNAの肝臓中濃度の間には炭素鎖長に関わらず回帰直線が認められた。以上から、雌雄マウスともペルフルオロアルキル鎖が長いほどPFCAの肝蓄積が多いこと、PFCAの蓄積が肝肥大、ペルオキシソームβ酸化およびミクロソーム1-アシル-GPCアシルトランスフェラーゼを誘導すること、さらにPFHA、PFOAおよびPFNAの肝内蓄積に見られた性差はペルオキシソームβ酸化における明確な性差を引き起こすほどではないことが示唆される。				1				A	B	肝毒性の変化とメカニズムの参考になる。	
D1196	実験動物（肝毒性）	Hasegawa Kanae(Department of Cardiovascular Medicine, Faculty of Medical Sciences, University of Fukui), Uzui Hiroyasu, Fukuoka Yoshitomo, Miyanaga Dai, Shiomi Yuichiro, Tama Naoto, Ikeda Hiroyuki, Ishida Kentaro, Miyazaki Shinsuke, Sekijima Yoshiki, Naiki Hironobu, Tada Hiroshi	非虚血性心筋症患者における心アミロイドーシス診断のための腹部fat pad fine-needle aspiration　心生検コホート77例からのエビデンス(Abdominal Fat Pad Fine-Needle Aspiration for Diagnosis of Cardiac Amyloidosis in Patients with Non-Ischemic Cardiomyopathy: Evidence from a Cohort of 77 Cardiac Biopsy Cases)(英語)	2022	International Heart Journal(1349-2365)63巻1号 Page49-55(2022.01). Doi: 10.1536/ihj.21-430	2016年1月～2020年3月に非虚血性心筋症患者77例を対象とした前向き研究を実施し、心アミロイドーシスが疑われる患者の初期スクリーニング検査としてのFat Pad Fine-Needle Aspiration(FPFNA)の有用性および安全性について検討した。全例を対象に腹部FPFNAおよび心内膜生検を施行した。その結果、腹部FPFNAプロセスは全例で5分以内に行われた。しかし、FPFNAサンプルの量が不十分であったため、1例では評価不能であった。心内膜生検や腹部FPFNAに関連する合併症は認められなかった。心内膜生検および腹部FPFNAの両方のデータが得られた患者76例(男性55例、平均62±13歳)を対象とした。7例が心アミロイドーシスと診断された(FPFNA陽性5例、心内膜生検AL 1例、ATTR 6例)。心アミロイドーシス診断における腹部FPFNA陽性の感度、特異度はそれぞれ71.4%、100%であった。以上から、腹部FPFNAは、非虚血性心筋症患者における心アミロイドーシスの初期スクリーニング検査として簡便かつ有用であることが示された。			1					B	C		Fat Pad Fine-Needle Aspiration(FPFNA)に関するものであり、PFASとは無関係。
D1197	in vitro（免疫毒性）	Phelps, DW; Palekar, AI; Conley, HE; Ferrero, G; Driggers, JH; Linder, KE; Kullman, SW; Reif, DM; Sheats, MK; DeWitt, JC; Yoder, JA	Legacy and emerging per- and polyfluoroalkyl substances suppress the neutrophil respiratory burst	2023	J. Immunotoxicol. 2023 Dec;20(1):2176953. doi: 10.1080/1547691X.2023.2176953.	Per- and polyfluoroalkyl substances (PFASs) are used in a multitude of processes and products, including nonstick coatings, food wrappers, and fire-fighting foams. These chemicals are environmentally-persistent, ubiquitous, and can be detected in the serum of 98% of Americans. Despite evidence that PFASs alter adaptive immunity, few studies have investigated their effects on innate immunity. The report here presents results of studies that investigated the impact of nine environmentally-relevant PFASs [e.g. perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid potassium salt (PFOS-K), perfluorononanoic acid (PFNA), perfluorohexanoic acid (PFHxA), perfluorohexane sulfonic acid (PFHxS), perfluorobutane sulfonic acid (PFBS), ammonium perfluoro(2-methyl-3-oxahexanoate) (GenX), 7H-perfluoro-4-methyl-3,6-dioxa-octane sulfonic acid (Nafion byproduct 2), and perfluoromethoxyacetic acid sodium salt (PFMOAA-Na)] on one component of the innate immune response, the neutrophil respiratory burst. The respiratory burst is a key innate immune process by which microbicidal reactive oxygen species (ROS) are rapidly induced by neutrophils in response to pathogens; defects in the respiratory burst can increase susceptibility to infection. The study here utilized larval zebrafish, a human neutrophil-like cell line, and primary human neutrophils to ascertain whether PFAS exposure inhibits ROS production in the respiratory burst. It was observed that exposure to PFHxA and GenX suppresses the respiratory burst in zebrafish larvae and a human neutrophil-like cell line. GenX also suppressed the respiratory burst in primary human neutrophils. This report is the first to demonstrate that these PFASs suppress neutrophil function and support the utility of employing zebrafish larvae and a human cell line as screening tools to identify chemicals that may suppress human immune function.		1	1	1	1			D	A	調査対象物質を含むPFASが好中球機能に与える影響を評価し、PFHxAとGenXによる抑制作用を検出。免疫抑制作用を示す可能性のある化学物質を同定するためのスクリーニングツールとしてゼブラフィッシュ幼生とヒト細胞株が有用であることを示唆した文献。本評価に活用できるかは要旨から判断できない。	濃度もしっかり振っている。今後ゼブラフィッシュを用いて試験系を開発していくなら，良い参考文献となる。
D1198	in vitro（代謝）	Modaresi, SMS; Wei, W; Emily, M; DaSilva, NA; Slitt, AL	Per- and polyfluoroalkyl substances (PFAS) augment adipogenesis and shift the proteome in murine 3T3-L1 adipocytes	2022	Toxicology. 2022 Jan:465:153044. doi: 10.1016/j.tox.2021.153044.	The Per- and polyfluomalkyl substances (PFAS) are a wide group of fluorinated compounds, which the health effects of many of them have not been investigated. Perfluorinated sulfonates, such as perfluorooctane sulfonate (PFOS) and perfluorinated carboxylates, such as perfluomoctanoic acid (PFOA) are members of this broad group of PFAS, and previous studies have shown a correlation between the body accumulation of PFOS and PFOA and increased adipogenesis. PFOA and PFOS have been withdrawn from the market and use is limited because of their persistence, toxicity, and bioaccumulative properties. Instead, short chain PFAS have been created to replace PFOA and PFOS, but the health effects of other short chain PFAS are largely unknown. Therefore, herein we aimed to comprehensively determined the potential adipogenesis of ten different PFAS (PFBS, PFHxS, PFOS, PFBA, PFHxA, PFHA, PFOA, PFNA, PFDA, and HFPO-DA) and investigated the differences in protein expression of 3T3-L1 cells upon exposure to each PFAS. 3T3-L1 cells were differentiated with or without each PFAS for 4-days, and cellular lipid was quantified using Nile Red staining. Analysis of the adipocyte pmteome was performed to identify the pathways related to adipogenesis and quantify proteins significantly affected by each PFAS. The results showed that in general, every PFAS investigated in our study has the potential to induce the 3T3-L1 differentiation to adipocytes in the presence of rosiglitazone, with the concentrations that range between 0.25 and 25 mu M. Proteomics analysis revealed specific markers regarding to adipogenesis upregulated upon exposure to each of the ten PFAS.	1	1	1	1	1			A	B	マウス3T3-L1細胞を用いた調査対象物質を含むPFASのin vitro評価。PFAS曝露による脂肪細胞分化の促進と脂肪形成に特異的なマーカータンパクの上昇を検出。メカニズムの参考。	多くのホルモンや薬物を同時投与しており，作用点がわかりづらい。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1199	in vitro（内分泌）	Croce, L; Coperchini, F; Tonacchera, M; Imbriani, M; Rotondi, M; Chiovato, L	Effect of long- and short-chain perfluorinated compounds on cultured thyroid cells viability and response to TSH	2019	J. Endocrinol. Invest. 2019 Nov:42(11):1329-1335. doi: 10.1007/s40618-019-01062-1.	PurposePerfluorinated chemicals are widespread pollutants persistent in the environment with links to some major health issues. The two main compounds, perfluoro-octanoic acid (PFOA) and perfluoro-alkyl sulphonate (PFOS), were recently classified as carcinogenetic and thus their use has been restricted. Short-chain PFCs were recently developed as an alternative, but no data regarding the possible endocrine toxicities of these compounds are available. Aim of this study was to investigate whether short-chain PFCs could jeopardize thyroid cell viability and/or interfere with the functional effect TSH.MethodsFisher rat thyroid line-5 (FRTL-5) was treated with increasing concentrations of PFOA, PFOS, perfluorobutanesulfonic acid (PFBS), perfluorobutanoic acid (PFBA), pentafluoropropionic anhydride (PFPA), perfluoropentanoic acid (PFPeA) to evaluate modifications in cell viability and TSH-stimulated cAMP production.ResultsNeither long nor short-chain PFCs affected cell viability (apart from PFOS 100 mu M), or interfered with cAMP production.ConclusionsThe results of the present study demonstrate for the first time that short-chain PFCs have no acute cytotoxic effect on thyroid cells in vitro and that cAMP production is not modulated by any of the tested PFCs.	1			1				D	B	ラット甲状腺細胞株（FRTL-5）を用いた調査対象物質を含むPFCsのin vitro評価。甲状腺細胞に対し、短鎖PFCsは急性細胞毒性を示さないこと、評価したいずれのPFCもcAMP産生には影響を与えないことを示唆。本評価に活用できるかは判断できない。	「低用量では甲状腺細胞に作用しない」と言うことを述べたいのであれば，採用しても良いが，作用メカニズム解析等には用いることができない。また，測定したパラメーターが少ないのも難点。
D1200	in vitro（内分泌）	Villeneuve, DL; Blackwell, BR; Cavallin, JE; Collins, J; Hoang, JX; Hofer, RN; Houck, KA; Jensen, KM; Kahl, MD; Kutsi, RN; Opseth, AS; Rodriguez, KJS; Schaupp, C; Stacy, EH; Ankley, GT	Verification of In Vivo Estrogenic Activity for Four Per- and Polyfluoroalkyl Substances (PFAS) Identified as Estrogen Receptor Agonists via New Approach Methodologies	2023	Environ Sci Technol. 2023 Mar 7;57(9):3794-3803. doi: 10.1021/acs.est.2c09315.	Given concerns about potential toxicological hazards of the thousands of data-poor per-and polyfluorinated alkyl substances (PFAS) currently in commerce and detected in the environment, tiered testing strategies that employ high-throughput in vitro screening as an initial testing tier have been implemented. The present study evaluated the effectiveness of previous in vitro screening for identifying PFAS capable, or incapable, of inducing estrogenic responses in fish exposed in vivo. Fathead minnows (Pimephales promelas) were exposed for 96 h to five PFAS (perfluorooctanoic acid [PFOA]; 1H,1H,8H,8H-perfluorooctane-1,8-diol [FC8-diol]; 1H,1H,10H,10H-perfluoro-decane-1,10-diol [FC10-diol]; 1H,1H,8H,8H-perfluoro-3,6-diox-aoctane-1,8-diol [FC8-DOD]; and perfluoro-2-methyl-3-oxahexanoic acid [HFPO-DA]) that showed varying levels of in vitro estrogenic potency. In agreement with in vitro screening results, exposure to FC8-diol, FC10-diol, and FC8-DOD caused concentration-dependent increases in the expression of transcript coding for vitellogenin and estrogen receptor alpha and reduced expression of insulin-like growth factor and apolipoprotein eb. Once differences in bioconcentration were accounted for, the rank order of potency in vivo matched that determined in vitro. These results provide a screening level benchmark for worst-case estimates of potential estrogenic hazards of PFAS and a basis for identifying structurally similar PFAS to scrutinize for putative estrogenic activity.					1			C	C	魚類におけるPFASのエストロゲン活性の検証に関する文献。	野生動物への影響解析という点では，有用な論文ではあるが，ヒトを意識しての実験系としては，ヒト細胞などとの比較がされていないので，重要性としては低くなる。
D1201	in vitro（免疫毒性）	Dragon, J; Hoaglund, M; Badireddy, AR; Nielsen, G; Schlezinger, J; Shukla, A	Perfluoroalkyl Substances (PFAS) Affect Inflammation in Lung Cells and Tissues	2023	Int. J. Mol. Sci. 2023 MAY 10;24(10):8539. doi: 10.3390/ijms24108539.	Adverse lung outcomes from exposure to per-and polyfluoroalkyl substances (PFAS) are known; however, the mechanism of action is poorly understood. To explore this, human bronchial epithelial cells were grown and exposed to varied concentrations of short-chain (perfluorobutanoic acid, perflurobutane sulfonic acid and GenX) or long-chain (PFOA and perfluorooctane sulfonic acid (PFOS)) PFAS, alone or in a mixture to identify cytotoxic concentrations. Non-cytotoxic concentrations of PFAS from this experiment were selected to assess NLRP3 inflammasome activation and priming. We found that PFOA and PFOS alone or in a mixture primed and activated the inflammasome compared with vehicle control. Atomic force microscopy showed that PFOA but not PFOS significantly altered the membrane properties of cells. RNA sequencing was performed on the lungs of mice that had consumed PFOA in drinking water for 14 weeks. Wild type (WT), PPARa knock-out (KO) and humanized PPARa (KI) were exposed to PFOA. We found that multiple inflammation- and immune-related genes were affected. Taken together, our study demonstrated that PFAS exposure could alter lung biology in a significant manner and may contribute to asthma/airway hyper-responsiveness.	1				1			D	C	ヒト気管支上皮細胞を用いた調査対象物質を含むPFASのin vitro評価。PFOAとPFOSの単独あるいは混合物で評価し、複数の炎症・免疫関連遺伝子の変動を確認。調査対象物質としての影響は、要旨から判断できない。	PFOS及びPFOAの解析が中心で，それ以外の物質単独のデータは限られている。採用する必要はない。
D1202	in vitro（内分泌）	Zhang, SH; Chen, K; Li, WM; Chai, Y; Zhu, J; Chu, BF; Li, NY; Yan, JL; Zhang, SL; Yang, YP	Varied thyroid disrupting effects of perfluorooctanoic acid (PFOA) and its novel alternatives hexafluoropropylene-oxide-dimer-acid (GenX) and ammonium 4,8-dioxa-3H-perfluorononanoate (ADONA) in vitro	2021	Environ. Int. 2021 Nov:156:106745. doi: 10.1016/j.envint.2021.106745.	Due to its potential adverse effects on human health, perfluorooctanoic acid (PFOA), one of the once widely used legacy per- and polyfluoroalkyl substances (PFASs), has been recently replaced by its novel alternatives including hexafluoropropylene-oxide-dimer-acid (GenX) and ammonium 4,8-dioxa-3H-perfluorononanoate (ADONA). These alternative PFASs are detected in water and exposed workers. PFASs can enter organs like thyroids, however, it is yet unknown whether the new alternatives are safer than PFOA. In the current study, we compared the thyroid disrupting effects of PFOA and its alternatives GenX and ADONA in vitro with both rat thyroid cell line FRTL5 and primary normal human thyroid (NHT) cells. Cells were exposed to ascendant doses of PFOA, GenX or ADONA for various incubation time and cell viability was assessed by WST-1 assay and LDH assay. The proliferation rate of survived cells was determined by crystal violet-based cell proliferation assay and MTT assay. The gene expression of thyroid hormone regulation-related genes in thyroid cells after exposure was quantified by RT-PCR and Western blot. Our data showed that both PFOA and GenX reduced thyroid cell viability in both dose and time dependent manner, with GenX being more toxic than PFOA at the same condition. Similarly, the proliferation rate of cells survived exposure to PFOA and GenX was considerably impaired, with GenX showing more profound adverse effect than PFOA. Unlike PFOA and GenX, ADONA showed no apparent adverse effects on the viability and proliferation of both thyroid cell types. Gene expression data revealed that all three PFASs altered gene expression in both thyroid cells and the altered gene expression seemed to be PFAS and cell type dependent. Taken together, our data reveal that the thyroid disrupting effects is increased in the order of GenX > PFOA > ADONA. Our findings will be beneficial for the guidance of the future usage of PFASs and development of better alternatives.			1	1	1		1	A	A	ラット甲状腺細胞株（FRTL5）とヒト初代正常甲状腺（NHT）細胞を用いたGenXおよび4,8-ジオキサ-3H-ペルフルオロノナン酸アンモニウム（ADONA）の甲状腺障害に関するin vitro評価。GenXは甲状腺細胞の生存率を用量・時間依存的に低下、増殖率も障害（GenX＞PFOA）。ADONAによる明確な悪影響は認めず。総じて甲状腺障害作用はGenX＞PFOA＞ADONA。定性評価の参考。	甲状腺細胞への毒性を解析し，GenXがPFOAより毒性が高いとする重要な論文。
D1203	in vitro（内分泌）	Kraugerud, M; Zimmer, KE; Ropstad, E; Verhaegen, S	Perfluorinated compounds differentially affect steroidogenesis and viability in the human adrenocortical carcinoma (H295R) in vitro cell assay	2011	Toxicol. Lett. 2011 Aug:205(1):62-68. doi: 10.1016/j.toxlet.2011.05.230.	Perfluorinated compounds (PFCs) comprise a large class of man-made chemicals of which some are persistent and present throughout the ecosystem. This raises concerns about potential harmful effects of such PFCs on humans and the environment. In order to investigate the effects of potentially harmful PFCs on steroid hormone production, human adrenocortical H295R cells were exposed to three persistent PFCs including perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) at six different concentrations (6 nM to 600 mu M) for 48 h. Exposure to 600 mu M PFOS resulted in a dose-responsive increase in oestradiol as well as a smaller dose-responsive increase in progesterone and testosterone secretion measured using radioimmunoassay. The aromatase activity was not significantly altered by PFOS. Only small changes in hormone secretion were detected following exposure to PFOA and PFNA. Gene expression of CYP11A. quantified using qRT-PCR was decreased by all exposure doses of PFOA, whereas HMGR expression was decreased by 60 nM PFNA. The viability markedly decreased by exposure to 600 mu M of PFOA or PFNA, but not PFOS. Flow cytometric analysis demonstrated a significant increase in apoptosis following exposure to PFNA at the highest concentration. We conclude that PFOS is capable of altering steroidogenesis in the H295R in vitro model by a mechanism other than changes in gene expression or activity of aromatase. Additionally, PFCs appear to differentially affect cell viability with induction of cell death via apoptosis at high doses of PFNA.			1					D	B	ヒト副腎皮質細胞H295Rを用いたPFNA（およびPFOS、PFOA）のin vitro評価。PFNA曝露による影響としては、ホルモン分泌の変動はわずかであった他、HMGR遺伝子発現低下、高濃度では生存率低下、アポトーシス増加を検出。本評価に活用できるかは判断できない。	濃度はきちんと振っている。PFOS, PFOAに比べてPFNAではあまり強い影響はみられていない。Negatative dataも重要なのであれば採用すべき論文。
D1204	in vitro（内分泌）	Zhao, BH; Lian, QQ; Chu, YH; Hardy, DO; Li, XK; Ge, RS	The inhibition of human and rat 11 beta-hydroxysteroid dehydrogenase 2 by perfluoroalkylated substances	2011	J. Steroid Biochem. Mol. Biol. 2011 May:125(1-2):143-147. doi: 10.1016/j.jsbmb.2010.12.017.	11 beta-Hydroxysteroid dehydrogenase 2 (11 beta-HSD2) regulates active glucocorticoid access to glucocorticoid and mineralocorticoid receptors by metabolizing it to an inactive form. Perfluoroalkylated substances (PFASs) are man-made polyfluorinated compounds that are widely used and persistent in the environment. We tested the inhibitory potencies of four PFASs including perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorohexanesulfonate (PFHxS) and perfluorobutane sulfonate (PFBS) on human and rat 11 beta-HSD2. PFOS was a potent inhibitor of both human (IC50 = 48 nM) and rat (IC50=293 nM) 11 beta-HSD2 activities. The potencies for the inhibition of human and rat 11 beta-HSD2 activities were PFOS>PFOA>PFHxS>PFBS. PFASs showed competitive inhibition of both human and rat 11 beta-HSD2 activities. This observation indicates that PFOS is a potent endocrine disruptor for glucocorticoid metabolism. Article from the Special issue on Targeted Inhibitors.				1			1	A	A	PFBSを含む4種類のPFASについて、ヒトとラットの11β-HSD2に対する阻害作用を評価。作用強度はPFOS＞PFOA＞PFHxS＞PFBSの順で、11β-HSD2活性を競合的に阻害。PFOSがグルココルチコイド代謝に対する強力な内分泌撹乱物質であることを示唆。定性評価の参考。	IC50もきちんととっており，重要な論文
D1205	in vitro（代謝）	Louisse, J; Rijkers, D; Stoopen, G; Janssen, A; Staats, M; Hoogenboom, R; Kersten, S; Peijnenburg, A	Perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), and perfluorononanoic acid (PFNA) increase triglyceride levels and decrease cholesterogenic gene expression in human HepaRG liver cells	2020	Arch. Toxicol. 2020 Sep:94(9):3137-3155. doi: 10.1007/s00204-020-02808-0.	Per- and polyfluoroalkyl substances (PFASs) are omnipresent in the environment, food chain, and humans. Epidemiological studies have shown a positive association between serum levels of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS), and increased serum cholesterol and, in some cases, also triglyceride levels. However, causality has been questioned, as animal studies, as well as a human trial, showed a decrease in serum cholesterol and no effects or a decrease in plasma triglycerides. To obtain more insight into the effects of PFASs on these processes, the present study investigated the effects of PFOA, PFOS, and perfluorononanoic acid (PFNA) on intracellular triglyceride and cholesterol levels in human HepaRG liver cells. DNA microarray analyses were performed to provide insight into underlying mechanisms. All PFASs induced an increase in cellular triglyceride levels, but had no effect on cholesterol levels. Gene set enrichment analysis (GSEA) of the microarray data indicated that gene sets related to cholesterol biosynthesis were repressed by PFOA, PFOS, and PFNA. Other gene sets commonly affected by all PFAS were related to PERK/ATF4 signaling (induced), tRNA amino-acylation (induced), amino acid transport (induced), and glycolysis/gluconeogenesis (repressed). Moreover, numerous target genes of peroxisome proliferator-activated receptor alpha (PPAR alpha) were found to be upregulated. Altogether, the present study shows that PFOA, PFOS, and PFNA increase triglyceride levels and inhibit cholesterogenic gene expression in HepaRG cells. In addition, the present study indicates that PFASs induce endoplasmic reticulum stress, which may be an important mechanism underlying some of the toxic effects of these chemicals.			1					A	B	ヒトHepaRG肝細胞を用いたPFNA（およびPFOA、PFOS）のin vitro評価。いずれも細胞内TG濃度の上昇とコレステロール生合成に関連する遺伝子発現の低下を誘導（コレステロールレベルは変化なし）、PPARα標的遺伝子の多くが発現上昇。小胞体ストレス誘導も示唆。メカニズムの参考。	影響は出ているが，in vitroであるにも関わらず100μmという高濃度での影響であり，必ず採択すべき，とまでは言えない。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1206	in vitro（代謝）	Solan, ME; Lavado, R	Effects of short-chain per- and polyfluoroalkyl substances (PFAS) on human cytochrome P450 (CYP450) enzymes and human hepatocytes: An in vitro study	2023	Curr. Res. Toxicol. 2023:5. doi: 10.1016/j.crtox.2023.100116	Short-chain per-and polyfluoroalkyl substances (PFAS) have been developed as alternatives to legacy long-chain PFAS, but they may still pose risks due to their potential to interact with biomolecules. Cytochrome P450 (CYP450) enzymes are essential for xenobiotic metabolism, and disruptions of these enzymes by PFAS can have significant human health implications. The inhibitory potential of two legacy long-chain (PFOA and PFOS) and five short-chain alternative PFAS (PFBS, PFHxA, HFPO-DA, PFHxS, and 6:2 FTOH) were assessed in recombinant CYP1A2, -2B6,-2C19,-2E1, and-3A4 enzymes. Most of the short-chain PFAS, except for PFHxS, tested did not result in significant inhibition up to 100 & mu;M. PFOS inhibited recombinant CYP1A2,-2B6,-2C19, and-3A4 enzymes. However, concentrations where inhibition occurred, were all higher than the averages reported in population biomonitoring studies, with IC50 values higher than 10 & mu;M. We also evaluated the activities of CYP1A2 and CYP3A4 in HepaRG monolayers following 48 h exposures of the short-chain PFAS at two con-centrations (1 nM or 1 & mu;M) and with or without an inducer (benzo[a]pyrene, BaP, for CYP1A2 and rifampicin for CYP3A4). Our findings suggest that both 1 nM and 1 & mu;M exposures to short-chain PFAS can modulate the CYP1A2 activity induced by BaP. Except for PFHxS, the short-chain PFAS appear to have little effect on CYP3A4 activity. Understanding the effects of PFAS exposure on biotransformation can shed light on the mechanisms of PFAS toxicity and aid in developing effective strategies for managing chemical risks, enabling regulators to make more informed decisions.		1		1	1			A	C	短鎖PFASがヒトCYP450酵素およびヒト肝細胞に及ぼす影響のin vitro評価。調査対象物質を含む5種類の短鎖PFASと長鎖PFAS（PFOA、PFOS）を対象。PFHxSを除くほとんどの短鎖PFASは高濃度までCYP450に対する有意な阻害作用なし。メカニズムの参考。	グラフの記載方法や統計の取り方がよくわからない。特に採択しなくても良い論文。
D1207	in vitro（代謝）	Watkins, AM; Wood, CR; Lin, MT; Abbott, BD	The effects of perfluorinated chemicals on adipocyte differentiation in vitro	2015	Mol. Cell. Endocrinol. 2015 Jan:400(C):90-101. doi: 10.1016/j.mce.2014.10.020.	The 3T3-L1 preadipocyte culture system has been used to examine numerous compounds that influence adipocyte differentiation or function. The perfluoroalkyl acids (PFAAs), used as surfactants in a variety of industrial applications, are of concern as environmental contaminants that are detected worldwide in human serum and animal tissues. This study was designed to evaluate the potential for PFAAs to affect adipocyte differentiation and lipid accumulation using mouse 3T3-L1 cells. Cells were treated with perfluorooctanoic acid (PFOA) (5-1001.1,M), perfluorononanoic acid (PFNA) (5-10012M), perfluorooctane sulfonate (PFOS) (50-300 iM), perfluorohexane sulfonate (PFHxS) (40-250 liM), the peroxisome proliferator activated receptor (PPAR) PPARa agonist Wyeth-14,643 (WY-14,643), and the PPARy agonist rosiglitazone. The PPARy agonist was included as a positive control as this pathway is critical to adipocyte differentiation. The PPARa agonist was included as the PFAA compounds are known activators of this pathway. Cells were assessed morphometrically and biochemically for number, size, and lipid content. RNA was extracted for qPCR analysis of 13 genes selected for their importance in adipocyte differentiation and lipid metabolism. There was a significant concentration-related increase in cell number and decreased cell size after exposure to PFOA, PFHxS, PFOS, and PFNA. All four PFAA treatments produced a concentrationrelated decrease in the calculated average area occupied by lipid per cell. However, total triglyceride levels per well increased with a concentration-related trend for all compounds, likely due to the increased cell number. Expression of mRNA for the selected genes was affected by all exposures and the specific impacts depended on the particular compound and concentration. Acox1 and Gapdh were upregulated by all six compounds. The strongest overall effect was a nearly 10-fold induction of Scdl by PFHxS. The sulfonated PFAAs-produced numerous, strong-changes in gene expression similar to the effects after treatment with the PPARy agonist rosiglitazone. By comparison, the effects on gene expression were muted for the carboxylated PFAAs and for the PPARa agonist WY-14,643. In summary, all perfluorinated compounds increased cell number, decreased cell size, increased total triglyceride, and altered expression of genes associated with adipocyte differentiation and lipid metabolism. Published by Elsevier Ireland Ltd.			1				1	A	A	マウス3T3-L1細胞を用いたPFNAを含むPFASのin vitro評価。曝露濃度依存的な細胞数の増加と細胞サイズの減少、ウェルあたりの総TG量の増加傾向、脂肪細胞の分化と脂質代謝に関連する遺伝子の発現変動（Acox1、Gapdh発現上昇等）を検出。メカニズムの参考。	濃度も６点振ってエンドポイントをきちんと測定した上で，遺伝子発現も解析している。良い論文
D1208	in vitro（内分泌）	Behnisch, PA; Besselink, H; Weber, R; Willand, W; Huang, J; Brouwer, A	Developing potency factors for thyroid hormone disruption by PFASs using TTR-TR beta CALUX (R) bioassay and assessment of PFASs mixtures in technical products	2021	Environ. Int. 2021 Dec:157:106791. doi: 10.1016/j.envint.2021.106791.	Background: Over the last decade, per- and polyfluoroalkyl substances (PFASs) have become one of the most heavily investigated persistent organohalogen compound class of environmental concern. However, knowledge about their toxicology is still scarce, although PFASs as individual compounds and their industrial mixtures were shown to exert effects on the thyroid hormone system. Methods: In vitro toxicity potency factors were established for thyroid hormone transport disruption potential using the novel TTR-TR beta CALUX (R) bioassay for major PFASs. We assessed technical PFASs mixtures, including aqueous film-forming foam (AFFF) surfactants and chromium mist suppressants (CMS) applications with and without total oxidizable precursor (TOP) by TTR-TR beta CALUX (R) assay for their thyroid hormone transport disrupting potential. Results: All PFASs listed in the German guideline for drinking water (German Environment Agency, 2017) affected the T4 binding to TTR, an important plasma thyroid hormone transport protein. For all tested PFASs, potency factors based on PC80 values relative to PFOA could be obtained and ranged between PFBA (0.0018) and PFOS (2.0). Applying in vitro potency factors obtained from the present in vitro TTR-TR beta CALUX (R) assay study and recently reported in vivo potency factors (Zeilmaker et al., 2018; Bil et al., 2021) on the above-mentioned German guideline for PFAS in drinking water, showed that the cumulative effect-based trigger values (in vivo and in vitro) are comparable (3.0 vs. 2.9 to 4.6 mu g PFOA-EQ/l). Additionally, AFFF surfactants and CMS with and without TOP assay were tested. Highest activities were found in the older AFFF surfactants (2013/2014) due to higher PFOS/PFOA levels, which were already substituted with 6:2 FTS in 2019, resulting in much lower PFOA-EQ levels. As expected also the PFOA-EQ levels increased in the samples with TOP treatment compared to the original AFFF surfactants and CMS as confirmed here by biological and chemical PFOA-equivalents (PFOA-EQ) analysis. Additionally, CMS (which have been used in the electroplating chromium industry since the 1950s) as well as PFOS-free, but not PFAS-free fume suppressants (such as Fumetrol (R) 21) have been tested in the TTR-TR beta CALUX (R) assay and showed much lower activity levels then the AFFFs, confirmed by the similar potency determination based on chemical PFASs analysis followed by transformation to PFOA-EQ for comparison. The potency factor of 6:2 FTS, which is the main substitute for PFOS in CMS, indicates that it is approximately 100-times less potent as a thyroid hormone disruptor as compared to PFOS. Conclusion: Potency factors based on PC80 values from TTR-TR beta CALUX (R) relative to PFOA have been developed for major PFASs. In AFFF surfactants and CMS a trend of higher activities with higher amounts of PFOS and PFOA have been found. PFOA and PFOS showed high responses in the TTR-TR beta CALUX (R) assay and had the largest contributions to the PFOA-EQs in the AFFF surfactants and CMS applications. Using potency factors as determined in the TTR-TR beta CALUX (R) to convert PFASs assessed by chemical analysis to	1							D	B	TTR-TRβCALUX(R)バイオアッセイを用いた評価。主要なPFASについて、PFOAに対するTTR-TR βCALUX（R）のPC80値に基づくpotency factorsを開発。本評価に活用できるかは判断できない。	甲状腺ホルモン受容体と結合タンパク質との結合に対する影響を見ている。影響は出ているが，作用点に関する解析がされておらず，弱い。
D1209	in vitro（免疫毒性）	Janssen, AWF; Louisse, J; Rijkers, D; Pinckaers, NET; Hoekstra, SA; Hoogenboom, RLAP; Peijnenburg, AACM; Beekmann, K	Perfluoroalkyl substances (PFASs) decrease the expression of recombination-activating genes (RAG1 and RAG2) in human B lymphoma Namalwa cells	2023	Arch. Toxicol. 2023 Feb:97(2):457-468. doi: 10.1007/s00204-022-03405-z.	Per- and polyfluoroalkyl substances (PFASs) are omnipresent and have been shown to induce a wide range of adverse effects, including hepatotoxicity, developmental toxicity and immunotoxicity. So far, little information is available about the mechanisms underlying the toxicity of PFASs, including those related to their immunotoxicity. Reported immunotoxic effects of PFASs include decreased antibody responses in experimental animals and humans, indicating that PFASs may, among others, affect B cell function. In the present study, we first assessed the effects of PFOA on the transcriptome of the human Namalwa B cell line using RNA seq analysis. Gene expression changes, analyzed using Ingenuity Pathway Analysis, pointed to various cellular processes affected by PFOA, including 'B cell development' and 'Primary immunodeficiency signaling'. Interestingly, PFOA decreased the expression of RAG1 and RAG2, genes involved in immunoglobulin and T cell receptor V(D)J recombination. As a next step, time- and concentration-dependent changes in the expression of RAG1 and RAG2 upon exposure to PFOA, PFNA, PFHxS and PFOS were studied through RT-qPCR analysis. Analysis with the concentration-response modeling software PROAST resulted in the following potency ranking: PFNA > PFOA > PFOS > PFHxS. Altogether, the present in vitro study provides insights into the effects of selected PFASs on B cells, identifying RAG1 and RAG2 expression as possible relevant targets that may play a role in the immunotoxicity of PFASs.			1					A	B	PFNAを含むPFASによるヒトバーキットリンパ腫細胞における組換え活性化遺伝子（RAG1およびRAG2）の発現低下に関する文献。RAG1、RAG2発現の時間および濃度依存的変化の作用強度は、PFNA＞PFOA＞PFOS＞PFHxS。PFNAのB細胞に対する免疫毒性に寄与する可能性のある関連標的としてRAG1とRAG2の発現を同定。メカニズムの参考。	曝露による遺伝子発現profileを作っただけで，細胞形態や機能等のエンドポイントをきちんと押さえていないので，発現変化がどのように毒性発現につながるのかわからない。
D1210	in vitro（内分泌）	Cocci, P; Mosconi, G; Palermo, FA	An In Silico and In Vitro Study for Investigating Estrogenic Endocrine Effects of Emerging Persistent Pollutants Using Primary Hepatocytes from Grey Mullet (Mugil cephalus)	2021	Environments. 2021 Jun;8(6):58. doi: 10.3390/environments8060058.	There is growing concern about the environmentally relevant concentrations of new emerging persistent organic pollutants, such as perfluorinated compounds and pharmaceuticals, which are found to bioaccumulate in aquatic organisms at concentrations suspected to cause reproductive toxicity due to the activation of estrogen receptor (ER) alpha and beta subtypes. Here, we use a combined in silico and in vitro approach to evaluate the impact of perfluorononanoic acid (PFNA) and Enalapril (ENA) on grey mullet (Mugil cephalus) hepatic estrogen signaling pathway. ENA had weak agonist activity on ER alpha while PFNA showed moderate to high agonist binding to both ERs. According to these effects, hepatocytes incubation for 48 h to PFNA resulted in a concentration-dependent upregulation of ER and vitellogenin gene expression profiles, whereas only a small increase was observed in ER alpha mRNA levels for the highest ENA concentration. These data suggest a structure-activity relationship between hepatic ERs and these emerging pollutants.			1					C	D	ボラ（Mugil cephalus）の初代肝細胞を対象。	ボラの肝臓のエストロゲンシグナルへの影響を見ている。魚類の実験が意味がない，とは言わないが，ボラは実験動物として一般的ではなく，ヒトや他の動物との比較が難しい。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1211	in vitro（内分泌）	Liu, SY; Yang, RJ; Yin, NY; Faiola, F	Effects of per- and poly-fluorinated alkyl substances on pancreatic and endocrine differentiation of human pluripotent stem cells	2020	Chemosphere. 2020 Sep:254:126709. doi: 10.1016/j.chemosphere.2020.126709.	Perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) are typical per- and polyfluorinated alkyl substances (PFASs) that epidemiological studies have already associated with diabetes. However, insufficient data on their toxicity have been reported to explain any mechanism of action, which could justify such an association. Meanwhile, short-chain PFASs designed to substitute PFOA and PFOS, have already raised increasing concerns for their biosafety. Here, we evaluated whether common PFASs affected pancreatic and endocrine cell development using a human pluripotent stem cell pancreatic induction model and human pancreatic progenitor cell (hPP) endocrine induction model. The short-chain PFASs, pentafluorobenzoic acid, perfluorohexanoic acid, perfluorobutanesulfonic acid, and perfluorohexanesulfonic acid, homologous to PFOA or PFOS, did not significantly disrupt hPP generation, unlike PFOA and PFOS, based on pancreatic and duodenal homeobox 1 (PDX1) expression. However, SRY box 9 (SOX9) expression was suppressed in PDX1+ hPPs. All six PFASs did not disrupt SOX9 expression or hPP proliferation. However, endocrine differentiation of hPPs was affected, as indicated by neurogenin-3 (NGN3) downregulation, owing to abnormal increases in SOX9 and hairy and enhancer of split-1 (HES1) expressions. Thus, hyperactivation of NOTCH signaling was repressed after hPPs committed to the endocrine lineage. In conclusion, our study demonstrates how powerful human pluripotent stem cell-based pancreatic differentiation models can be in developmental toxicity evaluations, compared to traditional toxicity assays, mostly based on live animals. Moreover, our findings suggest that PFASs may alter pancreatic development after the pancreatic domain emerges from the gut tube, and provide in- sights into their toxicity mechanisms.		1		1				D	B	ヒト多能性幹細胞膵臓誘導モデルとヒト膵臓前駆細胞（hPP）内分泌誘導モデルを用いた、調査対象物質を含むPFASのin vitro評価。PFASsが膵臓ドメインが出現した後に膵臓の発達を変化させる可能性があることを示唆。メカニズムの参考となるかもしれないが、要旨からは判断できない。	ヒト多能性幹細胞を用いた実験であるが，残念ながら，細胞分化と遺伝子発現の相関をきちんと取っていない。また濃度も１ドーズである。
D1212	in vitro（内分泌）	Cassone, CG; Vongphachan, V; Chiu, S; Williams, KL; Letcher, RJ; Pelletier, E; Crump, D; Kennedy, SW	In Ovo Effects of Perfluorohexane Sulfonate and Perfluorohexanoate on Pipping Success, Development, mRNA Expression, and Thyroid Hormone Levels in Chicken Embryos	2012	Toxicol. Sci. 2012 May:127(1):216-224. doi: 10.1093/toxsci/kfs072.	Perfluoroalkyl acids (PFAAs), specifically perfluorinated sulfonates and carboxylates, are synthetic substances known for their chemical stability, resistance to degradation, and potential to biomagnify in food chains. The toxicological and biological effects of PFAAs in avian species are not well characterized, although there is some evidence to suggest that they can impact neurodevelopment and hatching success. Our laboratory recently reported significant effects of perfluorohexane sulfonate (PFHxS) and perfluorohexanoate (PFHxA) on messenger RNA (mRNA) levels of thyroid hormone (TH)-responsive genes in chicken embryonic neuronal cells. In this study, we determined in ovo effects of PFHxS and PFHxA exposure (maximum dose = 38,000 and 9700 ng/g egg, respectively) on embryonic death, developmental endpoints, tissue accumulation, mRNA expression in liver and cerebral cortex, and plasma TH levels. Pipping success was reduced to 63% at the highest dose of PFHxS; no effects were observed for PFHxA. PFHxS exposure (38,000 ng/g) decreased tarsus length and embryo mass. PFHxS and PFHxA accumulated in the three tissue compartments analyzed as follows: yolk sac > liver > cerebral cortex. Type II and type III 5′-deiodinases (D2 and D3) and cytochrome P450 3A37 mRNA levels were induced in liver tissue of chicken embryos exposed to PFHxS, whereas D2, neurogranin (RC3), and octamer motif binding factor 1 mRNA levels were upregulated in cerebral cortex. Plasma TH levels were reduced in a concentration-dependent manner following PFHxS exposure; PFHxA had no effect. This in ovo study successfully validated previous in vitro results concerning the modulation of TH-responsive genes and identified adverse effects associated with TH homeostasis in response to PFHxS treatment.		1						C	A	鳥類（ニワトリ胚）を用いた評価。	濃度も振って甲状腺ホルモンの代謝を関連遺伝子発現とともに調べている。ニワトリ胎仔をモデルにしないとできない内容も含まれており良い論文。
D1213	in vitro（内分泌）	Li, J; Cao, HM; Feng, HR; Xue, Q; Zhang, AQ; Fu, JJ	Evaluation of the Estrogenic/Antiestrogenic Activities of Perfluoroalkyl Substances and Their Interactions with the Human Estrogen Receptor by Combining In Vitro Assays and In Silico Modeling	2020	Environ. Sci. Technol. 2020 Nov:54(22):14514-14524. doi: 10.1021/acs.est.0c03468.	The potential estrogenic activities of perfluoroalkyl substances (PFASs) are controversial. Here, we investigated the estrogenic/antiestrogenic activities of PFASs and explored the corresponding interaction mode of PFASs with the estrogen receptor (ER) by combining in vitro assays and in silico modeling. We found that three PFASs (perfluorobutanoic acid, perfluorobutane sulfonate, and perfluoropentanoic acid) exerted antiestrogenic effects by inhibiting luciferase activity, whereas perfluorohexane sulfonate (PFHxS) and perfluorooctane sulfonate (PFOS) exerted estrogenic effects by inducing luciferase activity. When coexposed to 17 beta-estradiol (E2), all tested PFASs attenuated the E2-stimulated luciferase activity; unexpectedly, each PFAS could further attenuate the luciferase activity generated by the cotreatment with ICI 182,780 and E2, with a minimal effective concentration comparable to that found in human serum. PFHxS and PFOS significantly induced the gene expression of TFF1; additionally, all PFASs inhibited the E2-induced gene expression of TFF1 and EGR3. Furthermore, the results of the blind docking analyses suggested that the interaction with the coactivator-binding region on the ER surface should be included as a pathway through which PFASs exert estrogenic and antiestrogenic activities. Finally, we revealed the critical molecular property of the zerorder molecular connectivity index (MCI) ((0)chi) that affects the antiestrogenic activity of PFASs.	1			1				A	B	調査対象物質を含むPFASのエストロゲン受容体との相互作用の評価。メカニズムの参考。	Lucアッセイによりエストロゲン＆抗エストロゲン作用を見たあと，標的遺伝子の発現変化を見ているが，それぞれ試験物質の濃度は１ドーズであり，参考文献としては不十分
D1214	in vitro（内分泌）	Zhao, BH; Hu, GX; Chu, YH; Jin, XD; Gong, SL; Akingbemi, BT; Zhang, ZQ; Zirkin, BR; Ge, RS	Inhibition of human and rat 3 beta-hydroxysteroid dehydrogenase and 17 beta-hydroxysteroid dehydrogenase 3 activities by perfluoroalkylated substances	2010	Chem.-Biol. Interact. 2010 Oct:188(1):38-43. doi: 10.1016/j.cbi.2010.07.001.	Perfluoroalkylated substances (PFASs) including perfluorooctane acid (PFOA) and perfluorooctane sulfonate (PFOS) have been classified as persistent organic pollutants and are known to cause reduced testosterone production in human males. The objective of the present study was to compare the potencies of five different PFASs including PFOA. PFOS, potassium perfluorooctane sulfonate (PFOSK), potassium perfluorohexane sulfonate (PFHxSK) and potassium perfluorobutane sulfonate (PFBSK) in the inhibition of 3 beta-hydroxysteroid dehydrogenase (3 beta-HSD) and 17 beta-hydroxysteroid dehydrogenase 3 (17 beta-HSD3) activities in the human and rat testes. Human and rat microsomal enzymes were exposed to various PFASs. PFOS and PFOSK inhibited rat 3 beta-HSD activity with IC50 of 1.3.5 +/- 0.05 and 1.77 +/- 0.04 mu M, respectively, whereas PFHxSK and PFBSK had no effect at concentrations up to 250 mu M. All chemicals tested weakly inhibited human 3 beta-HSD activity with IC(50)s over 250 mu M. On the other hand, PFOS. PFOSK and PFOA inhibited human 17 beta-HSD3 activity with IC(50)s of 6.02 +/- 1.02, 4.39 +/- 0.46 and 127.60 +/- 28.52 mu M, respectively. The potencies for inhibition of 17 beta-HSD3 activity were determined to be PFOSK > PFOS> PFOA> PFHxSK = PFBSK for human 17 beta-HSD3 activity. There appears to be a species-dependent sensitivity to PFAS-mediated inhibition of enzyme activity because the IC(50)s of PFOS(K) for inhibition of rat 17 beta-HSD3 activity was greater than 250 mu M. In conclusion, the present study shows that PFOS and PFOSK are potent inhibitors of rat 3 beta-HSD and human 17 beta-HSD3 activity, and implies that inhibition of steroidogenic enzyme activity may be a contributing factor to the effects that PFASs exert on androgen secretion in the testis.				1				A	C	PFBSを含むPFASについて、ヒトおよびラット精巣における3β-ヒドロキシステロイドデヒドロゲナーゼ（3β-HSD）および17β-ヒドロキシステロイドデヒドロゲナーゼ3（17β-HSD3）活性の阻害作用を比較。その力価は、PFOSK＞PFOS＞PFOA＞PFHxSK＝PFBSK。ステロイド生成酵素活性の阻害が、PFASによる精巣のアンドロゲン分泌に及ぼす影響の一因である可能性を示唆。メカニズムの参考。	対象物質については1ドーズのみで実施されているので，参考文献としては適切でない。
D1215	in vitro（内分泌）	Chen L, Lin X, Shi S, Li M, Mortimer M, Fang W, Li F, Guo LH.	Activation of estrogen-related receptor: An alternative mechanism of hexafluoropropylene oxide homologs estrogenic effects	2023	Sci Total Environ. 2023 Aug 12;901:166257. doi: 10.1016/j.scitotenv.2023.166257. Online ahead of print.	Perfluorooctanoic acid (PFOA) alternatives such as hexafluoropropylene oxide homologs (HFPOs) cause concern due to increased occurrence in the environment as well as potential bioaccumulation and toxicity. HFPOs have been demonstrated to activate the estrogen receptor (ER) pathway. The ER pathway is homologous and connected to the estrogen-related receptor (ERR) pathway, but HFPOs effects on the ERR pathway have not been studied. Hence, we assessed the potential estrogenic effects of HFPOs via ERRγ pathway. In vitro assays revealed that HFPO dimeric, trimeric, and tetrameric acids (HFPO-DA, -TA, and -TeA, respectively), acted as ERRγ agonists, activating the transcription of both human and zebrafish ERRγ at low concentrations, but inhibiting zebrafish ERRγ at high concentrations. We also found that HFPO-TA promoted the human endometrial cancer cells (Ishikawa cells) proliferation via ERRγ/EGF, Cyclin D1 pathway. The HFPO-TA-induced proliferation of Ishikawa cells was inhibited by co-exposure with a specific antagonist of ERRγ, GSK5182. In vivo exposure of female zebrafish to HFPO-TA disturbed sex hormone levels, interfered with the gene expression involved in estrogen synthesis and follicle regulation, and caused histopathological lesions in the ovaries, which were similar to those induced by a known ERRγ agonist GSK4716. Taken together, this study revealed a new mechanism concerning the estrogenic effect of HFPOs via activation of the ERRγ pathway.					1			1	A	A	GenXのエストロゲン作用メカニズムに関する評価。in vivo試験はゼブラフィッシュだが、in vitro試験はヒトERRγ、ヒト子宮内膜がん細胞（Ishikawa）を用いた評価も実施。ERRγ経路の活性化を介した HFPO のエストロゲン活性を示唆。メカニズムの参考。	濃度はしっかり振ってあり，nMレベルで影響が出ているのは重要な知見。
D1216	実験動物（免疫毒性）	Lee, HY; You, DJ; Taylor-Just, AJ; Linder, KE; Atkins, HM; Ralph, LM; De la Cruz, G; Bonner, JC	Pulmonary exposure of mice to ammonium perfluoro(2-methyl-3-oxahexanoate) (GenX) suppresses the innate immune response to carbon black nanoparticles and stimulates lung cell proliferation	2022	Inhal. Toxicol. 2022 Aug:34(9-10):244-259. doi: 10.1080/08958378.2022.2086651.	Background Per- and polyfluoroalkyl substances (PFAS) have been associated with respiratory diseases in humans, yet the mechanisms through which PFAS cause susceptibility to inhaled agents is unknown. Herein, we investigated the effects of ammonium perfluoro(2-methyl-3-oxahexanoate) (GenX), an emerging PFAS, on the pulmonary immune response of mice to carbon black nanoparticles (CBNP). We hypothesized that pulmonary exposure to GenX would increase susceptibility to CBNP through suppression of innate immunity. Methods Male C57BL/6 mice were exposed to vehicle, 4 mg/kg CBNP, 10 mg/kg GenX, or CBNP and GenX by oropharyngeal aspiration. Bronchoalveolar lavage fluid (BALF) was collected at 1 and 14 days postexposure for cytokines and total protein. Lung tissue was harvested for histopathology, immunohistochemistry (Ki67 and phosphorylated (p)-STAT3), western blotting (p-STAT3 and p-NF-kappa B), and qRT-PCR for cytokine mRNAs. Results CBNP increased CXCL-1 and neutrophils in BALF at both time points evaluated. However, GenX/CBNP co-exposure reduced CBNP-induced CXCL-1 and neutrophils in BALF. Moreover, CXCL-1, CXCL-2 and IL-1 beta mRNAs were increased by CBNP in lung tissue but reduced by GenX. Western blotting showed that CBNP induced p-NF-kappa B in lung tissue, while the GenX/CBNP co-exposed group displayed decreased p-NF-kappa B. Furthermore, mice exposed to GenX or GenX/CBNP displayed increased numbers of BALF macrophages undergoing mitosis and increased Ki67 immunostaining. This was correlated with increased p-STAT3 by western blotting and immunohistochemistry in lung tissue from mice co-exposed to GenX/CBNP. Conclusions Pulmonary exposure to GenX suppressed CBNP-induced innate immune response in the lungs of mice yet promoted the proliferation of macrophages and lung epithelial cells.					1				B	B	GenXを雄性C57BL/6マウスに咽頭吸引させたin vivo試験だが、単用量のため参考扱い。カーボンブラックナノ粒子に誘発されるマウス肺における自然免疫反応の抑制、マクロファージと肺上皮細胞の増殖促進を示唆。	濃度が１ドーズなので結果の解釈が難しい。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1217	実験動物（代謝）	Rashid, F; Dubinkina, V; Ahmad, S; Maslov, S; Irudayaraj, JMK	Gut Microbiome-Host Metabolome Homeostasis upon Exposure to PFOS and GenX in Male Mice	2023	Toxics. 2023 Mar;11(3):281. doi: 10.3390/toxics11030281.	Alterations of the normal gut microbiota can cause various human health concerns. Environmental chemicals are one of the drivers of such disturbances. The aim of our study was to examine the effects of exposure to perfluoroalkyl and polyfluoroalkyl substances (PFAS)-specifically, perfluorooctane sulfonate (PFOS) and 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy) propanoic acid (GenX)-on the microbiome of the small intestine and colon, as well as on liver metabolism. Male CD-1 mice were exposed to PFOS and GenX in different concentrations and compared to controls. GenX and PFOS were found to have different effects on the bacterial community in both the small intestine and colon based on 16S rRNA profiles. High GenX doses predominantly led to increases in the abundance of Clostridium sensu stricto, Alistipes, and Ruminococcus, while PFOS generally altered Lactobacillus, Limosilactobacillus, Parabacteroides, Staphylococcus, and Ligilactobacillus. These treatments were associated with alterations in several important microbial metabolic pathways in both the small intestine and colon. Untargeted LC-MS/MS metabolomic analysis of the liver, small intestine, and colon yielded a set of compounds significantly altered by PFOS and GenX. In the liver, these metabolites were associated with the important host metabolic pathways implicated in the synthesis of lipids, steroidogenesis, and in the metabolism of amino acids, nitrogen, and bile acids. Collectively, our results suggest that PFOS and GenX exposure can cause major perturbations in the gastrointestinal tract, aggravating microbiome toxicity, hepatotoxicity, and metabolic disorders.					1			D	B	GenX（およびPFOS）曝露によるマウス腸内細菌叢-宿主メタボロームのホメオスタシスの評価。雄性CD-1マウスを用いたin vivo試験だが、要旨からは曝露手法、用量設定が不明であり、本評価に活用可能か判断できない。	影響が出ているのは興味深いが，曝露量は5mg/kg以上でかなり多い。
D1218	生態毒性（内分泌）	Lee, JW; Lee, JW; Shin, YJ; Kim, JE; Ryu, TK; Ryu, J; Lee, J; Kim, P; Choi, K; Park, K	Multi-generational xenoestrogenic effects of Perfluoroalkyl acids (PFAAs) mixture on Oryzias latipes using a flow-through exposure system	2017	Chemosphere 2017 Feb:169:212-223. doi: 10.1016/j.chemosphere.2016.11.035	To elucidate the multi-generational estrogenic potential of Perfluoroalkyl acids (PFAAs) mixture, vitellogenin (VTG) expression, growth indices, histological alteration, fecundity, hatching rate, larval survival rate, and sex ratio of Japanese medaka (Oryzias latipes) were investigated by exposing the fish to a mixture of perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorobutane sulfonate (PFBS), and perfluorononanoic acid (PFNA) for three generations (238 days). Mixture composition is in the ratio of 1:1:1:1. In addition, whole body burden for each PFAA was analyzed. According to the results, concentrated levels of the PFAAs in both F1 and F2 generation O. latipes were ordered PFOS > PFNA > PFOA > PFBS at both low concentration (0.5 mu g/L) and high concentration (5 mu g/L), whereas a significant difference in whole body burden based on sex or generation was not detected. Significant induction of VTG expression in F2 and the decline of the gonad somatic index (GSI) in FI were observed following PFAAs mixture exposure ($p < 0.05$, one-way ANOVA). Furthermore, suppression level of reproduction rate relative to the control increased as generation was transferred to the next in response to PFAA5 mixture or 17 beta-estradiol exposure, with the inhibition of hatchability observed in the FI generation. The PFAA high concentration caused significant alteration of FI generation sex ratio, suggesting the adverse effect of PFAA in population level (Chi-square test, $P > 0.05$). Overall, this study demonstrated that PFAA mixture could have the potential of multi-generational endocrine disruptors in 0. latipes.				1	1			C	C	PFAAsのメダカに対する多世代にわたる内分泌かく乱作用を示唆。	混合物質として投与しているので，単独物質としての影響については解釈ができない。
D1219	実験動物（免疫毒性）	Tang, L; Qiu, WH; Zhang, SW; Wang, JZ; Yang, X; Xu, BT; Magnuson, JT; Xu, EG; Wu, MH; Zheng, CM	Poly- and Perfluoroalkyl Substances Induce Immunotoxicity via the TLR Pathway in Zebrafish: Links to Carbon Chain Length	2023	Environ. Sci. Technol. 2023 Apr:57(15):6139-6149. doi: 10.1021/acs.est.2c09716.	Previous studies have reported the immunotoxicity of per-and polyfluoroalkyl substances (PFASs), but it remains a significant challenge to assess over 10,000 distinct PFASs registered in the distributed structure-searchable toxicity (DSSTox) database. We aim to reveal the mechanisms of immunotoxicity of different PFASs and hypothesize that PFAS immunotoxicity is dependent on the carbon chain length. Perfluorobutanesulfonic acid (PFBA), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA) representing different carbon chain lengths (4-9) at environmentally relevant levels strongly reduced the host's antibacterial ability during the zebrafish's early-life stage. Innate and adaptive immunities were both suppressed after PFAS exposures, exhibiting a significant induction of macrophages and neutrophils and expression of immune-related genes and indicators. Interestingly, the PFAS-induced immunotoxic responses were positively correlated to the carbon chain length. Moreover, PFASs activated downstream genes of the toll-like receptor (TLR), uncovering a seminal role of TLR in PFAS immunomodulatory effects. Myeloid differentiation factor 88 (MyD88) morpholino knock-down experiments and MyD88 inhibitors alleviated the immunotoxicity of PFASs. Overall, the comparative results demonstrate differences in the immunotoxic responses of PFASs due to carbon chain length in zebrafish, providing new insights into the prediction and classification of PFASs mode of toxic action based on carbon chain length.	1		1	1				C	A	ゼブラフィッシュに対するPFASの免疫毒性の炭素鎖長による違いを評価。	免疫毒性の根拠資料になると思います。
D1220	実験動物（代謝）	Roth, K; Yang, Z; Agarwal, M; Liu, W; Peng, ZY; Long, Z; Birbeck, J; Westrick, J; Liu, WQ; Petriello, MC	Exposure to a mixture of legacy, alternative, and replacement per- and polyfluoroalkyl substances (PFAS) results in sex-dependent modulation of cholesterol metabolism and liver injury	2021	Environ. Int. 2021 Dec:157:106843. doi: 10.1016/j.envint.2021.106843.	Background: Epidemiological studies have shown Per- and polyfluoroalkyl substances (PFAS) to be associated with diseases of dysregulated lipid and sterol homeostasis such as steatosis and cardiometabolic disorders. However, the majority of mechanistic studies rely on single chemical exposures instead of identifying mechanisms related to the toxicity of PFAS mixtures. Objectives: The goal of the current study is to investigate mechanisms linking exposure to a PFAS mixture with alterations in lipid metabolism, including increased circulating cholesterol and bile acids. Methods: Male and female wild-type C57BL/6J mice were fed an atherogenic diet used in previous studies of pollutant-accelerated atherosclerosis and exposed to water containing a mixture of 5 PFAS representing legacy, replacement, and alternative subtypes (i.e., PFOA, PFOS, PFNA, PFHxS, and GenX), each at a concentration of 2 mg/L, for 12 weeks. Changes at the transcriptome and metabolome level were determined by RNA-seq and highresolution mass spectrometry, respectively. Results: We observed increased circulating cholesterol, sterol metabolites, and bile acids due to PFAS exposure, with some sexual dimorphic effects. PFAS exposure increased hepatic injury, demonstrated by increased liver weight, hepatic inflammation, and plasma alanine aminotransferase levels. Females displayed increased lobular and portal inflammation compared to the male PFAS-exposed mice. Hepatic transcriptomics analysis revealed PFAS exposure modulated multiple metabolic pathways, including those related to sterols, bile acids, and acyl carnitines, with multiple sex-specific differences observed. Finally, we show that hepatic and circulating levels of PFOA were increased in exposed females compared to males, but this sexual dimorphism was not the same for other PFAS examined. Discussion: Exposure of mice to a mixture of PFAS results in PFAS-mediated modulation of cholesterol levels, possibly through disruption of enterohepatic circulation.			1	1	1			B	C	5種類のPFAS（PFOA、PFOS、PFNA、PFHxS、GenX）の経口曝露（2 mg/L飲水、12週間）によるコレステロール代謝と肝障害への影響を評価したC57BL/6Jマウスを用いたin vivo試験。単用量だが複数の性差を検出しており参考となる。	混合物質として投与しているので，単独物質としての影響については解釈ができない。
D1221	実験動物（免疫毒性）	Liu, CH; Gin, KYH	Immunotoxicity in Green Mussels Under Perfluoroalkyl Substance (PFAS) Exposure: Reversible Response and Response Model Development	2018	Environ. Toxicol. Chem. 2018 Apr:37(4):1138-1145. doi: 10.1002/etc.4060.	The immunotoxicity of 4 commonly detected perfluoroalkyl substances (PFASs), namely, perfluorooctanesulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA) was investigated by measuring biomarkers of the immune profile of green mussels, Perna viridis. The biomarkers included neutral red retention, phagocytosis, and spontaneous cytotoxicity, all of which were tested on mussel hemocytes. Hemocytes are an important component of the invertebrate immune system. We found that exposure to PFASs could lead to reduced hemocyte cell viability and suppress immune function by up to 50% of normal performance within the experimental exposure range. The results indicate that PFASs have an immunotoxic potential and thus could pose severe health risks to aquatic organisms. The reported immunotoxicity is likely to result from the compounds' direct and indirect interactions with the hemocyte membrane, and therefore likely to affect the functionality of these cells. The immunotoxic response was found to be related to the organism's burden of PFASs, and was reversible when the compounds were removed from the test organisms. Based on this relationship, models using an organism's PFAS concentration and bioaccumulation factor (BAF) as the independent variables were established to quantify PFAS-induced immunotoxicity. The models help us to gain a better understanding of the toxic mechanism of PFASs, and provide a tool to evaluate adverse effects for the whole group of compounds with one mathematical equation.				1				C	D	PFASのミドリイガイに対する免疫毒性の評価。	実験動物としてGreen Musselを用いていいるが，一般化が難しく，結果の解釈が難しい。
D1222	実験動物（内分泌）	Xu, RA; Shen, QX; Li, SL; Li, XJ; Li, HT; Lu, Y; Lian, QQ; Ge, RS	Effects of perfluoroalkyl substances on neurosteroid synthetic enzymes in the rat	2017	Chem.-Biol. Interact. 2017 Jun:272:182-187. doi: 10.1016/j.cbi.2017.05.017	Perfluoroalkylated substances (PFASs), including perfluorooctyl sulphonate (PFOS) and perfluorooctane acid (PFOA), have been classified as persistent organic pollutants and are known to cause endocrine disrupting effects in humans. The objective of the present study was to compare the potencies of four different PFASs, PFOS, PFOA, perfluorohexyl sulfonate (PFHxS), and perfluorobutyl sulfonate (PFBS), to inhibit neurosteroidogenic 5 alpha-reductase 1 (SRD5A1), 3 alpha-hydroxysteroid dehydrogenase (AKR1C9), and retinol dehydrogenase 2 (RoDH2) in rats. The potencies of PFASs to inhibit SRD5A1 are PFOS > PFOA > PFHxS = PFBS, with IC50 values of PFOS and PFOA of 1.92 +/- 0.07 and 14.2 +/- 0.07 mu M and no effects for PFHxS and PFBS at 100 mu M, respectively. The potencies of PFASs to inhibit AKR1C9 and RoDH2 are PFOS > PFOA > PFHxS = PFBS, with IC50 values of PFOS and PFOA on these two enzymes about 100 mu M and no effects for PFHxS and PFBS at 100 mu M respectively. PFOS and PFOA competitively inhibited rat SRD5A1. In conclusion, PFOS and PFOA are potent inhibitors of rat SRD5A1, thereby controlling the biosynthesis of neurosteroids.					1			A	C	4種類のPFAS（PFOS、PFOA、PFHxS、PFBS）のラット神経ステロイド合成酵素に対する影響を評価（in vitro試験）。神経ステロイドの生合成を制御。ステロイド５α還元酵素1（SRD5A1）に対する阻害活性強度は、PFOS > PFOA > PFHxS = PFBS。定性評価の参考。	高用量でのみ効果が出ており，実験系として対象物質毒性の解析には適切でない。
D1223	実験動物（代謝）	Chen, L; Zhu, MY; Liu, YF; Yang, ZC; Li, H; Mu, HX; Liu, S; Wu, B	Perfluorobutanesulfonate exposure induces metabolic disturbances in different regions of mouse gut	2023	Sci. Total Environ. 2023 Mar:866:161261. doi: 10.1016/j.scitotenv.2022.161261.	Perfluorobutanesulfonate (PFBS), an alternative to perfluorooctanesulfonate (PFOS), has raised many health concerns. However, PFBS toxicity in the mammalian gut remains unclear. C57BL/6 mice were exposed to 10 mu g/L and 500 mu g/L PFBS or 500 mu g/L PFOS in their water supply for 28 days. PFBS toxicity in the ileum and colon was explored and com-pared to that of PFOS. Biochemical analysis showed that tumor necrosis factor-a (TNF-a) and interleukin-1f3 (IL-1f3) levels increased in the ileum exposed to 10 mu g/L PFBS, whereas no significant changes were observed in those levels in the colon. Catalase (CAT) activity, malondialdehyde (MDA), TNF-a, and IL-1f3 levels increased and glutathione (GSH) levels decreased in the ileum of the 500 mu g/L-PFBS group, whereas only MDA levels increased in the colon of the 500 mu g/L-PFBS group. The results showed that more severe damage occurred in the ileum than in the colon after PFBS exposure, and these align with the 500 mu g/L-PFOS group exposure as well. Furthermore, metabolomic anal-ysis revealed glutathione metabolism as a vital factor in inducing PFBS and PFOS toxicities in the ileum. Steroid hor-mone and amino acid metabolisms were other important factors involved in PFBS and PFOS toxicities, respectively. In the colon, GSH, pyrimidine, and glucose (especially galactose) metabolism was the main contributor to PFBS toxicity, and sulfur amino acid metabolism was the main pathway for PFOS toxicity. This study provides more evidence of the health hazards due to low-dose PFBS exposure in the mammalian gut.					1			B	B	PFBSの毒性をPFOSと比較。10、500 μg/L PFBSに28日間曝露したC57BL/6マウスにおいて、10 μg/Lで回腸のTNF-αとIL-1f3が上昇し、500 μg/Lでは、回腸のカタラーゼ活性、マロンジアルデヒド（MDA）、TNF-α、IL-1f3の上昇とグルタチオンの低下、結腸のMDA上昇が観察。500 μg/L-PFOS群の傾向と一致。	腸管の機能や形態への影響を見ずに酵素活性やサイトカイン濃度のみを見ている。これらの物質への作用メカニズムも解析していないので，積極的に採択すべきレベルではない。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1224	実験動物（内分泌）	Zhang, SN; Guo, XC; Lu, SY; He, J; Wu, Q; Liu, XH; Han, ZY; Xie, P	Perfluorohexanoic acid caused disruption of the hypothalamus-pituitary-thyroid axis in zebrafish larvae	2022	Ecotox. Environ. Safe. 2022 Mar:232:113283. doi: 10.1016/j.ecoenv.2022.113283.	Perfluorohexanoic acid (PFHxA) has been recognized as an alternative to the wide usage of perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS) in the fluoropolymer industry for years. PFHxA has been frequently detected in the environment due to its wide application. However, the ecological safety of PFHxA, especially its toxicological effects on aquatic organisms, remains obscure. In the present study, PFHxA at different concentrations (0, 0.48, 2.4, and 12 mg/L) was added to the culture medium for zebrafish embryo/ larval exposure at 96 h postfertilization (hpf). Zebrafish larvae showed a slow body growth trend and changes in thyroid hormone levels (THs) upon PFHxA exposure, indicating the interference effect of PFHxA on fish larval development. Moreover, the transcription levels of genes related to the hypothalamic-pituitary-thyroid (HPT) axis were also analyzed. The gene expression level of thyroid hormone receptor beta (tr beta) was upregulated in a dose dependent manner. Exposure to 0.48 mg/L PFHxA increased the expression levels of the thyrotrophic-releasing hormone (trh) and thyroid hormone receptor alpha (tr alpha). Significant increases in corticotrophin-releasing hormone (crh) and transthyretin (ttr) gene expression were also observed when the zebrafish larvae were treated with 12 mg/L PFHxA, except iodothyronine deiodinases (dio1), which decreased obviously at that point. There were significant declines in the transcription of both thyroid-stimulating hormone beta (tsh beta) and uridined iphosphate-glucuronosyltransferase (ugt1ab) upon exposure to 2.4 mg/L PFHxA. In addition, PFHxA induced a dose related inhibitory effect on the transcription of sodium/iodide symporter (nis). Finally, the thyroid status will be destroyed after exposure to PFHxA, thus leading to growth impairment in zebrafish larvae.		1						C	A	PFHxAによるゼブラフィッシュ幼生の成長障害を示唆。	きちんと成長発達遅延があることを確認しながら，甲状腺ホルモン系への影響を見ている。ゼブラフィッシュは実験系としても確立しており，良い論文である
D1225	実験動物（代謝）	Li, Z; Yu, ZY; Yin, DQ	Multi- and trans-generational disturbances of perfluorobutane sulfonate and perfluorohexane sulfonate on lipid metabolism in Caenorhabditis elegans	2021	Chemosphere. 2021 Oct:280:130666. doi: 10.1016/j.chemosphere.2021.130666.	Short-chained perfluorobutane sulfonate (PFBS, four-carbon) and perfluorohexane sulfonate (PFHxS, sixcarbon) are widely employed to substitute long-chained per- and poly-fluoroalkyl substances (PFASs). Recent studies showed the potential persistence of PFBS and PFHxS, and also reported their correlation with obesity. However, the long-term outcome and underlying mechanisms remained poorly understood. Presently, the effects of PFBS and PFHxS were studied on C. elegans with multi- and trans-generational experiments. The multi-generational effects were measured in continuous four generational exposure (i.e., F1 to F4). Results showed that PFBS did not stimulate the fat content in F1 but in F4 with continuous but different disturbances on the lipid metabolism and the insulin and insulin-like (IIS) pathway. PFHxS stimulated the fat content in F1 and F4 with similar disturbances on the lipid metabolism and IIS pathway. The trans-generational results showed that the effects of PFBS and PFHxS on the lipid metabolism and IIS pathway were not totally recovered in the offspring of F1 (i.e., T1 -T3) and F4 (i.e., T1'-T3') which were not continuously exposed. PFHxS showed a common pattern to up-regulate daf-7 in both multi- and trans-generational effects. The long-term consequences of the short-chained PFASs substitutes should be concerned and epigenetic regulations should be considered in future mechanism studies.				1			C	A		1ドーズだが低用量（1ng/L）での曝露で継世代影響を見ている。線虫は実験系として確立しており，良い論文である。
D1226	実験動物（代謝）	Blanc, M; Karrman, A; Kukucka, P; Scherbak, N; Keiter, S	Mixture-specific gene expression in zebrafish (Danio rerio) embryos exposed to perfluorooctane sulfonic acid (PFOS), perfluorohexanoic acid (PFHxA) and 3,3 ',4,4 ',5-pentachlorobiphenyl (PCB126)	2017	Sci. Total Environ. 2017 Jul:590:249-257. doi: 10.1016/j.scitotenv.2017.02.232	Perfluorooctane sulfonic acid (PFOS) and 3,3 ',4,4 ',5-pentachlorobiphenyl (PCB126) are persistent organic pollutants of high concern because of their environmental persistence, bioaccumulation and toxic properties. Besides, the amphiphilic properties of fluorinated compounds such as PFOS and perfluorohexanoic acid (PFHxA) suggest a role in increasing cell membrane permeability and solubilizing chemicals. The present study aimed at investigating whether PFOS and PFHxA are capable of modifying the activation of PCB126 toxicity-related pathways. For this purpose, zebrafish embryos were exposed in semi-static conditions to 7.5 mu g/L of PCB126 alone, in the presence of 25 mg/L of PFOS, 15.7 mg/L of PFHxA or in the presence of both PFOS and PFHxA. Quantitative PCR was performed on embryos aged from 24 h post fertilization (hpf) to 96 hpf to investigate expression changes of genes involved in metabolism of xenobiotics (ahr2, cypla), oxidative stress (gpxla, tp53), lipids metabolism (acaa2, osbpl1a), and epigenetic mechanisms (dnmt1, dnmt3ba). Cypla and ahr2 expression were significantly induced by the presence of PCB126. However. after 72 and 78 h of exposure, induction of cypla expression was significantly lower when embryos were co-exposed to PCB126 + PFOS + PFHxA when compared to PCB126-exposed embryos. Significant upregulation of gpxla occurred after exposure to PCB126 + PFHxA and to PCB126 + PFOS + PFHxA at 30 and 48 hpf. Besides, embryos appeared more sensitive to PCB126 + PFOS + PFHxA at 78 hpf:acaa2 and osbplla were significantly downregulated; dnmtl was significantly upregulated. While presented as environmentally safe, PFHxA demonstrated that it could affect gene expression patterns in zebrafish embryos when combined to PFOS and PCB126, suggesting that such mixture may increase PCB126 toxicity. This is of particular relevance since PFHxA is persistent and still being ejected into the environment. Moreover, it provides additional information as to the importance to integrate mixture effects of chemicals in risk assessment and biomonitoring frameworks.		1					C	C		PCBとの複合影響を見ているので，参考論文としては適切ではない。
D1227	システマティックレビュー（内分泌）	Gundacker, C; Audouze, K; Widhalm, R; Granitzer, S; Forsthuber, M; Jornod, F; Wielsoe, M; Long, M; Halldorsson, TI; Uhl, M; Bonefeld-Jorgensen, EC	Reduced Birth Weight and Exposure to Per- and Polyfluoroalkyl Substances: A Review of Possible Underlying Mechanisms Using the AOP-HelpFinder	2022	Toxics. 2022 Nov;10(11):684. doi: 10.3390/toxics10110684.	Prenatal exposure to per- and polyfluorinated substances (PFAS) may impair fetal growth. Our knowledge of the underlying mechanisms is incomplete. We used the Adverse Outcome Pathway (AOP)-helpFinder tool to search PubMed for studies published until March 2021 that examined PFAS exposure in relation to birth weight, oxidative stress, hormones/hormone receptors, or growth signaling pathways. Of these 1880 articles, 106 experimental studies remained after abstract screening. One clear finding is that PFAS are associated with oxidative stress in in vivo animal studies and in vitro studies. It appears that PFAS-induced reactive-oxygen species (ROS) generation triggers increased peroxisome proliferator-activated receptor (PPAR)gamma expression and activation of growth signaling pathways, leading to hyperdifferentiation of pre-adipocytes. Fewer proliferating pre-adipocytes result in lower adipose tissue weight and in this way may reduce birth weight. PFAS may also impair fetal growth through endocrine effects. Estrogenic effects have been noted in in vivo and in vitro studies. Overall, data suggest thyroid-damaging effects of PFAS affecting thyroid hormones, thyroid hormone gene expression, and histology that are associated in animal studies with decreased body and organ weight. The effects of PFAS on the complex relationships between oxidative stress, endocrine system function, adipogenesis, and fetal growth should be further explored.							D	C	要旨からPFASの種類は不明。レビュー論文だがメカニズムの参考になるかもしれない（出生時体重の減少とPFAS曝露： AOP-HelpFinderを用いた想定メカニズムの検討）。	実験ではなく，文献解析なので参考論文にはならない。
D1228	実験動物（内分泌）	Ibor, OR; Andem, AB; Eni, G; Arong, GA; Adeougn, AO; Arukwe, A	Contaminant levels and endocrine disruptive effects in Clarias gariepinus exposed to simulated leachate from a solid waste dumpsite in Calabar, Nigeria	2020	Aquat. Toxicol. 2020 Feb:219:105375. doi: 10.1016/j.aquatox.2019.105375.	Solid waste dumpsites (SWDs) and landfills are significant sources of emerging contaminants to terrestrial and aquatic ecosystems. We have studied the endocrine disruptive effects of simulated leachate from a solid waste dumpsite in Calabar, Nigeria. Juvenile C. gariepinus were exposed to simulated leachate, diluted to 0:0 (control), 1:10, 1:50, 1:100 for 3, 7 and 14 days. In addition, 17 beta-estradiol (E2: 100 mu g/L)-exposed positive control group was included. Hepatic transcripts for the genes encoding vitellogenin (vg), estrogen receptor-alpha (er-alpha), and aromatase (cyp19a1) were analyzed by real-time PCR. Protein expression for Vtg and Cyp19 were measured by immunoblotting and plasma steroid hormones (testosterone: T and E2) were measured using enzyme immunoassay (EIA). Soil samples from the dumpsite were analyzed for selected group of contaminants showing that DEHP was the only detected phthalate ester (PE) at 1300 +/- 400 ng/g. Further, perfluoroalkyl substances (PFASs) such as PFBS, PFOS, PFHxA, PFOA, PFNA, PFDA, PFUnDA and PFDoDA were detected in the soil samples from the dumpsite. We observed significant and apparent concentration-dependent increases in mRNA (vtg, er-alpha, and cyp19a1) and their corresponding functional protein products, after exposure to the simulated leachates. Further, the simulated leachate produced concentration-specific changes in plasma E2 and T levels. In general, the estrogenic endocrine and reproductive alterations in the exposed fish may directly be attributed to the PFASs and DEHP detected at the dumpsites. However, in addition to PFASs and DEHP, there could be other estrogenic contaminants in the leachate. Given the rapid utilization, for residential purposes, and increases in human settlement in areas around the Lemna SWDs, this study provides a direct cause-and-effect evidence of the potential contaminants at the dumpsite with significant environmental and human health consequences.		1	1	1			C	C		土壌中のPFASを含めた環境化学物質による影響を解析しているので，参考論文にはならない。
D1229	実験動物（内分泌）	Godfrey, A; Hooser, B; Abdelmoneim, A; Sepulveda, MS	Sex-specific endocrine-disrupting effects of three halogenated chemicals in Japanese medaka	2019	J. Appl. Toxicol. 2019 Aug:39(8):1215-1223. doi: 10.1002/jat.3807.	Several halogenated chemicals are found in an array of products that can cause endocrine disruption. Human studies have shown that endocrine responses are sex specific, with females more likely to develop hypothyroidism and males more likely to have reproductive impairment. The objective of this study was to assess sex differences on thyroid and estrogenic effects after exposure of Japanese medaka (Oryzias latipes, SK2MC) to halogenated compounds. This strain is an excellent model for these studies as sex can be determined non-destructively a few hours postfertilization. Medaka embryos were exposed to sublethal concentrations of Tris(1,3-dichloro-2-propyl) phosphate (TDCPP, 0.019 mg/L), perfluorooctanoic acid (PFOA, 4.7 mg/L) and its next generation alternative, perfluorobutyric acid (PFBA, 137 mg/L). Methimazole (inhibits thyroid hormone synthesis) and the thyroid hormone triiodothyronine served as reference controls. Fish were exposed throughout embryo development until 10 days postfertilization. Females displayed significantly larger swim bladders (which are under thyroid hormone control) after exposure to all chemicals with the exception of triiodothyronine, which caused the opposite effect. Females exposed to TDCPP and PFOA had increased expression of vitellogenin and exposure to PFOA upregulated expression of multiple thyroid-related genes. Upregulation of estrogenic-regulated genes after exposure to TDCPP, PFOA and methimazole was only observed in males. Overall, our results suggest that females and males show an estrogenic response when exposed to these halogenated chemicals and that females appear more susceptible to thyroid-induced swim bladder dysfunction compared with males. These results further confirm the importance of considering sex effects when assessing the toxicity of endocrine-disrupting compounds.	1						C	C	PFBA（およびPFOA, TDCPP）のメダカに対する内分泌かく乱作用と性差を評価。	1ドーズ，しかも高用量での実験なので，解釈が難しい。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1230	実験動物（内分泌）	Tang, LZ; Liu, MY; Song, SW; Hu, CY; Lam, PKS; Lam, JCW; Chen, LG	Interaction between hypoxia and perfluorobutane sulfonate on developmental toxicity and endocrine disruption in marine medaka embryos	2020	Aquat. Toxicol. 2020 May:222:105466. doi: 10.1016/j.aquatox.2020.105466.	The co-occurrence of hypoxia and xenobiotics is extremely common in natural environments, highlighting the necessity to elicit their interaction on aquatic toxicities. In the present study, marine medaka embryos were exposed to various concentrations (nominal 0, 1, 3.3 and 10 mg/L) of perfluorobutane sulfonate (PFBS), an environmental pollutant of emerging concern, under either normoxia (6.9 mg/L) or hypoxia (1.7 mg/L) condition. After acute exposure fill 15 days post-fertilization, single or combined toxicities of PFBS and hypoxia on embryonic development (e.g., mortality, hatching and heartbeat) and endocrine systems were investigated. Sex and thyroid hormones were measured by enzyme-linked immunosorbent assay. Transcriptional changes of endocrine genes were determined by quantitative real-time PCR assays. Co-exposure to 10 mg/L PFBS and hypoxia caused a further reduction in survival rate and heart beat compared to single exposure. PFBS induced a precocious hatching, while no larvae hatched under hypoxia condition. By disturbing the balance of sex hormones, either PFBS or hypoxia single exposure produced an anti-estrogenic activity in medaka larvae. However, PFBS and hypoxia combinations reversed to estrogenic activity in co-exposed larvae. Variation in disrupting pattern may be attributed to the interactive effects on steroidogenic pathway involving diverse cytochrome P450 enzymes. Regarding thyroid system, PFBS exposure caused detriments of multiple processes along thyroidal axis (e.g., feedback regulation, synthesis and transport of thyroid hormones, receptor-mediated signaling and thyroid gland development), while hypoxia potently impaired the development and function of thyroid gland. Combinations of PFBS and hypoxia interacted to dysregulate the function of thyroid endocrine system. In summary, the present study revealed the dynamic interaction of PFBS pollutant and hypoxia on aquatic developmental toxicities and endocrine disruption. Considering the frequent co-occurrence of xenobiotics and hypoxia, current results would be beneficial to improve our understanding about their interactive mechanisms and provide baseline evidences for accurate ecological risk evaluation.				1				C	C		インドメダカは実験動物としては確立しており，モデルとして用いるのは問題ないが，研究の中心が低酸素下での影響で，正常な酸素状態でのデータはばらつきが大きくあまり参考にならない。
D1231	実験動物（代謝）	Liu, MY; Tang, LZ; Hu, CY; Huang, ZL; Sun, BL; Lam, JCW; Lam, PKS; Chen, LG	Antagonistic interaction between perfluorobutanesulfonate and probiotic on lipid and glucose metabolisms in the liver of zebrafish	2021	Aquat. Toxicol. 2021 Aug:237:105897. doi: 10.1016/j.aquatox.2021.105897.	Perfluorobutanesulfonate (PFBS) and probiotic bacteria can interact to induce hepatic hypertrophy. However, the molecular events occurring in the hypertrophic liver are still unknown. Therefore, we performed this followup study using adult zebrafish that were exposed for 40 days to 0 and 10 mu g/L PFBS, with or without dietary supplementation of probiotic Lactobacillus rhamnosus. After PFBS or/and probiotic exposures, proteome perturbation, histological pathogenesis and glucose metabolism were investigated in the livers. Proteomic analysis showed potent intervention of PFBS or/and probiotic with hepatic functions. PFBS single exposure caused marked disturbances in lipid metabolisms, which may underlie the severe vacuolization in male liver. The addition of probiotic alleviated the lipid metabolic disorders of PFBS. Furthermore, probiotic supplementation enhanced ATP energy production using glucose in mitochondrial respiratory chain of male fish. However, PFBS alone caused remarkable increase in blood glucose level (by 2.5-fold relative to the control), underlining the onset of hyperglycemia symptom. In contrast, the liver of male fish from the coexposure group functioned appropriately, which immediately increased insulin levels by 2.2-fold to reduce the glucose accumulation in blood. In female liver, PFBS alone significantly decreased the blood glucagon concentration by 2.9-fold. The deficiency of glucagon hormone consequently contributed to the accumulation of glycogen (3.2-fold) therein. Vigorous antagonistic interaction between PFBS and probiotic was noted with respect to glucose metabolism, which restored ATP, glucose, glycogen and glucagon to the control levels. Overall, the present study finds that probiotic L. rhamnosus is efficient to mitigate the metabolic disorders of PFBS on lipid and glucose, highlighting the potential values of probiotic bacteria to protect the aquatic ecosystem.				1				C	B		肝臓における糖代謝への影響について調べているが，１ドーズなので解釈が難しい。
D1232	実験動物（代謝）	Hu, CY; Huang, ZL; Sun, BL; Liu, MY; Tang, LZ; Chen, LG	Metabolomic profiles in zebrafish larvae following probiotic and perfluorobutanesulfonate coexposure	2022	Environ. Res. 2022 Mar;204(Pt D):112380. doi: 10.1016/j.envres.2021.112380.	Probiotic supplements are able to attenuate the developmental toxicity of perfluorobutanesulfonate (PFBS) pollutant. However, the underlying mechanisms remain unexplored. To this end, the present study acutely exposed zebrafish larvae for 4 days to 0 and 10 mg/L of PFBS, with or without the addition of probiotic Lactobacillus rhamnosus in the rearing water. The metabolomics approach was used to reveal the combined effects of PFBS and probiotics on metabolic dynamics, based on which gene transcriptions, enzymatic activities, and behavioral endpoints were further examined. The results showed that probiotic supplements were the major driver of the metabolomic fingerprints in coexposed zebrafish larvae. The addition of probiotic bacteria significantly decreased the methylation potential whilst up-regulating the demethylation process of genomic DNA, which may globally stimulate the gene expression to improve somatic growth. Acute exposure to PFBS significantly increased the cortisol concentration in zebrafish larvae, subsequently inducing stress response and hyperactive behavior. In contrast, probiotic supplementation promoted the degradation of cortisol, thus alleviating the stressful state. Antagonistic action of probiotics against PFBS developmental toxicity was also noted regarding the locomotor behavior. In addition, gut microbiota-mediated production of secondary bile acids was remarkably enhanced by probiotic supplements regardless of PFBS exposure. Overall, the present study underlines the efficacy of probiotic bacteria to protect zebrafish larvae from the metabolic disturbances of PFBS, thereby providing more evidence to support the application of probiotics in aquaculture and fishery as an environmentally-friendly choice.				1				C	B		D1231と同じ研究グループによる論文で，実験手技も論文の体裁もほぼ同じ，なので同じ問題点があり，積極的に採択すべき論文ではない。
D1233	実験動物（内分泌）	Sun, BL; Liu, MY; Tang, LZ; Hu, CY; Huang, ZL; Chen, LG	Probiotics inhibit the stunted growth defect of perfluorobutanesulfonate via stress and thyroid axes in zebrafish larvae	2021	Environ. Pollut. 2021 Dec:290:118013. doi: 10.1016/j.envpol.2021.118013.	Perfluorobutanesulfonate (PFBS) is an emerging pollutant in aquatic environments and potently disrupts the early developmental trajectory of teleosts. Considering the persistent and toxic nature of PFBS, it is necessary to develop in situ protective measures to ameliorate the toxic damage of PFBS. Probiotic supplements are able to mitigate the growth retardation defects of PFBS. However, the interactive mechanisms remain elusive. To this end, this study acutely exposed zebrafish larvae to a concentration gradient of PFBS (0, 1, 3.3 and 10 mg/L) for 4 days, during which probiotic bacteria Lactobacillus rhamnosus were added in the rearing water. After exposure, alterations in gene transcriptions and key hormones along the hypothalamus-pituitary-interrenal (HPI), growth hormone/insulin-like growth factor (GH/IGF) and hypothalamus-pituitary-thyroid (HPT) axes were examined. The results showed that PFBS single exposure significantly increased the cortisol concentrations, suggesting the induction of stress response, while probiotic supplementation effectively decreased the cortisol levels in coexposed larvae in an attempt to relieve the stress of PFBS toxicant. It was unexpected that probiotic additive significantly decreased the larval GH concentrations independent of PFBS, thereby eliminating the contribution of GH/IGF axis to the growth improvement of probiotics. In contrast, probiotic bacteria remarkably increased the concentration of thyroid hormones, particularly the thyroxine (T4), in zebrafish larvae. The pronounced downregulation of uridinediphosphate glucoronosyltransferases (UDPGT) gene pointed to the blocked elimination process of T4 by probiotics. Furthermore, proteomic fingerprinting found that probiotics were potent to shape the protein expression pattern in PFBS-exposed zebrafish larvae and modulated multiple biological processes that are essential for the growth. In summary, the present findings suggest that HPI and HPT axes may cooperate to enhance the growth of fish larvae under PFBS and probiotic coexposures.				1				C	B		濃度は振っているが，probioticとの複合影響を見ており，解釈が難しい。
D1234	実験動物（代謝）	Sun, BL; Liu, MY; Tang, LZ; Hu, CY; Huang, ZL; Zhou, XZ; Chen, LG	Probiotic supplementation mitigates the developmental toxicity of perfluorobutanesulfonate in zebrafish larvae	2021	Sci. Total Environ. 2021 Dec:799:149458. doi: 10.1016/j.scitotenv.2021.149458.	Perfluorobutanesulfonate (PFBS) is an emerging pollutant of international concern, which is found to impair the early embryonic development of fishes. In the context of ubiquitous and persistent pollution, it is necessary to explore mitigatory strategies against the developmental toxicity of PFBS. In this study, zebrafish larvae were acutely exposed to 0, 1, 3.3 and 10 mg/L of PFBS till 168 h post-fertilization (hpf), during which probiotic Lactobacillus rhamnosus bacteria were administered via the exposure media. After the singular or combined exposure, interaction between PFBS and probiotics on the growth of zebrafish larvae was measured. PFBS exposure significantly decreased the larval body weight, weight gain and specific growth rate, while probiotic supplementation efficiently inhibited the growth retardation caused by PFBS. Furthermore, PFBS and probiotic combinations remarkably activated the antioxidant capacity to timely scavenge the reactive oxidative species and protect the larvae from lipid peroxidation. Biochemical assay and fluorescent staining verified that PFBS exposure significantly promoted the production of bile acids, which were further enhanced by the probiotics. In coexposed zebrafish larvae, up-regulation of peroxisome proliferator-activated receptor (PPARb) would enhance the beta-oxidation of fatty acids to meet the energy demand from larval growth, subsequently decreasing fatty acid concentrations. In addition, probiotic supplements masked the dysbiosis of PFBS and potently shaped the gut microbiota, which closely modulated the production of bile acids. Overall, the present findings underline the beneficial effects of probiotics to protect the developing larvae from the aquatic toxicities of PFBS, thus highlighting the potential application values of probiotic recipe in aquaculture and ecological reservation.				1				C	B		D1233と同じ研究グループによるもので，同様の問題があるため積極的には採用しづらい。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1235	実験動物（代謝）	Hu, CY; Liu, MY; Tang, LZ; Liu, HK; Sun, BL; Chen, LG	Probiotic intervention mitigates the metabolic disturbances of perfluorobutanesulfonate along the gut-liver axis of zebrafish	2021	Chemosphere. 2021 Dec:284:131374. doi: 10.1016/j.chemosphere.2021.131374.	ABS T R A C T Probiotic supplementation is effective to modulate the metabolic disorders caused by perfluorobutanesulfonate (PFBS). However, the underlying mechanisms remain unclear. To this end, the present study exposed adult zebrafish to PFBS (0 and 10 mu g/L), probiotics, or their binary combinations for 40 days. After the exposure, the nutritional stores, intestinal organization, and metabolic activities along the gut-liver axis were investigated. The results showed that PFBS exposure decreased the nutrient reserves significantly, especially the lipid content, which was alleviated by the probiotic administration. Intestinal mucus secretion was promoted remarkably in the presence of the probiotic, which enhanced epithelial protection against PFBS damage. Metagenomic analysis showed that PFBS alone induced gut microbial dysbiosis, which was efficiently antagonized by the probiotic bacteria. Intestinal metabolomic profiling revealed that ferroptosis occurred because of the unrestricted lipid peroxidation following PFBS exposure. However, probiotic administration prevented the ferroptotic symptoms induced by PFBS, further highlighting the beneficial effects of the probiotic on the host. In PFBS-exposed livers, high levels of bile acid metabolites (e.g., taurochenodeoxycholic acid) accumulated, implying the induction of cholestasis. Notably, probiotic addition recovered the metabolomic homeostasis under PFBS stress, probably resulting from the activation of detoxification pathways based on the pentose and glucuronate interconversion. Overall, the present study provides systematic evidence of the antagonistic interaction between PFBS and the probiotic regarding the metabolic activities along the microbe, gut and liver axis, highlighting the application values of probiotic recipe in aquaculture industry and ecological reservation.				1				C	B		D1231, D1232と同じ体裁，研究内容で，測定するパラメーターだけ変えている。内容的にはD1231, D1232と同様の問題がある。
D1236	実験動物（免疫毒性）	Hu, CY; Huang, ZL; Liu, MY; Sun, BL; Tang, LZ; Chen, LG	Shift in skin microbiota and immune functions of zebrafish after combined exposure to perfluorobutanesulfonate and probiotic Lactobacillus rhamnosus	2021	Ecotox. Environ. Safe. 2021 Jul:218:112310. doi: 10.1016/j.ecoenv.2021.112310.	Dysbiosis of fish skin microbiome and immunity by environmental pollutants are rarely studied in toxicological research in spite of their importance for fish health. In the present study, adult zebrafish were exposed to 0 and 10 mu g/L of perfluorobutanesulfonate (PFBS) for 40 days, with or without the supplementation of probiotic Lactobacillus rhamnosus, with objectives to explore the interaction between PFBS pollutant and probiotic bacteria on skin mucosal microbiota and immune response. Amplicon sequencing analysis found that PFBS alone significantly disturbed the microbial community composition and abundance on the skin, favoring the growth of stress-tolerant bacteria (e.g., Deinococcus and Enhydrobacter genera). However, the administration of probiotic inhibited the dysbiosis of PFBS and shaped the skin microbiome in the combined exposure group. PFBS single exposure also promoted the production of mucus on the skin of male zebrafish, which may be related to the growth of Limnobacter bacteria. In contrast, probiotic supplements remarkably improved the immune functions in male skin mucus from the combined group, as evidenced by the consistent increases in lysozyme activity, immunoglobulin concentrations and peroxidase activity. Overall, the present study provides the first clue about the singular and combined effects of PFBS and probiotic on skin microbiota and immunity, highlighting the beneficial action of probiotic L. rhamnosus against PFBS stress.				1				C	B		D1231, D1232, D1235と同じ体裁，研究内容で，測定するパラメーターだけ変えている。内容的にはD1231, D1233と同様の問題がある。
D1237	実験動物（代謝）	Chen, LG; Lam, JCW; Tang, LZ; Hu, CY; Liu, MY; Lam, PKS; Zhou, BS	Probiotic Modulation of Lipid Metabolism Disorders Caused by Perfluorobutanesulfonate Pollution in Zebrafish	2020	Environ. Sci. Technol. 2020 Jun:54(12):7494-7503. doi: 10.1021/acs.est.0c02345.	To determine whether and how probiotic supplement can alter gut microbiota dysbiosis and lipid metabolism disorders caused by perfluorobutanesulfonate (PFBS), the present study exposed adult zebrafish to 0, 10, and 100 mu g/L PFBS for 28 days, with or without dietary administration of probiotic Lactobacillus Blood rhamnosus. Regarding intestinal health and gut microbiota, probiotic supplement altered the innate toxicities of PFBS, depending on exposure concentration and the sex of the fish. Lactobacillus genus correlated positively ($P < 0.001$; $r > 0.5$) with other beneficial bacteria in the gut microbiota, thereby indirectly regulating host metabolic activities. In female fish, the PFBS and probiotic combination enhanced fatty acid synthesis and beta-oxidation, but mitigated the accumulation of cholesterol in the blood compared with PFBS single exposure, highlighting the benefits of the probiotic to host health. In male zebrafish, probiotic administration antagonized the PFBS-induced disturbances of bile acid metabolism, presumably via farnesoid X receptor signaling. However, coexposure to PFBS and probiotic caused significant accumulation of triglyceride in male livers (2.6-fold relative to the control), implying the induction of hepatic steatosis. Overall, the present study underlined the potential of probiotics to modulate gut microbial dysbiosis and lipid metabolism disorders caused by PFBS exposure, which could provide implications to the application of probiotics in aquaculture.				1				C	B		D1231, D1232, D1235, 1236と同じ体裁，研究内容で，測定するパラメーターだけ変えている。内容的にはD1231, D1234と同様の問題がある。
D1238	実験動物（内分泌）	Liu, Y; Wang, JS; Fang, XM; Zhang, HX; Dai, JY	The thyroid-disrupting effects of long-term perfluorononanoate exposure on zebrafish (Danio rerio)	2011	Ecotoxicology 2011 Jan:20(1):47-55. doi: 10.1007/s10646-010-0555-3.	Concentrations of perfluorononanoate (PFNA) suggest an obvious increase in the environment, wildlife, and humans. However, the potential toxicity of PFNA still remains to be fully elucidated. Our present work is directed toward evaluating specific thyroid endpoints, and studying the long-term and the trans-generational effects of PFNA on zebrafish. Zebrafish (Danio rerio) were exposed to different concentrations of PFNA (0, 0.05, 0.1, 0.5, and 1 mg/l) from their early life stages (F(0), 23 day post-fertilization dpf), and the exposure period lasted for 180 days. At the end of the exposure period, thyroid follicle histology and plasma thyroid hormone levels in male zebrafish were evaluated as direct endpoints for the specific thyroid toxicities, while gene expression relative to the hypothalamus-pituitary-thyroid axis was also investigated to study the underlying mechanisms. In addition, offspring embryos (F(1)) from the PFNA exposure parental zebrafish was reared in water either without PFNA or under continual exposure to PFNA for an additional 180 days to investigate effects of multi-generational exposures on the circulating T(3) levels and thyroid-associated gene expression. Our results demonstrate significantly elevated plasma T(3) levels were observed in both F(0) and F(1) adults, as well as PFNA-induced histological changes in the thyroid follicles of F(0) male zebrafish. In the liver, the abundance of gene transcript encoding the protein transthyretin (TTR) was significantly induced, while the expression of UDP-glucuronosyltransferases in F(0) adult males was inhibited. The induced thyroid-disrupting effects also demonstrated a trans-generational effect that was reflected by altered gene expression related to thyroid hormone (TH) synthesis and metabolism in F(1) larvae. Our results provide the first evidence for the thyroid-disrupting effects of long-term PFNA exposure in zebrafish.			1					C	A		濃度を振って甲状腺ホルモンの濃度を調べた上，合成に関わる遺伝子発現の解析を行っている。参考となるデータ。
D1239	実験動物（代謝）	Liu, MY; Sun, BL; Zhou, XZ; Chen, LG	Disturbed glucose metabolism by perfluorobutanesulfonate pollutant and benefit of young fecal transplantation in aged zebrafish	2022	Ecotox. Environ. Safe. 2022 Aug:241:113721. doi: 10.1016/j.ecoenv.2022.113721.	Perfluorobutanesulfonate (PFBS) is an environmental pollutant of emerging concern, which significantly impacts the metabolism and health of animals. Because of the loss of functional capacity, the aged animals are regarded more susceptible to the toxicity of environmental pollutants. In the present study, aged zebrafish were employed as the toxicological animal and transplanted with the feces collected from young donors for 14 days, after which the acclimated elderly were exposed to PFBS at environmentally relevant concentrations (0 and 100 mu g/L) for another 14 days. When the exposure was concluded, glucose metabolic disturbances of PFBS in the aged and efficacy of young fecal transplant to mitigate the toxicity of PFBS were explored along the gut-liver axis. The results showed that PFBS exposure significantly inhibited the enzymatic activity of alpha-amylase in the gut, but increased the alanine aminotransferase (ALT) activity in the blood of the aged zebrafish, suggesting the impairment of intestinal digestive functions of carbohydrates and the induction of liver damage by PFBS. However, young fecal transplantation successfully ameliorated the toxicity of PFBS on alpha-amylase and ALT, underlining the benefits conveyed to the health of the elderly. In addition, transplantation of young feces was efficient to alleviate the hyperglycemia symptom in the elderly via stimulating the secretion of insulin. PFBS exposure increased blood glucagon level, disrupted insulin receptor transcription, and depleted hepatic glycogen store, which were all mitigated by young fecal transplant. Hepatic proteomic analysis also found dynamic interactions between young fecal transplantation and PFBS pollutant on the metabolic pathways of glucose and glycogen, involving glycolysis, gluconeogenesis, glycogenesis, and glycogenolysis. Overall, the present findings highlighted the beneficial effects of young fecal transplantation to protect the aged from the glucose metabolism toxicity of PFBS, thus providing a plausible measure to improve the health aging status.				1				C	B		D1231, D1232, D1235, D1236, D1237と同じ体裁，研究内容で，測定するパラメーターだけ変えている。内容的にはD1231, D1234と同様の問題がある。
D1240	実験動物（代謝）	Liu, MY; Tang, LZ; Hu, CY; Sun, BL; Huang, ZL; Chen, LG	Interaction between probiotic additive and perfluorobutanesulfonate pollutant on offspring growth and health after parental exposure using zebrafish	2021	Ecotox. Environ. Safe. 2021 May:214:112107. doi: 10.1016/j.ecoenv.2021.112107.	Perfluorobutanesulfonate (PFBS) pollutant and probiotic bacteria can interact to affect the reproductive outcomes of zebrafish. However, it is still unexplored how the growth and health of offspring are modulated by the combination of PFBS and probiotic. In the present study, adult zebrafish were exposed to 0 and 10 ?g/L PFBS for 40 days, with or without dietary supplementation of probiotic Lactobacillus rhamnosus. After parental exposure, the development, growth and viability of offspring larvae were examined, with the integration of molecular clues across proteome fingerprint, growth hormone/insulin-like growth factor (GH/IGF) axis, calcium homeostasis, hypothalamic-pituitary-adrenal (HPA) axis and nutrient metabolism. Parental probiotic supplementation significantly increased the body weight and body length of offspring larvae. Despite the spiking of PFBS, larvae from the combined exposure group still had longer body length. RNA processing and ribosomal assembly pathways may underlie the enhancement of offspring growth by probiotic bacteria. However, the presence of PFBS remarkably increased the concentrations of cortisol hormone in offspring larvae as means to cope with the xenobiotic stress, which required more energy production. As evidenced by the proteomic analysis, the addition of probiotic bacteria likely alleviated the energy metabolism disorders of PFBS, thus allocating more energy for the larval offspring growth from the combined group. It was noteworthy that multiple molecular disturbances caused by PFBS were antagonized by probiotic additive. Overall, the present study elucidated the intergenerational interaction between PFBS and probiotic on offspring growth and health after parental exposure.				1				C	B		D1231, D1232, D1235, D1236, D1237, D1239と同じ体裁，研究内容で，測定するパラメーターだけ変えている。内容的にはD1231, D1235と同様の問題がある。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1241	実験動物（代謝）	Hu, CY; Tang, LZ; Liu, MY; Lam, PKS; Lam, JCW; Chen, LG	Probiotic modulation of perfluorobutanesulfonate toxicity in zebrafish: Disturbances in retinoid metabolism and visual physiology	2020	Chemosphere. 2020 Nov:258:127409. doi: 10.1016/j.chemosphere.2020.127409.	Perfluorobutanesulfonate (PFBS), an aquatic pollutant of emerging concern, is found to disturb gut microbiota, retinoid metabolism and visual signaling in teleosts, while probiotic supplementation can shape gut microbial community to improve retinoid absorption. However, it remains unknown whether probiotic bacteria can modulate the toxicities of PFBS on retinoid metabolism and visual physiology. In the present study, adult zebrafish were exposed for 28 days to 0,10 and 100 mu g/L PFBS, with or without dietary administration of probiotic Lactobacillus rhamnosus. Interaction between PFBS and probiotic was examined regarding retinoid dynamics (intestine, liver and eye) and visual stimuli transmission. PFBS single exposures remarkably inhibited the absorption of retinyl ester in female intestines, which were, however, restored by probiotic to normal status. Although coexposure scenarios markedly increased the hepatic storage of retinyl ester in females, mobilization of retinol was reduced in livers by single or combined exposures regardless of sex. In the eyes, transport and catalytic conversion of retinol to retinal and retinoic acid were interrupted by PFBS alone, which were efficiently antagonized by probiotic presumably through an indirect action. In response to the availability of retinal chromophore, transcriptions of opsins and arrestin genes were altered adaptively to control visual perception and termination. Neurotransmission across retina circuitry was changed accordingly, centering on epinephrine and norepinephrine. In summary, the present study found the efficient modulation of probiotic on retinoid metabolic disorders of PFBS pollution, which subsequently impacted visual signaling. A future work is warranted to provide mechanistic clues in retinoid interaction.				1				C	B		D1233, D1234と同様の問題があり，採択は難しい。この辺り同じ研究グループが測定のパラメータだけを変えて同じ体裁，同じ研究手法で論文を書いており，好ましいやり方とは思えない。
D1242	実験動物（内分泌）	Godfrey, A; Hooser, B; Abdelmoneim, A; Horzmann, KA; Freemanc, JL; Sepulveda, MS	Thyroid disrupting effects of halogenated and next generation chemicals on the swim bladder development of zebrafish	2017	Aquat. Toxicol. 2017 Dec:193:228-235. doi: 10.1016/j.aquatox.2017.10.024	Endocrine disrupting chemicals (EDCs) can alter thyroid function and adversely affect growth and development. Halogenated compounds, such as perfluorinated chemicals commonly used in food packaging, and brominated flame retardants used in a broad range of products from clothing to electronics, can act as thyroid disruptors. Due to the adverse effects of these compounds, there is a need for the development of safer next generation chemicals. The objective of this study was to test the thyroid disruption potential of old use and next generation halogenated chemicals. Zebrafish embryos were exposed to three old use compounds, perfluorooctanoic acid (PFOA), tetrabromobisphenol A (TBBPA) and tris (1,3-dichloro-2-propyl) phosphate (TDCPP) and two next generation chemicals, 9,10-dihydro-9-oxa-10-phosphaphenanthrene-10-oxdie (DOPO) and perfluorobutyric acid (PFBA). Sub-chronic (0-6 days post fertilization (dpf)) and chronic (0-28 dpf) exposures were conducted at 1% of the concentration known to kill 50% (LC50) of the population. Changes in the surface area of the swim bladder as well as in expression levels of genes involved in the thyroid control of swim bladder inflation were measured. At 6 dpf, zebrafish exposed to all halogenated chemicals, both old use and next generation, had smaller posterior swim bladder and increased expression in the gene encoding thyroid peroxidase, tpo and the genes encoding two swim bladder surfactant proteins, sp-a and sp-c. These results mirrored the effects of thyroid hormone-exposed positive controls. Fish exposed to a TPO inhibitor (methimazole, MMI) had a decrease in tpo expression levels at 28 dpf. Effects on the anterior swim bladder at 28 dpf, after exposure to MMI as well as both old and new halogenated chemicals, were the same, i.e., absence of SB in 50% of fish, which were also of smaller body size. Overall, our results suggest thyroid disruption by the halogenated compounds tested via the swim bladder surfactant system. However, with the exception of TBBPA and TDCPP, the concentrations tested (similar to 5-137 ppm) are not likely to be found in the environment.	1							C	A		濃度は振っていないが，曝露期間を振り，形態や生理機能も調べた上で，甲状腺ホルモン系との関連を調べている。参考論文になる。
D1243	実験動物（免疫毒性）	Xie, XX; Zhou, JF; Hu, LT; Shu, RN; Zhang, MY; Xiong, Z; Wu, FC; Fu, ZW	Exposure to hexafluoropropylene oxide dimer acid (HFPO-DA) disturbs the gut barrier function and gut microbiota in mice	2021	Environ. Pollut. 2021 Dec:290:117934. doi: 10.1016/j.envpol.2021.117934.	Hexafluoropropylene oxide dimer acid (HFPO-DA) is the substitute for perfluoro octanoic acid (PFOA), and recently it has been detected in environmental water samples worldwide and has multiple toxicities. However, whether it will affect the intestines and gut microbiota remains unclear. In this study, in order to evaluate the gut toxicity of HFPO-DA in mammals, male mice were orally exposed to 0, 2, 20, 200 mu g/L HFPO-DA, respectively, for 6 weeks. Our results showed that HFPO-DA exposure caused colonic inflammation which was coupled with increased TNF-alpha levels in serum and increased mRNA expression levels of TNF-alpha, p65, TLR4, MCP-1 of the colon in mice after exposure to 200 mu g/L HFPO-DA. We also found that HFPO-DA exposure induced the decreased mRNA expression levels and protein levels of MUC2 and ZO-1, which means the dysfunction of gut barrier in the colon. In the ileum, we found that HFPO-DA exposure induced the increased mRNA expression levels of various inflammatory factors, but no obvious changes was found to barrier function. Additionally, HFPO-DA exposure caused the imbalance of cecal gut microbiota and changes of cecal microbiota diversity. Taken together, all these results indicate the potential gut toxicity of HFPO-DA and is perceived as a major problem of health risk that affects the inflammation, gut barrier dysfunction, and gut microbiota disturbance in mammals.					1			A	B	HFPO-DA (GenX) 曝露による雄性マウスにおける炎症、腸管バリア機能障害を示唆。2, 20, 200 μg/Lを6週間経口投与したした結果、200 μg/Lで血清中TNF-α濃度が上昇し、大腸のTNF-α、p65、TLR4、MCP-1のmRNA発現が増加。腸管バリア機能障害を示すMUC2、ZO-1 mRNAおよびタンパク質レベルの低下、糞便腸内細菌叢の不均衡と多様性の変化も誘導。B or A候補。	mRNA解析は濃度を振って行っているが，形態解析やフローラの解析を最大用量でのみ行っている。関連する遺伝子発現はより低用量でも生じており，そちらの影響も見るべきであった。AとBの境界の論文。
D1244	実験動物（代謝）	Hu, CY; Sun, BL; Liu, MY; Yu, JX; Zhou, XZ; Chen, LG	Fecal transplantation from young zebrafish donors efficiently ameliorates the lipid metabolism disorder of aged recipients exposed to perfluorobutanesulfonate	2022	Sci. Total Environ. 2022 Jun:823:153758. doi: 10.1016/j.scitotenv.2022.153758.	Aging is a biological process that is accompanied by the gradual loss of physiological functions. Under the context of ubiquitous and persistent environmental pollution, the elderly will be more vulnerable to the detrimental effects of toxic pollutants than the young. With objectives to explore effective measures to ameliorate the double stress of aging and toxicants, the present study transplanted the feces from young zebrafish donors to aged recipients, which were concurrently exposed to perfluorobutanesulfonate (PFBS), an emerging environmental pollutant of international concern. After exposure, growth, hepatic structural organization, and lipid metabolism were examined. The results showed that, irrespective of PFBS toxicity, transplantation of young feces significantly enhanced the growth of the aged. In the livers of aged and PFBS-exposed zebrafish, vacuolization symptom was prevalently observed, while young fecal transplantation alleviated the structural defects in aged livers. In the gut of the elderly, digestive activity of lipids was promoted after the transplantation of young feces. The blood of the aged females accumulated significantly higher concentration of triglyceride (TG) than the young counterparts (2.6-fold), implying that the elderly were at high risk of cardiovascular diseases. PFBS treatment of the aged further increased blood TG levels by 2.0 fold relative to the aged control group, pointing to the aggravation of the health of the elderly by environmental pollution. However, it is intriguing that young fecal transplantation efficiently inhibited the metabolic toxicity of PFBS and restored the normal level of blood TG, which provided more evidence about the benefit of young fecal transplant to improve the health of the aged individuals. In the aged livers transplanted with young feces, mitochondrial beta-oxidation of fatty acids was consistently activated. Overall, the present study verified the efficacy of young fecal transplantation to mitigate the metabolic disorders resulting from aging and an environmental pollutant.				1				C	B		D1231, D1232, D1235, D1236, D1237, D1239, D1240と同じ体裁，研究内容で，測定するパラメーターだけ変えている。内容的にはD1231, D1235と同様の問題がある。
D1245	実験動物（内分泌）	Ishibashi, H; Yamauchi, R; Matsuoka, M; Kim, JW; Hirano, M; Yamaguchi, A; Tominaga, N; Arizono, K	Fluorotelomer alcohols induce hepatic vitellogenin through activation of the estrogen receptor in male medaka (Oryzias latipes)	2008	Chemosphere. 2008 May:71(10):1853-1859. doi: 10.1016/j.chemosphere.2008.01.065.	Here we report on the in vivo estrogenic effects of two fluorotelomer alcohols, such as 1H,1H,2H,2H-perfluorodecan-1-ol (6:2 FTOH) and 1H,1H,2H,2H-perfluorodecan-1-ol (8:2 FTOH), in male medaka (Oryzias latipes). An in vitro yeast two-hybrid assay indicated a significant, dose-dependent interaction between medaka estrogen receptor alpha (ER alpha) and coactivator TIF2 upon treatment with 6:2 FTOH, 8:2 FTOH or 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-nonadecafluoro-1-decanol (NFDH). The relative ranks of tested chemicals on the estrogenic effects for medaka ER alpha descended in the order of estradiol-17 beta (100) >> 6:2 FTOH (0.16) > NFDH (0.016) > 8:2 FTOH (0.0044). In contrast, no interaction with the ER alpha was observed upon treatment with perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorododecanoic acid (PFDA) or perfluoroundecanoic acid (PFUnDA). Expression analysis of hepatic vitellogenin (VTG) protein showed estrogenic potentials with, 6:2 FTOH and 8:2 FTOH, indicative of the induction of VTG synthesis in the livers of male medaka. We also investigated mRNA expression levels of two ER subtypes (ER alpha and beta) and two VTGs (VTG I and VTG II) in the livers of male medaka following exposure to FTOHs. Quantitative real-time polymerase chain reaction analyses revealed that hepatic ER alpha, VTG I, and VTG II mRNA responded rapidly to FTOHs such as 6:2 FTOH and 8:2 FTOH after 8-h exposure, whereas no effects of these compounds on ERP mRNA transcription were observed. These results from both in vitro and in vivo assays strongly suggest that certain FTOHs, such as 6:2 FTOH and 8:2 FTOH, induce hepatic VTG through activation of ER alpha in male medaka.			1					C	C		研究の主目的はFTOHのエストロゲン作用で，PFNAは用いてはいるが詳細な解析は行われていない。
D1246	実験動物（代謝）	Sun, BL; Liu, MY; Tang, LZ; Zhou, XZ; Hu, CY; Chen, LG	Variability in fecal metabolome depending on age, PFBS pollutant, and fecal transplantation in zebrafish: A non-invasive diagnosis of health	2023	J. Environ. Sci. 2023 May:127:530-540. doi: 10.1016/j.jes.2022.06.019	To protect the wellbeing of research animals, certain non-invasive measures are in increas-ing need to facilitate an early diagnosis of health and toxicity. In this study, feces speci-men was collected from adult zebrafish to profile the metabolome fingerprint. Variability in fecal metabolite composition was also distinguished as a result of aging, perfluorobu-tanesulfonate (PFBS) toxicant, and fecal transplantation. The results showed that zebrafish feces was very rich in a diversity of metabolites that belonged to several major classes, in-cluding lipid, amino acid, carbohydrate, vitamin, steroid hormone, and neurotransmitter. Fecal metabolites had functional implications to multiple physiological activities, which were characterized by the enrichment of digestion, absorption, endocrine, and neurotrans-mission processes. The high richness and functional involvement of fecal metabolites pin-pointed feces as an abundant source of diagnostic markers. By comparison between young and aged zebrafish, fundamental modifications of fecal metabolomes were caused by aging progression, centering on the neuroactive ligand-receptor interaction pathway. Exposure of aged zebrafish to PFBS pollutant also significantly disrupted the metabolomic structure in feces. Of special concern were the changes in fecal hormone intermediates after PFBS expo-sure, which was concordant with the in vivo endocrine disrupting effects of PFBS. Further-more, it was intriguing that transplantation of young zebrafish feces efficiently mitigated the metabolic perturbation of PFBS in aged recipients, highlighting the health benefits of ther-apeutic strategies based on gut microbiota manipulation. In summary, the present study provides preliminary clues to evidence the non-invasive advantage of fecal metabolomics in the early diagnosis and prediction of physiology and toxicology.					1			C	B		D1231, D1232, D1235, D1236, D1237, D1239, D1240と同じ体裁，研究内容で，測定するパラメーターだけ変えている。内容的にはD1231, D1235と同様の問題がある。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1247	実験動物（内分泌）	Horie, Y; Nomura, M; Okamoto, K; Takahashi, C; Sato, T; Miyagawa, S; Okamura, H; Iguchi, T	Effect of thyroid hormone-disrupting chemicals on swim bladder inflation and thyroid hormone-related gene expression in Japanese medaka and zebrafish	2022	J. Appl. Toxicol. 2022 Aug:42(8):1385-1395. doi: 10.1002/jat.4302.	We compared the influence of thyroid hormone-disrupting chemicals (heptafluorobutanoic acid, PFBA and tris[1,3-dichloro-2-propyl] phosphate, TDCPP) and thyroid hormone (3,3',5-triiodo-L-thyronine, T3) on swim bladder inflation and thyroid hormone-related gene expression in Japanese medaka and zebrafish. The swim bladder of most larvae had inflated at 4 h post hatching (hph) in Japanese medaka and at 48 hph in zebrafish in controls. In both fish species, the swim bladder inflation was inhibited in larvae exposed to PFBA (lowest observed effect concentration [LOEC] in medaka: 40 mg/L; in zebrafish: 80 mg/L), TDCPP (LOEC in medaka: 1 mg/L; in zebrafish: 0.5 mg/L), and T3 (no inhibition in Japanese medaka; LOEC in zebrafish: 7.5 mu g/L). We also examined the influence of PFBA, TDCPP, and T3 on the expression of thyroid stimulating hormone subunit beta (tsh beta) or thyroid hormone receptor alpha (tr alpha) and beta (tr beta). No changes were observed in the expression of genes after PFBA and TDCPP exposure; however, T3 exposure upregulated tr alpha and tr beta expression in both fish species. When the results were compared between Japanese medaka and zebrafish, swim bladder inflation in both species was found to be inhibited by exposure to thyroid hormone-disrupting chemicals. Our results show that inhibition of the swim bladder inflation at 4 hph in Japanese medaka and 48 hph in zebrafish is a potential indicator of thyroid hormone-disturbing activity of chemicals.	1							C	B		
D1248	実験動物（代謝）	Sun, WQ; Zhang, XM; Qiao, Y; Griffin, N; Zhang, HX; Wang, L; Liu, H	Exposure to PFOA and its novel analogs disrupts lipid metabolism in zebrafish	2023	Ecotox. Environ. Safe. 2023 Jul:259:115020. doi: 10.1016/j.ecoenv.2023.115020.	Perfluorooctanoic acid (PFOA), a typical perfluoroalkyl group compound, has received worldwide attention due to its significant environmental toxicity. Following regulatory bans on the production and emission of PFOA, concerns have been raised about the potential health risks and the safety of novel perfluoroalkyl analogues. HFPO-DA (trade name Gen-X) and HFPO-TA are two perfluoroalkyl analogues known to be bioaccumulative, whose level of toxicity and whether they are safe alternatives to PFOA remain unclear. In the following study, the physiological and metabolic effects of exposure to PFOA and its novel analogues were explored in zebrafish using 1/3 LC50 (PFOA 100 mu M, Gen-X 200 mu M, HFPO-TA 30 mu M). At the same LC50 toxicological effect, exposure to PFOA and HFPO-TA resulted in abnormal phenotypes such as spinal curvature, pericardial edema and aberrant body length, while Gen-X was little changed. Metabolically, PFOA, HFPO-TA and Gen-X all significantly increased total cholesterol in exposed zebrafish with PFOA and HFPO-TA also increasing total triglyceride levels. Transcriptome analysis showed that the number of differentially expressed genes in PFOA, Gen-X, and HFPO-TA treated conditions compared to control groups were 527, 572, and 3, 933, respectively. KEGG and GO analysis of differentially expressed genes revealed pathways and functions related to lipid metabolism as well as significant activation of the peroxisome proliferators-activated receptor (PPARs) pathway. Furthermore, RT-qPCR analysis identified significant dysregulation in the downstream target genes of PPAR alpha, which is responsible for lipid oxidative catabolism, and the SREBP pathway, which is responsible for lipid synthesis. In conclusion, both perfluoroalkyl analogues HFPO-TA and Gen-X exhibit significant physiological and metabolic toxicity to aquatic organisms and their environmental accumulation should be closely regulated.					1			C	B	ゼブラフィッシュを用いた生態毒性評価。Gen-XとHFPO-TAによる代謝異常を示唆。	試験対象物質の影響は十分確認できていない。
D1249	実験動物（代謝）	Kudo, N; Kawashima, Y	Induction of triglyceride accumulation in the liver 4 rats by perfluorinated fatty acids with different carbon chain lengths: Comparison with induction of peroxisomal beta-oxidation	2003	Biol. Pharm. Bull. 2003 Jan:26(1):47-51. doi: 10.1248/bpb.26.47.	The potency to accumulate triglyceride (TG) was compared between perfluorinated fatty acids (PFCAs) with different carbon chain lengths in the liver of male and female rats and induction of peroxisomal beta-oxidation. In male rats, either perfluoroheptanoic acid (C7) or perfluorooctanoic acid (C8) had no effect, although perfluorononanoic acid (C9) and perfluorodecanoic acid (ClO) markedly accumulated TG. In female rats, C7, C8, and C9 did not cause TG accumulation, whereas ClO caused TG accumulation at the same level as in male rats. TG accumulation induced by C9 was regulated by the level of testosterone in male rats. In contrast with TG accumulation, peroxisomal beta-oxidation was induced by C8, C9, and C10 in male rats and by C9 and C10 in female rats. Only a slight difference was observed in the induction by C9 between male and female rats. The induction of TG accumulation by these PFCAs occurred in a dose-dependent manner and significantly correlated with hepatic concentrations of PFCA regardless of their carbon chain length, as was observed with induction of peroxisomal beta-oxidation. There is, however, a striking difference in the hepatic concentration of PFCA required to cause induction of TG accumulation and that of peroxisomal beta-oxidation. The concentration of PFCA required to induce TG accumulation is much higher than that to induce peroxisomal beta-oxidation. These results strongly suggest that TG accumulation induced by PFCAs, as well as the induction of peroxisomal beta-oxidation, is dependent only on the number of PFCA molecules in hepatocytes, but is not due to the difference in their chemical structures, and that there is a marked difference in the PFCA threshold to cause distinct biological effects.								B	D	炭素鎖長の異なるPFCAsによるラット肝臓TG蓄積を比較（PFNA他PFHpA、PFOA、PFDA対象）。要旨からは曝露条件は不明なためB（参考） or D。	フッ素化脂肪酸が該当する物質なのか同定できなかった。
D1250	鳥類（内分泌）	Tartu, S; Gabrielsen, GW; Blevin, P; Ellis, H; Bustnes, JO; Herzke, D; Chastel, O	Endocrine and Fitness Correlates of Long-Chain Perfluorinated Carboxylates Exposure in Arctic Breeding Black-Legged Kittiwakes	2014	Environ. Sci. Technol. 2014 Nov:48(22):13504-13510. doi: 10.1021/es503297n.	Increasing levels of poly- and perfluorinated alkyl substances (PFASs) have recently been described in Arctic biota. These emerging substances are Of concern given their resistance to. degradation and metabolization. Some studies have reported endocrine disrupting effects for some PFASs. However, there is a gap of knowledge on the potential relationships between PFASs and hormones mediating the life-history trade-off between reproduction and survival, such as glucocorticoids. The aims of this study were to (1) describe the concentration of plasma perfluoroalkyl sulfonates and perfluoroalkyl carboxylates in Svalbard black-legged kittiwakes (Rissa tridactyla) in relation to gender and body-condition, (2) explore the relationships between PFASs and corticosterone (the major glucocorticoid in birds), and (3) assess the consequences of PFAS exposure for reproductive success. Perfluorononanoate, was positively related to body-condition male kittiwakes; perfluorotridecanoate and perfluorotetradecanoate to decreased, baseline corticosterone in both sexes; and perfluorododecanoate was related to lower hatching success These results underline the importance of considering each compound separately when investigating the hazardous effects of PFASs on wildlife.			1					C	D	鳥類を対象としたPFAS曝露レベルとホルモンレベルとの関連性等の調査	ミツユビカモメは環境化学物質の内分泌撹乱作用を同定するきっかけとなった動物ではあるが，結果を一般化できるのかは不明。
D1251	実験動物（内分泌）	Chen, PY; Yang, J; Chen, G; Yi, SJ; Liu, ML; Zhu, LY	Thyroid-Disrupting Effects of 6:2 and 8:2 Polyfluoroalkyl Phosphate Diester (diPAPs) at Environmentally Relevant Concentrations from Integrated In Silico and In Vivo Studies	2020	Environ. Sci. Technol. Lett. 2020 May:7(5):330-336. doi: 10.1021/acs.estlett.0c00191.	Polyfluoroalkyl phosphate esters (PAPs), a kind of poly/perfluoroalkyl substance, are used in food contact materials. Herein, a three-dimensional quantitative structure-activity relationship (3D-QSAR) model was developed and applied to predict the binding affinity of 6:2 and 8:2 polyfluoroalkyl phosphate diesters (diPAPs) with transthyretin (ttr) to potentially displace thyroid hormones. The predicted activity of 6:2 diPAP was higher than that of 8:2 diPAP, and both were comparable to that of perfluorobutanesulfonate, suggesting their potential endocrine disrupting effects. For verification, zebrafish embryos were incubated with 6:2 and 8:2 diPAPs at 0.5-50 ng/L for 7 days. Both diPAPs reduced total and free thyroxine (T4) and triiodothyronine (T3) levels but elevated deiodinases levels, suggesting inhibited synthesis and increased metabolism of thyroid hormones. Consistent with the results of 3D-QSAR, the efficacy of 6:2 diPAP was generally higher than that of 8:2 diPAP, which might be due to the higher binding affinities of 6:2 diPAP for thyroid hormone receptor (TR) beta and TTR, predicted by molecular docking. For both diPAPs, the decreased thyroid hormones weakened the activation of TR alpha, thus significantly reducing the TR alpha level in the intestine. The integrated results provide strong evidence of thyroid toxicities of 6:2 and 8:2 diPAPs.				1				D	D	比較としてPFBSのデータを含むかもしれないが、要旨から本評価に活用可能か判断できない。	6:2及び8:2 diPAPの影響の解析の論文で，試験対象物質のPFBSについては見当たりませんが？
D1252	実験動物（免疫毒性）	Rushing BR, Hu Q, Franklin JN, McMahen R, Dagnino S, Higgins CP, Strynar MJ, DeWitt JC.	Evaluation of the immunomodulatory effects of 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate in C57BL/6 mice	2017	Toxicol Sci. 2017 Jan 23:kfw251. doi: 10.1093/toxsci/kfw251. Online ahead of print.	2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate was designed to replace perfluorooctanoic acid (PFOA), which has been mostly phased out of U.S. production due to environmental persistence, detectable human and wildlife serum concentrations, and reports of systemic toxicity. In rodent models, PFOA exposure suppresses T cell-dependent antibody responses (TDAR) and vaccine responses in exposed humans. To determine replacement compound effects on TDAR and related parameters, male and female C57BL/6 mice were gavaged with 0, 1, 10, or 100 mg/kg/day for 28 days. Mice immunized with antigen on day 24 were evaluated for TDAR and splenic lymphocyte subpopulations five days later. Serum and urine were collected for test compound concentrations and liver peroxisome proliferation was measured. Relative liver weight at 10 and 100 mg/kg and peroxisome proliferation at 100 mg/kg were increased in both sexes. TDAR was suppressed in females at 100 mg/kg. T lymphocyte numbers were increased in males at 100 mg/kg; B lymphocyte numbers were unchanged in both sexes. Females had less serum accumulation and higher clearance than males, and males had higher urine concentrations than females at all times and doses. While this PFOA-replacement compound appears less potent at suppressing TDAR relative to PFOA, it produces detectable changes in parameters affected by PFOA; further studies are necessary to determine its full immunomodulatory profile and potential synergism with other per- and polyfluoroalkyl substances of environmental concern.								A	D	C57BL/6マウス（雌雄）を用いたGenXの免疫毒性評価。3用量設定しているが高用量。1, 10, or 100 mg/kg/day、28日間経口曝露により、雌雄ともに10、100 mg/kgで相対肝臓重量、100 mg/kgでペルオキシソーム増殖が増加し、雌では100 mg/kgでTDAR が抑制、雄では100 mg/kgでTリンパ球数が増加。B or A候補。	試験対象物質は本論文には含まれないかと
D1253	実験動物（代謝）	Wang Y, Chen X, Wang B, Lu G, Liu J, Wu D, Yan Z.	Toxicity comparison of perfluorooctanoic acid (PFOA), hexafluoropropylene oxide dimer acid (HFPO-DA), and hexafluoropropylene oxide trimer acid (HFPO-TA) in zebrafish gut	2023	Aquat Toxicol. 2023 Aug 12;262:106655. doi: 10.1016/j.aquatox.2023.106655. Online ahead of print.	Hexafluoropropylene oxide dimer acid (HFPO-DA) and hexafluoropropylene oxide trimer acid (HFPO-TA) are considered as alternatives to perfluorooctanoic acid (PFOA). In this study, zebrafish were exposed to different concentrations of PFOA, HFPO-DA, and HFPO-TA (5 μg/L and 500 μg/L), and the toxic effects on oxidative damage, inflammation, and cell apoptosis in the gut were compared. Additionally, changes in gut metabolome profiles and microbial community structure were analyzed. The results revealed that exposures to HFPO-DA and HFPO-TA led to lower levels of oxidative damage compared to PFOA exposure. However, all three treatments had comparable effects on inflammation and apoptosis. The main biological pathways affected by all three exposures were lipid metabolism, nucleotide metabolism, amino acid metabolism, and environmental information processing. The effects on metabolome profiles were much higher for HFPO-DA and HFPO-TA compared to PFOA at a concentration of 5 μg/L. At a concentration of 500 μg/L, HFPO-DA and HFPO-TA showed similar effects to PFOA. This study also examined the Pearson correlations between gut microbiota and the toxic effects mentioned above. The abundance of specific apoptosis-related genera differed among the three target chemicals, suggesting they may act differently in inducing apoptosis. The correlations between HFPO-DA and HFPO-TA were mostly similar, which helps explain the similar effects observed in their respective treatment groups on metabolic profiles. Overall, this study indicates that HFPO-DA and HFPO-TA may not be safe alternatives to PFOA and provides valuable insights into their toxic effects and risk assessment in water environments.					1			C	B	ゼブラフィッシュを用いた生態毒性評価。HFPO-DA、HFPO-TAがPFOA と同様の毒性を有することを示唆。	酸化ストレスマーカーは曝露によりほとんど変化なし，サイトカインは一部変化，という結果で，それ以外の機能変化のパラメーターを解析していない。脂質代謝や細胞死に関係する遺伝子発現は測定されているが，実際に生じているかが測定されていないので，発現変化の意味づけがわからない。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1254	in vitro（生殖発生毒性）	Blake, BE; Rickard, BP; Fenton, SE	A High-Throughput Toxicity Screen of 42 Per- and Polyfluoroalkyl Substances (PFAS) and Functional Assessment of Migration and Gene Expression in Human Placental Trophoblast Cells	2022	Front. Toxicol. 2022 Apr:4:881347. doi: 10.3389/ftox.2022.881347.	Per- and polyfluoroalkyl substances (PFAS) have become ubiquitous environmental contaminants that have been associated with adverse pregnancy outcomes in women and experimental research models. Adverse developmental and reproductive outcomes have been investigated for relatively few PFAS, and such studies are not scalable to address the thousands of unique chemical structures. As the placenta has been reported as a PFAS target tissue, the human placental trophoblast JEG-3 cell line was employed in a high-throughput toxicity screen (HTTS) to evaluate the effects of 42 unique PFAS on viability, proliferation, and mitochondrial membrane potential (MMP). HTTS concentration-response curve fitting determined EC50 values for 79% of tested compounds for at least one of the three endpoints. Trophoblast migratory potential was evaluated for a subset of six prioritized PFAS using a scratch wound assay. Migration, measured as the percent of wound closure after 72 h, was most severely inhibited by exposure to 100 mu M perfluorooctanoic acid (PFOA; 72% closure), perfluorooctanesulfonic acid (PFOS; 57% closure), or ammonium perfluoro-2-methyl-3-oxahexanoate (GenX; 79% closure). PFOA and GenX were subsequently evaluated for disrupted expression of 46 genes reported to be vital to trophoblast health. Disrupted regulation of oxidative stress was suggested by altered expression of GPEX1 (300 mu M GenX and 3 mu M GenX), GPER1 (300 mu M GenX), and SOD1 and altered cellular response to xenobiotic stress was indicated by upregulation of the placental efflux transporter, ABCG2 (300 mu M GenX, 3 mu M GenX, and 100 mu M PFOA). These findings suggest the placenta is potentially a direct target of PFAS exposure and indicate that trophoblast cell gene expression and function are disrupted at PFAS levels well below the calculated cytotoxicity threshold (EC50). Future work is needed to determine the mechanism(s) of action of PFAS towards placental trophoblasts.					1			C	C		PFOA、PFOS、GenX の評価を行っているが、細胞株を持ちた in vitro 試験 であり、生殖発生毒性試験とは言えない。胎盤を標的とした毒性発現の機序解析の参考にはなるが、生殖発生毒性を total に評価する論文とはなり得ないと判断した。
D1255	in vitro（生殖発生毒性）	Bangma, J; Szilagyi, J; Blake, BE; Plazas, C; Kepper, S; Fenton, SE; Fry, RC	An assessment of serum-dependent impacts on intracellular accumulation and genomic response of per- and polyfluoroalkyl substances in a placental trophoblast model	2020	Environ. Toxicol. 2020 Dec:35(12):1395-1405. doi: 10.1002/tox.23004.	Per- and polyfluoroalkyl substances (PFAS), a class of environmental contaminants, have been detected in human placenta and cord blood. The mechanisms driving PFAS-induced effects on the placenta and adverse pregnancy outcomes are not well understood. This study investigated the impact of perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and a replacement PFAS known as hexafluoropropylene oxide dimer acid (HFPO-DA, tradename GenX) on placental trophoblasts in vitro. Several key factors were addressed. First, PFAS levels in cell culture reagents at baseline were quantified. Second, the role of supplemental media serum in intracellular accumulation of PFAS in a human trophoblast (JEG3) cell line was established. Finally, the impact of PFAS on the expression of 96 genes involved in proper placental function in JEG3 cells was evaluated. The results revealed that serum-free media (SFM) contained no detectable PFAS. In contrast, fetal bovine serum-supplemented media (SSM) contained PFNA, PFUdA, PFTrDA, and 6:2 FTS, but these PFAS were not detected internally in cells. Intracellular accumulation following 24 hr treatments was significantly higher when cultured in SFM compared to SSM for PFOS and PFOA, but not HFPO-DA. Treatment with PFAS was associated with gene expression changes (n = 32) in pathways vital to placental function, including viability, syncytialization, inflammation, transport, and invasion/mesenchymal transition. Among the most robust PFAS-associated changes were those observed in the known apoptosis-related genes,BADandBAX. These results suggest a complex relationship between PFAS, in vitro culture conditions, and altered expression of key genes necessary for proper placentation.					1			C	C		D1254 と同一グループによる同様の報告。 PFOS、PFOA、GenX の評価を行っているが、細胞株を持ちた in vitro 試験 であり、生殖発生毒性試験とは言えない。胎盤を標的とした毒性発現の機序解析の参考にはなるが、生殖発生毒性を total に評価する論文とはなり得ないと判断した。
D1256	生態毒性（生殖発生毒性スクリーニング）	Gong, HJ; Du, J; Xu, J; Yang, Y; Lu, H; Xiao, H	Perfluorononanoate and Perfluorobutane Sulfonate Induce Cardiotoxic Effects in Zebrafish	2022	Environ. Toxicol. Chem. 2022 Oct:41(10):2527-2536. doi: 10.1002/etc.5447.	Globally, per- and polyfluoroalkyl substances are common artificial ingredients in industrial and consumer products. Recently, they have been shown to be an emerging human health risk. Perfluorononanoic acid (PFNA)/perfluorononanoate and perfluorobutane sulfonic acid (PFBS)/perfluorobutane sulfonate cause reproductive toxicity and hepatotoxicity, disrupt thyroid functions, and damage embryonic development in zebrafish. However, the cardiotoxic effects of PFNA and PFBS have not been fully established. We found that PFNA and PFBS exposures repress hatchability while increasing malformation and mortality in zebrafish embryos. Hematoxylin and eosin staining as well as assessment of the transgenic zebrafish line Tg(myl7:nDsRed) revealed that exposure of embryos to PFNA increases the occurrence of severe cardiac malformations relative to exposure to PFBS. Moreover, we evaluated the differential expressions of cardiac development-associated genes in response to PFNA and PFBS, which validated the potential cardiotoxic effects, consistent with cardiac dysfunctions. Overall, our findings reveal novel cardiotoxic effects of PFNA and PFBS in zebrafish, implying that they may exert some cardiotoxic effect in humans. To the best of our knowledge, ours is the first study to show that PFNA exerts more severe cardiotoxic effects in zebrafish when compared with PFBS. Based on these findings, studies should evaluate the mechanisms of their cardiotoxic effects.					1			C	C		PFNA と PFBS のゼブラフィッシュを用いた試験。 おそらく引用文献に、両化合物の齧歯類（哺乳類？）を用いた生殖発生毒性試験があり、その生殖発生および、肝毒性・甲状腺への影響・心毒性の結果を受けての試験（特に心毒性の発生機序）。 引用文献に重要な情報がある可能性はあるが、この論文自体の有用性は低いと判断した。
D1257	in vitro（生殖発生毒性）	Davidsen, N; Rosenmai, AK; Lauschke, K; Svingen, T; Vinggaard, AM	Developmental effects of PFOS, PFOA and GenX in a 3D human induced pluripotent stem cell differentiation model	2021	Chemosphere. 2021 Sep:279:130624. doi: 10.1016/j.chemosphere.2021.130624.	Polyfluoroalkyl substances (PFASs), including perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), are persistent pollutants routinely found in human blood. PFASs have been associated with health issues such as decreased birth weight and impaired vaccination response in children. Substitutes to these PFASs, such as ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)propanoate (GenX) have been introduced, although hazard information is limited. Human induced pluripotent stem cell (hiPSC) based models are valuable for studying these compounds, as they mimic human embryonic development. We used our recently developed PluriBeat assay to investigate PFOS, PFOA and GenX for effects on early embryonic development in vitro. In our assay hiPSCs go through the early stages of embryonic development in 3D cultures of embryoid bodies (EBs) that mimic the human blastocyst until they finally form beating cardiomyocytes. Both PFOS and PFOA had a strong effect on cardiomyocyte differentiation at non-cytotoxic concentrations, with PFOS being more potent than PFOA. Moreover, both compounds decreased EB size at the highest test concentrations. GenX induced a weak concentration-dependent effect on differentiation of one hiPSC line, but not of another. Transcriptional analysis of mRNA from the cardiomyocytes showed that PFOS increased expression of the early cardiac marker ISL1, whereas PFOA decreased expression of the cardiomyocyte marker MYH7. This suggest that PFOS and PFOA perturb cardiomyocyte differentiation by disrupting molecular pathways similar to those taking place in the developing embryo. Based on these findings, we conclude that our PluriBeat assay has the potential to become a valuable, sensitive model system for elucidating embryotoxic effects of PFASs in future.					1			C	B		PFOS, PFOA, GenX の in vitro assay。 実験動物を用いた生殖発生毒非特異的試験ではないので、基本的には C 評価であるが、ヒト iPS を用いた新規 assay 系であるので、毒性発現の機序解析に参考になる可能性があるので、B 評価とした。
D1258	in vitro（生殖発生毒性）	Marchese, MJ; Li, SM; Liu, B; Zhang, JJ; Feng, LP	Perfluoroalkyl Substance Exposure and the BDNF Pathway in the Placental Trophoblast	2021	Front. Endocrinol. 2021 Jul:12:694885. doi: 10.3389/fendo.2021.694885.	Background: Per- and polyfluoroalkyl substances (PFAS) are persistent organic pollutants that have become globally ubiquitous in humans and the environment. In utero PFAS exposure is associated with neurodevelopmental effects; however, the mechanism is poorly understood. Brain-derived neurotrophic factor (BDNF) signaling is critical to fetal neurodevelopment during pregnancy and maintains important regulatory roles later in life. This study aims to characterize placental BDNF signaling and investigate whether PFAS exposure disrupts the signaling pathway in placental trophoblast cells. Methods: The expression and localization of BDNF receptors-p75(NTR) and TrkB-in first trimester and term human placentas and trophoblast cells were investigated by immunofluorescence staining. To assess the effects of PFAS exposure on the BDNF pathway, BeWo cells were treated with PFAS mixtures that mimicked blood levels in a highly exposed population and major PFAS compounds in the mixture at 0.01, 0.1, 1, and 10 mu M concentrations. Changes in pro-BDNF levels and phosphorylation of TrkB receptors were examined by Western blot. Results: In first trimester human placentas, TrkB and p75(NTR) receptors were primarily localized to syncytiotrophoblast and cytotrophoblast cells. At term, TrkB and p75(NTR) receptors were primarily observed in the placental villous stroma. TrkB receptor staining in trophoblasts was reduced at term, while p75(NTR) receptor staining was negative. TrkB receptors were confined to the nuclear and perinuclear spaces, and phosphorylation occurred at the Tyr816 residue in BeWo cells. Exposure to PFOS, PFOA, PFBS, and the six-PFAS mixture did not significantly affect BDNF levels or activation (phosphorylation) of TrkB. Treating cells with 1 mu M and 10 mu M of PFNA resulted in increased TrkB phosphorylation compared to unexposed controls, but BDNF levels were unchanged. Conclusions: BDNF receptors are present in different regions of human placental villi, indicating diverse functions of BDNF signaling in placental development. Our findings suggest that the BDNF pathway in placental trophoblast cells is not disrupted by exposures to PFOS, PFOA, PFBS, and a PFAS mixture, but may be affected by PFNA exposures. Further investigation is needed on how PFAS affects other critical signaling pathways during fetal neurodevelopment.					1			C	C		混合 PFAS をヒト胎盤絨毛（癌）細胞 BeWo cells に暴露して、Brain-derived neurotrophic factor (BDNF) signaling を検討した論文。生殖発生毒性試験とは言えない（毒性機序解析？）。
D1259	in vitro（生殖発生毒性）	Szilagyi, JT; Freedman, AN; Kepper, SL; Keshava, AM; Bangma, JT; Fry, RC	Per- and Polyfluoroalkyl Substances Differentially Inhibit Placental Trophoblast Migration and Invasion In Vitro	2020	Toxicol. Sci. 2020 Jun:175(2):210-219. doi: 10.1093/toxsci/kfaa043.	Per- and polyfluoroalkyl substances (PFAS) are used as industrial surfactants and chemical coatings for household goods such as Teflon. Despite regulatory efforts to phase out legacy PFAS, they remain detectable in drinking water throughout the United States. This is due to the stability of legacy PFAS and the continued use of replacement compounds. In humans, PFAS have been detected in placenta and cord blood and are associated with low birth weight and preeclampsia risk. Preeclampsia is a leading cause of maternal mortality and is driven by insufficient endometrial trophoblast invasion, resulting in poor placental blood flow. PFAS alter invasion of other cell types, but their impact on trophoblasts is not understood. We therefore assessed the effects of PFAS on trophoblast migration, invasion, and gene expression in vitro. Trophoblast migration and invasion were assessed using a modified scratch assay in the absence or presence of Matrigel, respectively. Treatment with perfluorooctanoic sulfate (PFOS), perfluorooctanoic acid (PFOA), and GenX (1000 ng/ml) each decreased trophoblast migration over 24 h. However, only GenX (1000 ng/ml) significantly inhibited trophoblast invasion. Treatment with PFOS, PFOA, and GenX also decreased trophoblast expression of chemokines (eg, CCL2), chemokine receptors (eg, CCR4), and inflammatory enzymes (eg, ALOX15) involved in migration. Inhibition of chemokine receptors with pertussis toxin (10 ng/ml), a G-protein inhibitor, inhibited trophoblast migration similar to the PFAS. Taken together, PFAS decrease trophoblast migration, invasion, and inflammatory signaling. By understanding the mechanisms involved, it may be possible to identify the biological and exposure factors that contribute to preeclampsia.					1			C	C		PFOS, PFOA, GenX の in vitro assay。 実験動物を用いた生殖発生毒非特異的試験ではない。機序解析にしても不要。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1260	in vitro（生殖発生毒性）	Pham, A; Zhang, J; Feng, LP	Exposure to perfluorobutane sulfonate and perfluorooctanesulfonic acid disrupts the production of angiogenesis factors and stress responses in human placental syncytiotrophoblast	2020	Reprod. Toxicol. 2020 Dec:98:269-277. doi: 10.1016/j.reprotox.2020.10.013	Poly- and per-fluoroalkyl substances (PFAS) have attracted widespread attention in recent years due to their bioaccumulation, toxicity, and ubiquitous nature. We and others have reported that maternal exposure to PFAS is associated with adverse birth outcomes due to altered placental functions. In this study, we investigated the effects of two major PFAS compounds, perfluorobutane sulfonate (PFBS) and perfluorooctanesulfonic acid (PFOS), on the regulation of the production of angiogenic factors and stress response in placental multinucleated syncytial BeWo cells using qRT-PCR and ELISA. Using this in vitro model, we showed that 1) PFOS or PFBS treatment did not seem to interrupt BeWo cell fusion through syncytins; 2) Exposure to PFOS at 10 mu M decreased a potent angiogenic factor PlGF gene expression, which is implicated in preeclampsia; 3) Exposure to either PFOS or PFBS significantly decreased the production of CGB7 and hCG except hCG secretion in PFOS (10 nM) and PFBS (100 nM) treatment groups; 4) Exposure to PFOS (10 mu M) increased the gene expression of the stress response molecules CRH while neither PFOS nor PFBS treatment affected a stress mitigation factor 11 beta-HSD2 expression. Our results demonstrate that exposure to PFOS or PFBS impacts several key pathways involved in placental cell functions. PFOS seems more potent than PFBS. These novel findings provide a potential explanation for the adverse reproductive complications associated with prenatal exposure to PFOS or PFBS, including preeclampsia and contribute to our knowledge of the reproductive toxicity of PFAS, specifically PFOS and PFBS.				1				C	C		D1258 と同グループによる、同様の試験。こちらは混合物ではなく、PFOS, PFOA, GenX をそれぞれ単独で、ヒト胎盤絨毛（癌）細胞 BeWo cells に暴露して、ストレス応答因子の変化を見ているが、生殖発生毒非特異的試験ではないし、機序解析にしても不要。
D1261	生態毒性（生殖発生毒性スクリーニング）	Jantzen, CE; Annunziato, KM; Cooper, KR	Behavioral, morphometric, and gene expression effects in adult zebrafish (Danio rerio) embryonically exposed to PFOA, PFOS, and PFNA	2016	Aquat. Toxicol. 2016 Nov:180:123-130. doi: 10.1016/j.aquatox.2016.09.011	Perfluoroalkylated substances (PFAS) are a class of persistent anthropogenic chemicals that have been detected worldwide. PFASs consist of fluorinated carbon chains of varying length, terminal groups, and have a number of industrial uses. A previous zebrafish study from our laboratory showed that acute (3-120 h post fertilization, 0.02-2.0 mu M), waterborne embryonic exposure to these chemicals resulted in chemical specific alterations at 5 days post fertilization (dpf), and some effects persisted up to 14 dpf. Using a gene battery consisting of 100 transcripts identified several genes that were up or down regulated. This current study looks at the long-term impacts of PFASs in adult zebrafish using the same exposure regimen. It was hypothesized that sub-lethal exposure of perfluorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA), or perfluorooctane sulfonate (PFOA) in embryonic zebrafish (3-120 hpf) would result in permanent morphometric, gene expression, and behavioral changes in adult fish similar to those observed at 5 and 14 dpf. Zebrafish were exposed to PFOS, PFOA, and PFNA (Control 0 mu M, 2.0 mu M) for the first five days post fertilization. At six months post fertilization, no PFAS treatment resulted in a significant change in total body length or weight. In terms of behavior, PFNA males showed a reduction in total distance traveled and time of immobility, and an increase in thigmotaxis behavior, aggressive attacks, and preference for the bright section of the tank. PFOS treated males had a reduced aggression behavior, and PFOA females preferred the dark section of the tank. Gene expression of slco2b1, slco1d1, and tgfb1a were analyzed because these transcripts were previously found to be affected by PFAS exposure in 5dpf and 14 dpf zebrafish and resulted in: significant decrease in expression of slco2b1 for both sexes in PFNA and PFOS treated groups, significant decrease of slco1d1 in all treatment groups for females and PFOS and PFOA exposed males, significant increase of tgfb1a in males treated with PFOS and PFNA, and a significant increase of bdnf in all PFAS male groups. This study demonstrates that acute, embryonic exposure (5 days) to individual PFASs result in significant biochemical and behavioral changes in young adult zebrafish 6 months after exposure. These three PFASs have long term and persistent impacts following short term embryonic exposure that persists into adulthood.								C	C		PFOS、PFOA、PFNA のゼブラフィッシュを用いた試験。ヒトへの影響を推測するには著しく不適。
D1262	in vitro（生殖発生毒性）	Steves, AN; Turry, A; Gill, B; Clarkson-Townsend, D; Bradner, JM; Bachli, I; Caudle, WM; Miller, GW; Chan, AWS; Easley, CA	Per- and polyfluoroalkyl substances impact human spermatogenesis in a stem-cell-derived mode	2018	Syst. Biol. Reprod. Med. 2018 :64(4):225-239. doi: 10.1080/19396368.2018.1481465	Per- and polyfluoroalkyl substances (PFASs) represent a highly ubiquitous group of synthetic chemicals used in products ranging from water and oil repellents and lubricants to firefighting foam. These substances can enter and accumulate in multiple tissue matrices in up to 100% of people assessed. Though animal models strongly identify these compounds as male reproductive toxicants, with exposed rodents experiencing declines in sperm count, alterations in hormones, and DNA damage in spermatids, among other adverse outcomes, human studies report conflicting conclusions as to the reproductive toxicity of these chemicals. Using an innovative, human stem-cell-based model of spermatogenesis, we assessed the effects of the PFASs perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and a mixture of PFOS, PFOA, and PFNA for their impacts on human spermatogenesis in vitro under conditions relevant to the general and occupationally exposed populations. Here, we show that PFOS, PFOA, PFNA, and a mixture of PFOS, PFOA, and PFNA do not decrease in vitro germ cell viability, consistent with reports from human studies. These compounds do not affect mitochondrial membrane potential or increase reactive oxygen species generation, and they do not decrease cell viability of spermatogonia, primary spermatocytes, secondary spermatocytes, or spermatids in vitro under the conditions examined. However, exposure to PFOS, PFOA, and PFNA reduces expression of markers for spermatogonia and primary spermatocytes. While not having direct effects on germ cell viability, these effects suggest the potential for long-term impacts on male fertility through the exhaustion of the spermatogonial stem cell pool and abnormalities in primary spermatocytes.			1					C	C		PFOS、PFOA、PFNAの混合物のヒト幹細胞生精子形成モデルを用いた in vitro 試験。動物実験の結果を受けた機序解析試験であるので、Ref に動物を用いた生殖ノルキサシン試験があれば、そちらが重要。 しかしながら、ヒトと実験動物では機序が違うようであるので、ヒト幹細胞を用いる系は、機序解析に有用であるのかもしれない。
D1263	生態毒性（生殖発生毒性スクリーニング）	Feng, ZY; McLamb, F; Vu, JP; Gong, SY; Gersberg, RM; Bozinovic, G	Physiological and transcriptomic effects of hexafluoropropylene oxide dimer acid in Caenorhabditis elegans during development	2022	Ecotox. Environ. Safe. 2022 Oct:244:114047. doi: 10.1016/j.ecoenv.2022.114047.	Per-and polyfluoroalkyl substances (PFAS) are chemicals resistant to degradation. While such a feature is desirable in consumer and industrial products, some PFAS, including perfluorooctanoic acid (PFOA), are toxic and bioaccumulate. Hexafluoropropylene oxide dimer acid (HFPO-DA), an emerging PFAS developed to replace PFOA, has not been extensively studied. To evaluate the potential toxicity of HFPO-DA with a cost-and time -efficient approach, we exposed C. elegans larvae for 48 h to 4 x 10-9-4 g/L HFPO-DA in liquid media and measured developmental, behavioral, locomotor, and transcriptional effects at various exposure levels. Worms exposed to 1.5-4 g/L HFPO-DA were developmentally delayed, and progeny production was significantly delayed ($p < 0.05$) in worms exposed to 2-4 g/L HFPO-DA. Statistically significant differential gene expression was identified in all fourteen HFPO-DA exposure groups ranging from 1.25 x 10-5 to 4 g/L, except for 6.25 x 10-5 g/L. Among 10298 analyzed genes, 2624 differentially expressed genes (DEGs) were identified in the develop-mentally delayed 4 g/L group only, and 78 genes were differentially expressed in at least one of the thirteen groups testing 1.25 x 10-5-2 g/L HFPO-DA exposures. Genes encoding for detoxification enzymes including cytochrome P450 and UDP glucuronosyltransferases were upregulated in 0.25-4 g/L acute exposure groups. DEGs were also identified in lower exposure level groups, though they did not share biological functions except for six ribosomal protein-coding genes. While our transcriptional data is inconclusive to infer mechanisms of toxicity, the significant gene expression differences at 1.25 x 10-5 g/L, the lowest concentration tested for transcriptional changes, calls for further targeted analyses of low-dose HFPO-DA exposure effects.					1			C	C		HFPO-DA（ヘキサフルオロプロピレンオキシド二量体酸）の毒性を検討した数少ない試験なのかもしれないが、対象生物が線虫（C. elegans）なので、評価に使用する価値は低いと判断した。
D1264	生態毒性（生殖発生毒性スクリーニング）	Liu, M; Yin, HW; Chen, XQ; Tian, YJ; Jiang, C; Yang, F; Yang, J; Zhang, JJ	Ecotoxicity evaluation of PFBSK for the whole environmental compartments and comprehensive comparison of hazard and risk to PFOS	2017	Hum. Ecol. Risk Assess. 2017;23(8):2150-2164. doi: 10.1080/10807039.2017.1369864.	A series of perfluorobutane sulfonate (PFBS)-related substances are produced as the alternatives to corresponding perfluorooctane sulfonate (PFOS). However, there is little reliable information about PFBS available for the whole ecotoxicology compartments. At present, its ecotoxicity of perfluorobutane sulfonate potassium (PFBSK) was selected as a typical PFBS chemical to investigate and evaluate its aquatic, terrestrial, microorganism and sediment toxicity according to the Organization for Economic Cooperation and Development (OECD) guideline under the framework of the REACH regulation. Meanwhile, the ecotoxicology hazard and risk for PFBSK and PFOS were compared comprehensively. PFBSK did not show acute and chronic aquatic, microorganisms and terrestrial animal toxicity, while exhibited some terrestrial plants toxicity. The ecotoxicology of PFBSK decreased sharply except for terrestrial plants compared with PFOS. Especially, for acute and chronic aquatic ecotoxicity, PFBSK is lower than 100 times those of PFOS. Although the similar terrestrial plants toxicity level was observed for PFBSK and PFOS, the lower risk of PFBSK was deduced for the reason that there was far less chances to be exposed and retained in the soil and sediment for its high water solubility and low adsorption. In conclusion, PFBSK showed lower ecotoxicity hazard and risk than those of PFOS. PFBSK could be an environmental friendly alternative to PFOS.					1			C	C		対象生物が今回の評価に不適と判断した。
D1265	in vitro（生殖発生毒性）	Jiao, XF; Liu, N; Xu, YD; Qiao, HY	Perfluorononanoic acid impedes mouse oocyte maturation by inducing mitochondrial dysfunction and oxidative stress	2021	Reprod. Toxicol. 2021 Sep:104:58-67. doi: 10.1016/j.reprotox.2021.07.002	Perfluorononanoic acid (PFNA), a member of PFAS, is frequently detected in human blood and tissues, even in follicular fluid of women. The exposure of PFNA, but not PFOA and PFOS, is positively correlated with miscarriage and increased time to pregnancy. Toxicological studies indicated that PFNA exposure is associated with immunotoxicity, hepatotoxicity, developmental toxicity, and reproductive toxicity in animals. However, there is little information regarding the toxic effects of PFNA on oocyte maturation. In this study, we investigated the toxic effects of PFNA exposure on mouse oocyte maturation in vitro. Our results showed that 600 mu M PFNA significantly inhibited germinal vesicle breakdown (GVBD) and polar body extrusion (PBE) in mouse oocytes. Our further study revealed that PFNA induced abnormal metaphase I (MI) spindle assembly, evidenced by malformed spindles and mislocalization of p-ERK1/2 in PFNA-treated oocytes. We also found that PFNA induced abnormal mitochondrial distribution and increased mitochondrial membrane potential. Consequently, PFNA increased reactive oxygen species (ROS) levels, leading to oxidative stress, DNA damage, and eventually earlystage apoptosis in oocytes. In addition, after 14 h culture, PFNA disrupted the formation of metaphase II (MII) spindle in most PFNA-treated oocytes with polar bodies. Collectively, our results indicate that PFNA interferes with oocyte maturation in vitro via disrupting spindle assembly, damaging mitochondrial functions, and inducing oxidative stress, DNA damage, and early-stage apoptosis.			1					C	C		PFNA をマウス卵母細胞に暴露した in vitro 試験。参考文献に発生毒性、生殖毒性を示した動物実験があるようであるが、この研究自体は in vitro での卵母細胞への毒性の機序解析である。Ref には重要な論文があるのかもしれない。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1266	in vitro（生殖発生毒性）	Ye, LP; Zhao, BH; Cai, XH; Chu, YH; Li, CC; Ge, RS	The inhibitory effects of perfluoroalkyl substances on human and rat 11 beta-hydroxysteroid dehydrogenase 1	2012	Chem.-Biol. Interact. 2012 Jan:195(2):114-118. doi: 10.1016/j.cbi.2011.11.007.	Perfluoroalkyl substances (PFASs) are man-made polyfluorinated compounds that are widely used and persistent in the environment. PFASs have potential effects on many biological systems including the development of lung. Glucocorticoids have been reported to promote fetal and neonatal lung development at the late stage, and 11 beta-hydroxysteroid dehydrogenase 1(11 beta HSD1) in the lung is critical for the generation of local active glucocorticoid cortisol (human) or corticosterone (rodents) from biologically inert 11keto-steroids. The purpose of the present study is to study the direct inhibitory effects of PFASs on 11 beta HSD1 activities and action modes. Microsomal 11 beta HSD1 was subjected to the exposure to various PFASs, including perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), potassium perfluorohexanesulfonate (PFHxS) and potassium perfluorobutane sulfonate (PFBS). PFOS and PFOA inhibited neonatal rat lung 11 beta HSD1 activity with IC(50)s of 3.45 mu M (95% Confidence Intervals, CI95: 1.97-6.37 mu M) and 45.31 mu M (CI95: 27.64-74.26 mu M), respectively, while PFHxS and PFBS did not inhibit the enzyme activity at 250 mu M. PFOS and PFOA inhibited human 11 beta HSD1 activity with IC(50)s of 7.56 mu M (CI95: 2.86-19.97 mu M) and 37.61 mu M (CI95: 24.49-57.75 mu M), respectively, while PFHxS and PFBS did not inhibit the enzyme activity at 250 mu M. PFASs showed competitive inhibition on both human and rat 11 beta HSD1. In conclusion, the present study shows that PFOS and PFOA are the inhibitors of 11 beta HSD1.				1					C	C		PFOS、PFOA、PFHxS、PFBS の直接的酵素阻害実験。生化学的実験であり、生殖発生毒性試験ではない。あまりにも毒性発現の焦点を絞りすぎていて参考にならない。
D1267	in vitro（生殖発生毒性）	Feng, JN; Soto-Moreno, EJ; Prakash, A; Balboula, AZ; Qiao, HY	Adverse PFAS effects on mouse oocyte in vitro maturation are associated with carbon-chain length and inclusion of a sulfonate group	2023	Cell Prolif. 2023 FEB;56(2):. doi: 10.1111/cpr.13353.	Objectives Per- and polyfluoroalkyl substances (PFAS) are man-made chemicals that are widely used in various products. PFAS are characterized by their fluorinated carbon chains that make them hard to degrade and bioaccumulate in human and animals. Toxicological studies have shown PFAS toxic effects: cytotoxicity, immunotoxicity, neurotoxicity, and reproductive toxicity. However, it is still unclear how the structures of PFAS, such as carbon-chain length and functional groups, determine their reproductive toxicity. Methods and Results By using a mouse-oocyte-in-vitro-maturation (IVM) system, we found the toxicity of two major categories of PFAS, perfluoroalkyl carboxylic acid (PFCA) and perfluoroalkyl sulfonic acid (PFSA), is elevated with increasing carbon-chain length and the inclusion of the sulfonate group. Specifically, at 600 mu M, perfluorohexanesulfonic acid (PFHxS) and perfluorooctanesulfonic acid (PFOS) reduced the rates of both germinal-vesicle breakdown (GVBD) and polar-body extrusion (PBE) as well as enlarged polar bodies. However, the shorter PFSA, perfluorobutanesulfonic acid (PFBS), and all PFCA did not show similar adverse cytotoxicity. Further, we found that 600 mu M PFHxS and PFOS exposure induced excess reactive oxygen species (ROS) and decreased mitochondrial membrane potential (MMP). Cytoskeleton analysis revealed that PFHxS and PFOS exposure induced chromosome misalignment, abnormal F-actin organization, elongated spindle formation, and symmetric division in the treated oocytes. These meiotic defects compromised oocyte developmental competence after parthenogenetic activation. Conclusions Our study provides new information on the structure-toxicity relationship of PFAS.				1					C	C		マウス卵母細胞にPFCA、PFSA、PFHxS、PFOS を暴露した in vitro 実験。構造活性相関を考える上では必要なのかもしれないが、生殖毒性試験としての有用性は低いと判断した。
D1268	in vitro（生殖発生毒性）	Hallberg, I; Kjellgren, J; Persson, S; Orn, S; Sjunnesson, Y	Perfluorononanoic acid (PFNA) alters lipid accumulation in bovine blastocysts after oocyte exposure during in vitro maturation	2019	Reprod. Toxicol. 2019 Mar:84:1-8. doi: 10.1016/j.reprotox.2018.11.005	Perfluorononanoic acid (PFNA) is one of the perfluoroalkyl acids present in human tissues. In this study, effects on early embryo development after PFNA exposure were investigated using the bovine in vitro production system. Oocytes were exposed to PFNA during maturation in vitro (10 mu g mL(-1) and 0.1 mu g mL(-1)), and then fertilized and cultured in parallel with control groups. Developmental parameters (cleavage, blastocyst formation) were followed and embryo quality evaluated (stage, grade). Embryos developed after exposure to 0.1 mu g mL(-1) were stained to distinguish nuclei, active mitochondria and neutral lipids. 10 mu g mL(-1) of PFNA had a severe negative effect on blastocyst formation (OR: 0.27 $p < 0.05$), an effect not observed at 0.1 mu g mL(-1). However, lipid droplet distribution was significantly altered in embryos exposed to 0.1 mu g mL(-1), suggesting a disturbance of lipid metabolism after exposure to sublethal levels of PFNA during oocyte maturation in vitro.				1					C	C		PHNA のウシの初期胚発生に対する影響を検討した in vitro 試験。生殖毒性試験としての有用性は低いと判断した。
D1269	in vitro（生殖発生毒性）	Marinello, WP; Mohseni, ZS; Cunningham, SJ; Crute, C; Huang, R; Zhang, JJ; Feng, LP	Perfluorobutane sulfonate exposure disrupted human placental cytotrophoblast cell proliferation and invasion involving in dysregulating preeclampsia related genes	2020	Faseb J. 2020 Nov:34(11):14182-14199. doi: 10.1096/fj.202000716RR.	We reported that maternal PFBS, an emerging pollutant, exposure is positively associated with preeclampsia which can result from aberrant trophoblasts invasion and subsequent placental ischemia. In this study, we investigated the effects of PFBS on trophoblasts proliferation/invasion and signaling pathways. We exposed a human trophoblast line, HTR8/SVneo, to PFBS. Cell viability, proliferation, and cell cycle were evaluated by the MTS assay, Ki-67 staining, and flow cytometry, respectively. We assessed cell migration and invasion with live-cell imaging-based migration assay and matrigel invasion assay, respectively. Signaling pathways were examined by Western blot, RNA-seq, and qPCR. PFBS exposure interrupted cell proliferation and invasion in a dose-dependent manner. PFBS (100 mu M) did not cause cell death but instead significant cell proliferation without cell cycle disruption. PFBS (10 and 100 mu M) decreased cell migration and invasion, while PFBS (0.1 mu M) significantly increased cell invasion but not migration. Further, RNA-seq analysis identified dysregulated HIF-1 alpha target genes that are relevant to cell proliferation/invasion and preeclampsia, while Western Blot data showed the activation of HIF-1 alpha, but not Notch, ERK1/2, (PI3K)AKT, and P38 pathways. PBFS exposure altered trophoblast cell proliferation/invasion which might be mediated by preeclampsia-related genes, suggesting a possible association between prenatal PFBS exposure and adverse placentation.				1					C	C		PFBS をヒト絨毛芽細胞株 HTR8/Svneo に暴露した in vitro 試験。胎盤に対する毒性影響の機序の解析であるが、この実験したいは評価に使用する価値は低い。この実験の計画の発想に至った、胎盤への影響があることを示した、齧歯類（哺乳類）の生殖発生毒性試験が Ref にあればそちらが重要。
D1270	生態毒性（生殖発生毒性スクリーニング）	Kim, M; Son, J; Park, MS; Ji, Y; Chae, S; Jun, C; Bae, JS; Kwon, TK; Choo, YS; Yoon, H; Yoon, D; Ryoo, J; Kim, SH; Park, MJ; Lee, HS	In vivo evaluation and comparison of developmental toxicity and teratogenicity of perfluoroalkyl compounds using Xenopus embryos	2013	Chemosphere. 2013 Oct:93(6):1153-1160. doi: 10.1016/j.chemosphere.2013.06.053.	Perfluoroalkyl compounds (PFCs) are environmental toxicants that persistently accumulate in human blood. Their widespread detection and accumulation in the environment raise concerns about whether these chemicals might be developmental toxicants and teratogens in ecosystem. We evaluated and compared the toxicity of PFCs of containing various numbers of carbon atoms (C8-11 carbons) on vertebrate embryogenesis. We assessed the developmental toxicity and teratogenicity of various PFCs. The toxic effects on Xenopus embryos were evaluated using different methods. We measured teratogenic indices (TIs), and investigated the mechanisms underlying developmental toxicity and teratogenicity by measuring the expression of organ-specific biomarkers such as xPTB (liver), Nkx2.5 (heart), and Cyl18 (intestine). All PFCs that we tested were found to be developmental toxicants and teratogens. Their toxic effects were strengthened with increasing length of the fluorinated carbon chain. Furthermore, we produced evidence showing that perfluorodecanoic acid (PFDA) and perfluoroundecanoic acid (PFuDA) are more potent developmental toxicants and teratogens in an animal model compared to the other PFCs we evaluated [perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA)]. In particular, severe defects resulting from PFDA and PFuDA exposure were observed in the liver and heart, respectively, using whole mount in situ hybridization, real-time PCR, pathologic analysis of the heart, and dissection of the liver. Our studies suggest that most PFCs are developmental toxicants and teratogens, however, compounds that have higher numbers of carbons (i.e., PFDA and PFuDA) exert more potent effects.				1					C	C		Xenopus を対象とした試験であるので、評価価値は低い。構造活性相関を調べているようなのでアフリカツメガエルでも良いのかもしれないが、哺乳類で同じことが起こる保証はない。
D1271	in vitro（生殖発生毒性）	Lindeman, B; Maass, C; Duale, N; Gutzkow, KB; Brunborg, G; Andreassen, A	Effects of per- and polyfluorinated compounds on adult rat testicular cells following in vitro exposure	2012	Reprod. Toxicol. 2012 Jul:33(4):531-537. doi: 10.1016/j.reprotox.2011.04.001.	Testicular toxicity is observed following exposure of rats to per- and polyfluorinated compounds (PFCs). Such compounds were also shown to induce oxidative stress and changes in ABC efflux transporters e.g. P-gp, implying two mechanisms which may contribute to testicular toxicity. We studied the toxicity of four PFCs (PFOA, PFNA, 8:2 FTOH and 6:2 FTOH) on primary rat testicular cells. DNA damage was studied by the comet assay including Fpg enzyme treatment to detect oxidative lesions. The levels of the ABC efflux transporters Bcrp1, Oat2 and P-gp were studied by real-time RT-PCR or flow cytometry. A PFNA associated increase in DNA SSBs was attributed to a subpopulation of moderately damaged cells possibly associated with cytotoxicity. No significant increase in oxidative DNA damage was measured for any of the PFCs. Expression levels of ABC efflux transporters suggest that PFCs may increase expression levels of the P-gp protein and the Oat2 gene.				1					C	C		PFOA、PFNA、 FTOH、FTOH をラット精巣初代細胞に暴露した in vitro 試験。機序解析試験であり、内因子の実験の元になった「過フッ素化およびポリフッ素化化合物（PFC）にラットが暴露されると、精巣毒性が観察される。」を示した、発生毒性試験が Ref にあればそちらが重要。
D1272	生態毒性（生殖発生毒性スクリーニング）	Patel, N; Ivantsova, E; Konig, I; Souders, CL; Martyniuk, CJ	Perfluorotetradecanoic Acid (PFTeDA) Induces Mitochondrial Damage and Oxidative Stress in Zebrafish (Danio rerio) Embryos/Larvae	2022	Toxics. 2022 Dec;10(12):776. doi: 10.3390/toxics10120776.	Industrial and consumer products, such as pesticides, lubricants, and cosmetics, can contain perfluorinated compounds (PFCs). Although many short-chain PFCs have been linked to physiological and behavioral changes in fish, there are limited data on longer-chain PFCs. The objective of this study was to determine the potential impact of perfluorotetradecanoic acid (PFTeDA) exposure on zebrafish (Danio rerio) during early developmental stages. We measured several endpoints including gene expression, mitochondrial bioenergetics, and locomotor activity in zebrafish. Survival, timing of hatching, and deformity frequency were unaffected by PFTeDA at the concentrations tested (0.01, 0.1, 1, and 10 mu M) over a 7-day exposure period. The expression levels of mitochondrial-related genes (cox1 and mt-nd3) and oxidative stress-related genes (cat, hsp70, and hsp90a) were increased in larval fish with exposure to 10 mu M PFTeDA; however, there was no change in oxidative respiration of embryos (i.e., basal respiration and oligomycin-induced ATP-linked respiration). Reactive oxygen species were reduced in larvae treated with 10 mu M PFTeDA, coinciding with the increased transcription of antioxidant defense genes. Both the visual motor response test and light-dark preference test were conducted on 7 dpf larvae and yielded no significant findings. This study improves current knowledge regarding toxicity mechanisms for longer-chain PFCs such as PFTeDA.									C	C		PFTeDA をゼブラフィッシュに暴露した実験。日哺乳類試験であり、格別な生殖発生毒性を示しているわけでもないので、評価に使用する価値は低いと判断した。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1273	実験動物（生殖発生毒性）	Cope, HA; Blake, BE; Love, C; McCord, J; Elmore, SA; Harvey, JB; Chappell, VA; Fenton, SE	Latent, sex-specific metabolic health effects in CD-1 mouse offspring exposed to PFOA or HFPO-DA (GenX) during gestation	2021	Emerg. Contam. 2021:7:219-235. doi: 10.1016/j.emcon.2021.10.004	Background: Perfluorooctanoic acid (PFOA) is an environmental contaminant associated with adverse metabolic outcomes in developmentally exposed human populations and mouse models. Hexa-fluoropropylene oxide-dimer acid (HFPO-DA, commonly called GenX) has replaced PFOA in many in-dustrial applications in the U.S. and Europe and has been measured in global water systems from <1 to 9350 ng/L HFPO-DA. Health effects data for GenX are lacking. Objective: Determine the effects of gestational exposure to GenX on offspring weight gain trajectory, adult metabolic health, liver pathology and key adipose gene pathways in male and female CD-1 mice. Methods: Daily oral doses of GenX (0.2, 1.0, 2.0 mg/kg), PFOA (0.1, 1.0 mg/kg), or vehicle control were administered to pregnant mice (gestation days 1.5-17.5). Offspring were fed a high-or low-fat diet (HFD or LFD) at weaning until necropsy at 6 or 18 weeks, and metabolic endpoints were measured over time. PFOA and GenX serum and urine concentrations, weight gain, serum lipid parameters, body mass composition, glucose tolerance, white adipose tissue gene expression, and liver histopathology were evaluated. Results: Prenatal exposure to GenX led to its accumulation in the serum and urine of 5-day old pups (P = 0.007, P < 0.001), which was undetectable by weaning. By 18 weeks of age, male mice fed LFD in the 2.0 mg/kg GenX group displayed increased weight gain (P < 0.05), fat mass (P = 0.016), hepatocellular microvesicular fatty change (P = 0.015), and insulin sensitivity (P = 0.014) in comparison to control males fed LFD. Female mice fed HFD had a significant increase in hepatocyte single cell necrosis in 1.0 mg/kg GenX group (P = 0.022) and 1.0 mg/kg PFOA group (P = 0.003) compared to control HFD females. Both sexes were affected by gestational GenX exposure; however, the observed phenotype varied between sex with males displaying more characteristics of metabolic disease and females exhibiting liver damage in response to the gestational exposure. Conclusions: Prenatal exposure to 1 mg/kg GenX and 1 mg/kg PFOA induces adverse metabolic outcomes in adult mice that are diet-and sex-dependent. GenX also accumulated in pup serum, suggesting that placental and potentially lactational transfer are important exposure routes for GenX.					1			B	A		試験計画が多少複雑ではあるが、GenX(HFPO-DA)とPFOA（陽性対照？） のCD-1マウスを用いた生殖発生毒性試験。投与群は GenX が３用量、PFOA を２用量設定し、妊娠1.5～17.5日目まで連日経口投与している。雌雄で毒性影響は異なるようであるが、GenX の生殖発生毒性の評価には十分参考にする価値のある論文である。
D1274	実験動物（生殖発生毒性）	Crute, CE; Landon, CD; Garner, A; Hall, SM; Everitt, JI; Zhang, SR; Blake, B; Olofsson, D; Chen, HY; Stapleton, HM; Murphy, SK; Feng, LP	Maternal exposure to perfluorobutane sulfonate (PFBS) during pregnancy: evidence of adverse maternal and fetoplacental effects in New Zealand White (NZW) rabbits	2023	Toxicol. Sci. 2023 Feb:191(2):239-252. doi: 10.1093/toxsci/kfac126.	Perfluorobutanesulfonic acid (PFBS) is a replacement for perfluorooctanesulfonic acid (PFOS) that is increasingly detected in drinking water and human serum. Higher PFBS exposure is associated with risk for preeclampsia, the leading cause of maternal and infant morbidity and mortality in the United States. This study investigated relevant maternal and fetal health outcomes after gestational exposure to PFBS in a New Zealand White rabbit model. Nulliparous female rabbits were supplied drinking water containing 0 mg/l (control), 10 mg/l (low), or 100 mg/l (high) PFBS. Maternal blood pressure, body weights, liver and kidney weights histopathology, clinical chemistry panels, and thyroid hormone levels were evaluated. Fetal endpoints evaluated at necropsy included viability, body weights, crown-rump length, and liver and kidney histopathology, whereas placenta endpoints included weight, morphology, histopathology, and full transcriptome RNA sequencing. PFBS-high dose dams exhibited significant changes in blood pressure markers, seen through increased pulse pressure and renal resistive index measures, as well as kidney histopathological changes. Fetuses from these dams showed decreased crown-rump length. Statistical analysis of placental weight via a mixed model statistical approach identified a significant interaction term between PFBS high dose and fetal sex, suggesting a sex-specific effect on placental weight. RNA sequencing identified the dysregulation of angiotensin (AGT) in PFBS high-dose placentas. These results suggest that PFBS exposure during gestation leads to adverse maternal outcomes, such as renal injury and hypertension, and fetal outcomes, including decreased growth parameters and adverse placenta function. These outcomes raise concerns about pregnant women's exposure to PFBS and pregnancy outcomes.				1				B	A		PFBS の NZW ウサギを用いた生殖発生毒性試験。投与群は２用量のみの設定で、飲水投与。投与期間が妊娠何日か不明であるが、一般的な検査項目は網羅しているようである。その他、胎盤への影響に特に着目しているようである。PFBSの生殖発生毒性の評価に参考にする価値がある論文である。
D1275	実験動物（生殖発生毒性）	Conley, JM; Lambright, CS; Evans, N; Medlock-Kakaley, E; Hill, D; McCord, J; Strynar, MJ; Wehmas, LC; Hester, S; MacMillan, DK; Gray, LE	Developmental toxicity of Nafion byproduct 2 (NBP2) in the Sprague-Dawley rat with comparisons to hexafluoropropylene oxide-dimer acid (HFPO-DA or GenX) and perfluorooctane sulfonate (PFOS)	2022	Environ. Int. 2022 Feb:160:107056. doi: 10.1016/j.envint.2021.107056.	Nafion byproduct 2 (NBP2) is a polyfluoroalkyl ether sulfonic acid that was recently detected in surface water, drinking water, and human serum samples from monitoring studies in North Carolina, USA. We orally exposed pregnant Sprague-Dawley rats to NBP2 from gestation day (GD) 14-18 (0.1-30 mg/kg/d), GD17-21, and GD8 to postnatal day (PND) 2 (0.3-30 mg/kg/d) to characterize maternal, fetal, and postnatal effects. GD14-18 exposures were also conducted with perfluorooctane sulfonate (PFOS) for comparison to NBP2, as well as data previously published for hexafluoropropylene oxide-dimer acid (HFPO-DA or GenX). NBP2 produced stillbirth (30 mg/kg), reduced pup survival shortly after birth (10 mg/kg), and reduced pup body weight (10 mg/kg). Histopathological evaluation identified reduced glycogen stores in newborn pup livers and hepatocyte hypertrophy in maternal livers at >= 10 mg/kg. Exposure to NBP2 from GD14-18 reduced maternal serum total T3 and cholesterol concentrations (30 mg/kg). Maternal, fetal, and neonatal liver gene expression was investigated using RT-qPCR pathway arrays, while maternal and fetal livers were also analyzed using TempO-Seq transcriptomic profiling. Overall, there was limited alteration of genes in maternal or F1 livers from NBP2 exposure with significant changes mostly occurring in the top dose group (30 mg/kg) associated with lipid and carbohydrate metabolism. Metabolomic profiling indicated elevated maternal bile acids for NBP2, but not HFPO-DA or PFOS, while all three reduced 3-indolepropionic acid. Maternal and fetal serum and liver NBP2 concentrations were similar to PFOS, but similar to 10-30-fold greater than HFPO-DA concentrations at a given maternal oral dose. NBP2 is a developmental toxicant in the rat, producing neonatal mortality, reduced pup body weight, reduced pup liver glycogen, reduced maternal thyroid hormones, and altered maternal and offspring lipid and carbohydrate metabolism similar to other studied PFAS, with oral toxicity for pup loss that is slightly less potent than PFOS but more potent than HFPO-DA.					1			A	B	妊娠中のSprague-Dawleyラットを用いて、フェノタイプが見れるまで濃度を上げて検証しているため	NBP2 と PFOS の妊娠 SD-rat に対する発生毒性試験。今回の対象化合物の実験ではない。GenX のデータは、おそらく Ref にあるはずなので、その論文は A 評価であると考えられる。
D1276	実験動物（生殖発生毒性）	Yue, YR; Li, SD; Qian, ZJ; Pereira, RF; Lee, J; Doherty, JJ; Zhang, ZY; Peng, Y; Clark, JM; Timme-Laragy, AR; Park, Y	Perfluorooctanesulfonic acid (PFOS) and perfluorobutanesulfonic acid (PFBS) impaired reproduction and altered offspring physiological functions in Caenorhabditis elegans	2020	Food Chem. Toxicol. 2020 Nov:145:111695. doi: 10.1016/j.fct.2020.111695.	Perfluorobutanesulfonic acid (PFBS), a shorter chain Per- and polyfluoroalkyl substances (PFASs) cognate of perfluorooctanesulfonic acid (PFOS), has been used as replacement for the toxic surfactant PFOS. However, emerging evidences suggest safety concerns for PFBS and its effect on reproductive health is still understudied. Therefore, the current work aimed to investigate the effect of PFBS, in comparison to PFOS, on reproductive health using Caenorhabditis elegans as an in vivo animal model. PFOS (>= 10 mu M) and PFBS (>= 1000 mu M) significantly impaired the reproduction capacity of C. elegans, represented as reduced brood size (total egg number) and progeny number (hatched offspring number), without affecting the hatchability. Additionally, the preconception exposure of PFOS and PFBS significantly altered the embryonic nutrient loading and composition, which further led to abnormalities in growth rate, body size and locomotive activity in F1 offspring. Though the effective exposure concentration of PFBS was approximately 100 times higher than PFOS, the internal concentration of PFBS was lower than that of PFOS to produce the similar effects of PFOS. In conclusion, PFOS and PFBS significantly impaired the reproductive capacities in C. elegans and the preconception exposure of these two compounds can lead to offspring physiological dysfunctions.				1				C	C		PFBS の線虫（C. elegans）を用いた試験。PFOS との比較を行っているが、哺乳類（最終的にはヒト）の生殖発生毒性の評価への利用度は低い。
D1277	実験動物（生殖発生毒性）	Conley, JM; Lambright, CS; Evans, N; Farraj, AK; Smoot, J; Grindstaff, RD; Hill, D; McCord, J; Medlock-Kakaley, E; Dixon, A; Hines, E; Gray, LE	Dose additive maternal and offspring effects of oral maternal exposure to a mixture of three PFAS (HFPO-DA, NBP2, PFOS) during pregnancy in the Sprague-Dawley rat	2023	Sci. Total Environ. 2023 Sep:892:164609. doi: 10.1016/j.scitotenv.2023.164609.	Simultaneous exposure to multiple per- and polyfluoroalkyl substances (PFAS) is common in humans across the globe. Individual PFAS are associated with adverse health effects, yet the nature of mixture effects after exposure to two or more PFAS remains unclear. Previously we reported that oral administration of hexafluoropropylene oxide-dimer acid (HFPO-DA, or GenX), Nafion byproduct 2 (NBP2), or perfluorooctane sulfonate (PFOS) individually during pregnancy produced maternal and F1 effects. Here, we hypothesized that responses to the combined exposure to these three PFAS would be dose additive. Pregnant Sprague-Dawley rats were exposed to a fixed-ratio equipotent mixture where the top dose contained each PFAS at their ED50 for neonatal mortality (100 % dose = PFOS 3 mg/kg; NBP2 10 mg/kg; HFPO-DA 110 mg/kg), followed by a dilution series (33.3, 10, 3.3, and 1 %) and vehicle controls (0 % dose). Consistent with the single chemical studies, dams were exposed from gestation day (GD)14-18 or from GD8-postnatal day (PND2). Fetal and maternal livers on GD18 displayed multiple significantly upregulated genes associated with lipid and carbohydrate metabolism at all dose levels, while dams displayed significantly increased liver weight (>= 3.3 % dose) and reduced serum thyroid hormones (>= 33.3 % dose). Maternal exposure from GD8-PND2 significantly reduced pup bodyweights at birth (>= 33.3 % dose) and PND2 (all doses), increased neonatal liver weights (>= 3.3 % dose), increased pup mortality (>= 3.3 % dose), and reduced maternal bodyweights and weight gain at the top dose. Echocardiography of adult F1 males and females identified significantly increased left ventricular anterior wall thickness (similar to 10 % increase), whereas other cardiac morphological, functional, and transcriptomic measures were unaffected. Mixture effects in maternal and neonatal animals conformed to dose addition using a relative potency factor (RPF) analysis. Results support dose addition-based cumulative assessment approaches for estimating combined effects of PFAS co-exposure.					1			A	B	妊娠中のSprague-Dawleyラットを用いて、用量を変えて検証しているため	GenX、NPB2、PFOS の複合暴露による SD-rat を用いた生殖発生毒性試験。混合物の影響を検討した試験であり、それぞれ単独で投与したものは過去に報告しているとしているので、Ref にあたった方が良いと考えられる。
D1278	実験動物（生殖発生毒性）	Marziali, L; Rosignoli, F; Valsecchi, S; Polesello, S; Stefani, F	Effects of Perfluoralkyl Substances on a Multigenerational Scale: A Case Study with Chironomus riparius (Diptera, Chironomidae)	2019	Environ. Toxicol. Chem. 2019 May:38(5):988-999. doi: 10.1002/etc.4392.	A multigenerational test with Chironomus riparius was performed to assess long-term effects on life-traits of exposure to selected perfluoroalkyl compounds: perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutane sulfonate (PFBS). These persistent contaminants are widespread in aquatic ecosystems at low concentrations, possibly exerting long-term toxicity. Larvae of C. riparius of a native population were exposed for 10 generations to 10 mu g/L nominal concentrations of PFOS, PFOA, and PFBS, comparable with the maximum values found in European rivers. All treatments showed reduced growth at most/several generations. No effects on survival, development, and reproduction were found. A final tolerance-induction test was performed exposing the pre-exposed experimental cohorts to 100 mu g/L PFOS and 150 mu g/L PFOA for a whole life cycle. Factorial analysis of variance revealed no difference between treatments (i.e., PFOS vs PFOA), indicating no induced tolerance. Instead, organisms pre-exposed to PFBS were the most stressed, followed by those pre-exposed to PFOA and PFOS, with earlier emergence and reduced adult weight. The results may be related to general stress and genetic erosion induced by long-term laboratory culture, but also to long-term toxicant exposure. However, no effects at the population level (population growth rate) were proved, and thus a toxicity risk in real ecosystems at the tested concentrations seems unlikely.					1			C	C		PFOS、PFOA、PFBA の Chironomus riparius（ユスリカ）を用いた多世代発生毒性試験。成長は遅れるものの、生存、発育、繁殖への影響は認められていないし、環境汚染物質評価としてはともかく、ヒトに対する影響評価に用いる価値はないと判断した。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1279	実験動物（生殖発生毒性）	Jantzen, CE; Annunziato, KA; Bugel, SM; Cooper, KR	PFOS, PFNA, and PFOA sub-lethal exposure to embryonic zebrafish have different toxicity profiles in terms of morphometrics, behavior and gene expression	2016	Aquat. Toxicol. 2016 Jun:175:160-170. doi: 10.1016/j.aquatox.2016.03.026	Polyfluorinated compounds (PFC) are a class of anthropogenic, persistent and toxic chemicals. PFCs are detected worldwide and consist of fluorinated carbon chains of varying length, terminal groups, and industrial uses. Previous zebrafish studies in the literature as well as our own studies have shown that exposure to these chemicals at a low range of concentrations (0.02-2.0 mu M; 20-2000 ppb) resulted in chemical specific developmental defects and reduced post hatch survival. It was hypothesized that sublethal embryonic exposure to perfluorooctanesulfonic acid (PFOS), perfluorononanoic acid (PFNA), or perfluorooctanoic acid (PFOA) would result in different responses with regard to morphometric, behavior, and gene expression in both yolk sac fry and larval zebrafish. Zebrafish were exposed to PFOS, PFOA, and PFNA (0.02, 0.2, 2.0 mu M) for the first five days post fertilization (dpf) and analyzed for morphometrics (5 dpf, 14 dpf), targeted gene expression (5 dpf, 14 dpf), and locomotive behavior (14 dpf). All three PFCs commonly resulted in a decrease in total body length, increased tfc3a (muscle development) expression and decreased ap1s (protein transport) expression at 5dpf, and hyperactive locomotor activity 14 dpf. All other endpoints measured at both life-stage time points varied between each of the PFCs. PFOS, PFNA, and PFOA exposure resulted in significantly altered responses in terms of morphometric, locomotion, and gene expression endpoints, which could be manifested in field exposed teleosts.								C	C		
D1280	実験動物（生殖発生毒性）	Rericha, Y; Cao, DP; Truong, L; Simonich, MT; Field, JA; Tanguay, RL	Sulfonamide functional head on short-chain perfluorinated substance drives developmental toxicity	2022	iScience. 2022 Feb;25(2):103789. doi: 10.1016/j.isci.2022.103789.	Per-and polyfluoroalkyl substances (PFAS) are ubiquitously detected in environmental and biological samples and cause adverse health effects. Studies have predominately focused on long-chain PFAS, with far fewer addressing short-chain alternatives. This study leveraged embryonic zebrafish to investigate developmental toxicity of a short-chain series: perfluorobutane sulfonate (PFBS), perfluoropentanoic acid (PFPeA), perfluorobutane sulfonamide (FBSA), and 4:2 fluorotelomer sulfonic acid (4:2 FTS). Following static exposures at 8 h postfertilization (hpf) to each chemical (1-100 mM), morphological and behavioral endpoints were assessed at 24 and 120 hpf. Only FBSA induced abnormal morphology, while exposure to all chemicals caused aberrant larval behavior. RNA sequencing at 48 hpf following 47 mM exposures revealed only FBSA significantly disrupted normal gene expression. Measured tissue concentrations were FBSA > PFBS > 4:2 FTS > PFPeA. This study demonstrates functional head groups impact bioactivity and bioconcentration.			1					C	C		
D1281	実験動物（生殖発生毒性）	Rogers, JM; Heintz, MM; Thompson, CM; Haws, LC	A putative adverse outcome network for neonatal mortality and lower birth weight in rodents: Applicability to per- and polyfluoroalkyl substances and relevance to human health	2023	Birth Defects Res. 2023 Jun:115(11):1011-1062. doi: 10.1002/bdr2.2185.	Background: Some per- and poly-fluoroalkyl substances (PFAS) cause neonatal mortality and lower birth weight in rodents. We constructed an Adverse Outcome Pathway (AOP) network for neonatal mortality and lower birth weight in rodents, comprising three putative AOPs. We then assessed strengths of the evidence for the AOPs and applicability to PFAS. Finally, we considered the relevance of this AOP network to human health.Methods: Literature searches targeted PFAS, peroxisome proliferator-activated receptor (PPAR) agonists, other nuclear receptors, relevant tissues, and developmental targets. We used reviews of established biology and described results of studies with prenatal PFAS exposure that assessed birth weight and neonatal survival. Molecular initiating events (MIEs) and key events (KEs) were proposed and strengths of KE relationships (KERs), applicability to PFAS, and human relevance were assessed.Results: Neonatal mortality has been observed in rodents following gestational exposure to most longer chain PFAS studied, often coincident with lower birth weight. In AOP 1, PPARa activation and PPAR? activation or downregulation are MIEs; placental insufficiency, fetal nutrient restriction, neonatal hepatic glycogen deficit, and hypoglycemia are KEs leading to neonatal mortality and lower birth weight. In AOP 2, constitutive androstane receptor (CAR) and pregnane X receptor (PXR) activation upregulates Phase II metabolism, lowering maternal circulating thyroid hormones. In AOP 3, disrupted pulmonary surfactant function and PPAR? downregulation cause neonatal airway collapse and mortality from respiratory failure.Conclusions: It is likely that different components of this AOP network will apply to different PFAS, largely determined by which nuclear receptors they activate. The MIEs and KEs in this AOP network can occur in humans, but differences in PPAR structure and function, and the timeline of liver and lung development, suggest that humans may be less susceptible to this AOP network. This putative AOP network elucidates knowledge gaps and research needed to better understand the developmental toxicity of PFAS.								A	D	AOPの質は要旨からはわからないが、参考になる可能性がある	文献調査による、げっ歯類の新生児死亡と出生時体重減少に関する有害事象発生機序を考察した文献であり、これをどう扱うべきなのか判断できない。 Ref い有用な論文が入っている可能性はあるが、大きく PFAS を扱っていることしか書いてないので、全く判断できません。
D1282	実験動物（生殖発生毒性）	Annunziato, KM; Marin, M; Liang, WL; Conlin, SM; Qi, WP; Doherty, J; Lee, J; Clark, JM; Park, Y; Timme-Laragy, AR	The Nrf2a pathway impacts zebrafish offspring development with maternal preconception exposure to perfluorobutanesulfonic acid	2022	Chemosphere. 2022 Jan;287(Pt 2):132121. doi: 10.1016/j.chemosphere.2021.132121.	Since the voluntary phaseout of perfluorooctanesulfonic acid (PFOS), smaller congeners, such as per-fluorobutanesulfonic acid (PFBS) have served as industrial replacements and been detected in contaminated aquifers. This study sought to examine the effects of a maternal preconception PFBS exposure on the develop-ment of eggs and healthy offspring. Adult female zebrafish received a one-week waterborne exposure of 0.08, 0.14, and 0.25 mg/L PFBS. After which, females were bred with non-exposed males and embryos collected over 5 successful breeding events. PFBS concentrations were detected in levels ranging from 99 to 253 pg/embryo in the first collection but were below the limit of quantitation by fourth and fifth clutches. Therefore, data were sub-sequently binned into early collection embryos in which PFBS was detected and late collections, in which PFBS was below quantitation. In the early collection, embryo 24 h survival was significantly reduced. In the late collection, embryo development was impacted with unique patterns emerging between Nrf2a wildtype and mutant larvae. Additionally, the impact of nutrient loading into the embryos was assessed through measurement of fatty acid profiles, total cholesterol, and triglyceride content. There were no clear dose-dependent effects, but again unique patterns were observed between the genotypes. Preconception PFBS exposures were found to alter egg and embryo development, which is mediated by direct toxicant loading in the eggs, nutrient loading into eggs, and the function of Nrf2a. These findings provide insight into the reproductive and developmental effects of PFBS and identify maternal preconception as a novel critical window of exposure.				1				C	C		PFBS のゼブラフィッシュを用いた生殖発生毒性試験。ゼブラフィッシュの遺伝子型によって毒性が異なることも報告しているが、ヒトに対する影響評価（および、その比較検討）に用いる価値はないと判断した。
D1283	実験動物（生殖発生毒性）	Cao, XY; Liu, J; Zhang, YJ; Wang, Y; Xiong, JW; Wu, J; Chen, L	Exposure of adult mice to perfluorobutanesulfonate impacts ovarian functions through hypothyroxinemia leading to down-regulation of Akt-mTOR signaling	2020	Chemosphere. 2020 Apr:244:125497. doi: 10.1016/j.chemosphere.2019.125497.	Perfluorobutanesulfonate (PFBS), a short-chain perfluoroalkyl substance, is used in many industrial products. Preliminary evidence suggests that exposure to PFBS may increase the risk of infertility. The aim of this study was to investigate the influence of PFBS on ovarian function. Herein, we show that exposure of adult female mice to PFBS (200 mg/kg/day) (PFBS-mice) caused a decrease in the levels of serum total triiodothyronine and thyroxine, which depended on the activation of peroxisome proliferator-activated receptor alpha (PPAR alpha). The numbers of secondary, early antral and antral follicles were reduced in PFBS-mice with an increase in the atretic follicles, and these changes were recovered by the replacement of L-thyroxinein or the treatment with PPAR alpha antagonist GW6471. PFBS-induced hypothyroxinemia led to a decrease in the levels of Akt, mTOR and p70S6K phosphorylation in ovarian granular cells and cumulus cells, which suppressed the proliferation of these cells and enhanced autophagic death of granular cells and cumulus cells. The levels of serum estradiol and progesterone were reduced in PFBS-mice with a low expression of the steroidogenic genes Star and P450scc in ovarian tissues, which were sensitive to the replacement of L-thyroxinein or the blockade of PPAR alpha. The results indicate that exposure to PFBS (>= 200 mg/kg/day) through reducing thyroid hormones causes down regulation of Akt-mTOR signaling in granular cells and cumulus cells, leading to the deficits in the development of follicles and the biosynthesis of ovarian hormones.				1				B	B		PFBS のマウスを持ちた試験である。一部生体への影響を検討している部分もあるようであるが、卵胞形成に対する影響も検討している。生殖発生毒性試験というよりは機序解析の試験のようである。しかしながら、現在行われている PFAS-WG では機序に関する論文も意味を持つことがあるので、排除するという判断もできない。
D1284	実験動物（生殖発生毒性）	Zhang, W; Sheng, N; Wang, MH; Zhang, HX; Dai, JY	Zebrafish reproductive toxicity induced by chronic perfluorononanoate exposure	2016	Aquat. Toxicol. 2016 Jun:175:269-276. doi: 10.1016/j.aquatox.2016.04.005	Perfluoroalkyl acids (PFAAs) are a group of anthropogenic compounds that have been widely used in consumer products for over 50 years. One of the most dominant PFAAs is perfluorononanoate (PFNA), a compound detected ubiquitously in aquatic ecosystems. While PFNA is suspected of being an endocrine disruptor, the mechanisms behind PFNA-induced reproductive disorders are poorly understood. The aim of this study was to investigate the reproduction-related effects and possible mechanisms of PFNA on adult zebrafish (Danio rerio) following 180 days of exposure at different concentrations (0.01, 0.1,1 mg/L). PFNA concentration in the gonads of zebrafish was tested by HPLC-MS/MS after chronic exposure to study possible inconsistent accumulation between the genders. The results showed that the accumulation of PFNA in the male gonads was almost one-fold higher than that in the female gonads, indicating a possible higher PFAA gonad burden for male zebrafish. Significant reductions in the male gonadosomatic index (GSI) and female egg production were observed. In addition, the decreased 72 h hatching rate displayed an evident dosage effect, indicating that maternal exposure to PFNA might impair offspring developmental success. To investigate how PFNA exposure affects the hypothalamic-pituitary-gonadal-liver axis (HPGL axis), the transcriptional levels of genes were measured by real-time PCR. The disrupted expression of genes, such as ER alpha, ER beta, FSHR, LHR, StAR, and 17 beta HSD, indicated the possible interference of PFNA on the HPGL axis function and sex hormone synthesis. Furthermore, testosterone (T) and estradiol (E-2) levels in serum and VTG content in the liver were detected to clarify the influences of PFNA on sex hormone levels. Except for the increase in serum estrogen levels, as an estrogen analogue, PFNA also induced the synthesis of biomarker protein vitellogenin (VTG) in the adult male liver. The results of this study indicate that chronic exposure to PFNA can lead to dysfunction in the HPGL axis and sex hormone synthesis and cause adverse effects on fish reproduction.				1				C	C		PFNA のゼブラフィッシュを用いた毒性発現機序解析の実験。遺伝子発現の変化などを検討しているが、ヒトに対する影響評価に用いる価値はないと判断した。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1285	実験動物（生殖発生毒性）	Tang, LZ; Song, SW; Hu, CY; Liu, MY; Lam, PKS; Zhou, BS; Lam, JCW; Chen, LG	Parental exposure to perfluorobutane sulfonate disturbs the transfer of maternal transcripts and offspring embryonic development in zebrafish	2020	Chemosphere. 2020 Oct:256:127169. doi: 10.1016/j.chemosphere.2020.127169.	Parental exposure to perfluorobutane sulfonate (PFBS), an aquatic pollutant of emerging concern, is previously found to impair the embryonic development of offspring. However, the impairing mechanisms remain to clarify. In the present study, adult zebrafish were exposed to 0, 10 and 100 mu g/L PFBS for 28 d, after which disturbances in maternal transcript transfer and offspring embryogenesis were investigated. Prior to zygotic genome activation, high-throughput transcriptomic sequencing revealed that parental PFBS exposure significantly altered the transcript profile of maternal origin in offspring eggs, while toxic actions varied as a function of PFBS concentrations. In offspring eggs derived from 10 mu g/L exposure group, differential transcripts were mainly associated with the histone-DNA interaction of nucleosome, which would modify the compacted chromatin configuration and accessibility of transcriptional factors to DNA sequences. In this regard, the timing of zygotic genome activation was presumably disrupted. Parental exposure to 100 mu g/L PFBS primarily interrupted the maternal transfer of adherens junction transcripts, which was supposed to dysregulate the cell-cell adhesion during early embryo formation. Development and growth of offspring embryos were significantly compromised by parental PFBS exposure, as exemplified by higher mortality, delayed hatching, slower heart rate, reduced body weight and neurobehavioral disorders. Overall, the present study presented the first toxicological evidence about the disturbances of PFBS in maternal transcript transfer, although the inherent linkage between maternal transcript modifications and offspring development defects still needs future works to construct.				1				C	C		PFBS のゼブラフィッシュに対する毒性発現機序解析。初期胚成長阻害の原因をトランスクリプトーム解析で分析しているが、生殖発生毒性の評価には使用できないと判断した。
D1286	実験動物（生殖発生毒性）	Liu, H; Sheng, N; Zhang, W; Dai, JY	Toxic effects of perfluorononanoic acid on the development of Zebrafish (Danio rerio) embryos	2015	J. Environ. Sci. 2015 Jun:32:26-34. doi: 10.1016/j.jes.2014.11.008	Perfluorononanoic acid (PFNA) is a nine-carbon perfluoroalkyl acid widely used in industrial and domestic products. It is a persistent organic pollutant found in the environment as well as in the tissues of humans and wildlife. There is a concern that this chemical might be a developmental toxicant and teratogen in various ecosystems. In the present study, the toxic effects of PFNA were evaluated in zebrafish (Danio rerio) embryos. One hour post-fertilization embryos were treated with 0, 25, 50, 100, 200, 300, 350, and 400 mu mol/L PFNA for 96 hr in 6-well plates. Developmental phenotypes and hatching rates were observed and recorded. Nineteen genes related to oxidative stress and lipid metabolism were examined using Quantitative RT-PCR and confirmed by whole mount in situ hybridization (WISH). Results showed that PFNA delayed the development of zebrafish embryos, reduced the hatching rate, and caused ventricular edema and malformation of the spine. In addition, the amount of reactive oxygen species in the embryo bodies increased significantly after exposure to PFNA compared with that of the control group. The Quantitative RT-PCR and WISH experiments demonstrated that mRNA expression of the lfabp and ucp2 genes increased significantly while that of sod1 and mt-nd1 decreased significantly after PFNA exposure. The mRNA expression levels of gpx1 and mt-atp6 decreased significantly in the high concentration group. However, the mRNA expression levels of both ppara and pparg did not show any significant variation after exposure. These findings suggest that PFNA affected the development of zebrafish embryos at relatively low concentrations.			1					C	C		PFNA のゼブラフッシュを用いた試験。発育遅延や奇形が観察されており、遺伝子発現の変化をその機序としているが、今回の評価には関連性が薄いと判断した。
D1287	実験動物（生殖発生毒性）	Tang, LZ; Song, SW; Hu, CY; Lam, JCW; Liu, MY; Zhou, BS; Lam, PKS; Chen, LG	Unexpected Observations: Probiotic Administration Greatly Aggravates the Reproductive Toxicity of Perfluorobutanesulfonate in Zebrafish	2020	Chem. Res. Toxicol. 2020 Jul:33(7):1605-1608. doi: 10.1021/acs.chemrestox.0c00139.	The present study exposed adult zebrafish to 0, 10, and 100 mu g/L perfluorobutanesulfonate (PFBS) with or without dietary supplement of probiotic Lactobacillus rhamnosus. Interaction between probiotic and PFBS on sex endocrine and reproduction was investigated. It was striking to find that PFBS and probiotic coexposures almost ceased the fecundity, which was accompanied by disturbances in sex hormones and oocyte maturation in females. In contrast, probiotic additive efficiently antagonized the estrogenic activity of PFBS in males. For the first time, this study reported that probiotic heavily depended on sex to modulate the endocrine disruption and reproductive toxicity of aquatic pollutants.				1				C	C		PFBS のゼブラフィッシュを用いた試験だが、プロバイオティクスの関与を検討しており、今回の評価には重要性は低いと判断した。
D1288	実験動物（生殖発生毒性）	Zhang, YJ; Xu, Y; Ding, H; Yu, WF; Chen, L	Prenatal exposure of female mice to perfluorononanoic acid delays pubertal activation of the reproductive endocrine axis through enhanced hepatic FGF21 production	2021	Chemosphere. 2021 Apr:269:128776. doi: 10.1016/j.chemosphere.2020.128776.	The developmental toxicity of perfluorononanoic acid (PFNA), a ubiquitous environmental contaminant, has been associated with the activation of PPAR alpha. This study investigated influence of prenatal exposure to PFNA in pubertal activation of reproductive endocrine axis in female mice and explored underlying molecular mechanisms. Herein, we show that when PFNA (3 mg kg(-1) body weight) was orally administered during gestational days 1-18, dams showed an increase in liver weight and hepatic FGF21 synthesis via PPAR alpha activation, and their female offspring (PFNA mice) showed an increase in liver weight and hepatic FGF21 synthesis from postnatal day (PND) 1 to PND21, which were corrected by the administration of the PPARa antagonist GW6471 from PND1-14 (pup-GW). Expression of vasopressin (VAP) in the hypothalamic suprachiasmatic nucleus (SCN) was reduced in PND14-30 PFNA mice, and could be rescued by pup-GW. Pubertal activation of kisspeptin neurons in anteroventral periventricular nucleus (AVPV) and hypothalamic GnRH neurons in PND21-30 PFNA mice was obviously suppressed, but were recovered by pup-GWor PND21-30 application of VAP. The times of vaginal opening and first estrus were delayed in PFNA mice with a decrease in ovary size and the numbers of primary, secondary and antral follicles, and corpora lutea, which were relieved by pup-GW or application of VAP. The findings indicate that prenatal exposure to PFNA through increased FGF21 production in postnatal female offspring impedes postnatal activation of SCN-VAP neurons, which suppresses pubertal onset in AVPV-kisspeptin neurons and reproductive endocrine axis, leading to delayed puberty and dysfunction of ovaries.			1					B	B		PFNA のマウスを用いた発生毒性試験であるが、PPARαの関与に主眼を置いており、包括的な生殖発生毒性試験ではない。その点では評価に重要な論文であるとは言えないが、現在行われている PFAS-WG でもPPARαを介した毒性発現機序の話題が上がることも多く、そういう意味では参考にはなるかもしれない。
D1289	実験動物（生殖発生毒性）	Hu, CY; Liu, MY; Sun, BL; Tang, LZ; Zhou, XZ; Chen, LG	Young fecal transplantation mitigates the toxicity of perfluorobutanesulfonate and potently refreshes the reproductive endocrine system in aged recipients	2022	Environ. Int. 2022 Sep:167:107418. doi: 10.1016/j.envint.2022.107418.	The aging process leads to the gradual impairment of physiological functions in the elderly, making them more susceptible to the toxicity of environmental pollutants. In this study, aged zebrafish were first transplanted with the feces from young donors and subsequently exposed to perfluorobutanesulfonate (PFBS), an emerging persistent toxic pollutant. The interaction between young fecal transplant and PFBS inherent toxicity was investigated, focusing on reproductive performance and the underlying endocrine mechanism. The results showed that PFBS single exposure increased the percentage of primary oocytes in aged ovaries, implying a blockage of oogenesis. However, transplantation of young feces completely abolished the effects of PFBS and promoted oocyte growth, as inferred by the obviously lower percentage of primary oocytes, accompanied by a higher percentage of cortical-alveolar oocytes. Measurement of sex hormones found that PFBS significantly increased the blood concentration of estradiol and disrupted the balance of sex hormones in the elderly, which were, however, efficiently ameliorated by young fecal transplantation. Based on gene transcription along the hypothalamic-pituitary-gonadal axis, hierarchical clustering analysis showed similar profiles of the reproductive endocrine system between young zebrafish and their aged counterparts transplanted with young feces, implying that young fecal transplantation might refresh the endocrine system of aged recipients, regardless of PFBS exposure. The increased transcription levels of mRNAs encoding vitellogenin, activinBA, and membrane bound progestin receptors would cooperatively enhance the growth and maturation of oocytes in the ovaries of aged zebrafish receiving young fecal transplantation. Overall, the findings highlighted the potent efficacy of young fecal transplantation to improve the reproductive function of the elderly and to mitigate the endocrine disruption of an environmental pollutant. These findings are expected to broaden our understanding of the efficacy, mechanisms, and application of fecal transplantation.				1				C	C		PFBS のゼブラフィッシュを用いた試験。高齢ゼブラフィッシュに若年ゼブラフィッシュの糞を移植するなど、ヒトで起こる何に結びつくのか不明。環境汚染に重点を置いていると考えられるため、今回の評価には使用できないと判断した。
D1290	実験動物（生殖発生毒性）	Hu, CY; Liu, MY; Tang, LZ; Sun, BL; Huang, ZL; Chen, LG	Probiotic Lactobacillus rhamnosus modulates the impacts of perfluorobutanesulfonate on oocyte developmental rhythm of zebrafish	2021	Sci. Total Environ. 2021 Jul:776:145975. doi: 10.1016/j.scitotenv.2021.145975.	Potent interaction between probiotic bacteria and perfluorobutanesulfonate (PFBS), an aquatic pollutant of emerging concern, was previously reported on reproduction of zebrafish. However, the underlying mechanism is largely unexplored. In this regard, the present study continued to focus on the interactive modes between probiotics and PFBS. Adult zebrafish were exposed for 28 days to 0 and 10 mu g/L PFBS with or without dietary supplementation of probiotic Lactobacillus rhamnosus. With the relevance to fecundity outcome, a suite of reproductive indices at transcriptional, hormonal, proteomic and histological levels of biological organization were measured herein. The fecundity monitoring results showed that probiotic additive shifted the impacts of PFBS on egg spawn, gradually approaching the control level. Based on ovary histological observation, oocyte growth was significantly promoted by probiotics or/and PFBS exposures, while the presence of probiotic bacteria partially antagonized the effects of PFBS on oocyte growth. The combination of probiotics and PFBS increased the concentration of maturation inducing hormones in ovary. Despite the enhanced hormonal signals, gene transcriptions of ovarian local auto/paracrine factors were consistently decreased in all exposure groups, suggesting the blocked transition from oocyte growth phase toward oocyte maturation phase. Ovary proteomic analysis found that PFBS exposure with or without probiotic bacteria mainly affected the RNA metabolic processes, although the addition of probiotics exerted extra influences on amino acid metabolism. Overall, the present study provided more mechanistic evidence about the interactive behavior between probiotic bacteria and PFBS pollutant. Feed additive of probiotic bacteria modulated the impacts of PFBS on egg production rhythm through oocyte growth and maturation phases.				1				C	C		プロバイティクスとPFBS の共作用をゼブラフィッシュを用いて検討しているが、ヒトや哺乳類実験動物の生殖発生毒性の評価には全く無関係であると判断した。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1291	実験動物（生殖発生毒性）	Annunziato, KM; Jantzen, CE; Gronske, MC; Cooper, KR	Subtle morphometric, behavioral and gene expression effects in larval zebrafish exposed to PFHxA, PFHxS and 6:2 FTOH	2019	Aquat. Toxicol. 2019 Mar:208:126-137. doi: 10.1016/j.aquatox.2019.01.009	Recent studies of perfluoroalkylated substances (PFASs) have focused on the toxicity of long chain PFASs, such as PFOS or PFOA, which have been demonstrated to cause an array of developmental and behavioral effects. However, less is known about low molecular weight PFASs and alternatives. This study examined the morphometric and behavioral effects in zebrafish following developmental exposures of C6 PFASs: perfluorohexanoic acid, PFHxA, perfluorohexane sulfonate, PFHxS, and 6:2 fluorotelomer alcohol, 6:2 FTOH. Embryos were exposed to 0.02-20 mu M concentrations of these compounds from the high stage ((similar to)3 h post fertilization, hpf) until 120 hpf. Morphometric and gene expression endpoints were examined at 120 hpf. Genes selected for analysis were previously shown to be altered in zebrafish developmentally exposed to PFOS and PFOA. Additionally, exposed larvae were transferred to clean water and reared until 14 days post fertilization, dpf, when behavioral assays were completed and morphometric endpoints examined. While PFHxA was found to be the most acutely toxic at 120 hpf, few morphometric effects were observed. Gene expression was the most sensitive endpoint with significant increased tgfb1a, bdnf, and ap1s1 expression observed with PFHxA exposure. PFHxS exposure produced morphometric effects in the larvae, specifically increased length and yolk sac area at 2 and 20 mu M. This phenotype persisted to the 14 dpf time point, where these larvae additionally displayed decreased distance traveled and crosses through the center of the arena of the behavioral assay. Exposure to 6:2 FTOH caused no morphometric effects at 120 hpf, and this compound was the least acutely toxic. However, expression of both tgfb1a and bdnf were increased by greater than 2 fold change at this time point. Effects also persisted to 14 dpf where a significant increase in distance traveled and velocity were observed in the behavioral assay. This study demonstrates effects on behavioral, morphometric and gene expression endpoints with developmental PFHxA, PFHxS, and 6:2 FTOH exposures in zebrafish.		1						C	C		PFHxA、PFHxS、6:2 FTOH のゼブラフィッシュを用いた試験。形態的異常のほか、遺伝子発現の変化、行動試験（魚の行動試験について私はわかりません）を検討している。いずれも環境毒性に主眼を置いていると考えられ、今回の評価には使用できないと判断した。
D1292	実験動物（生殖発生毒性）	Tang, LZ; Li, J; Sun, BL; Bai, YC; Zhou, XZ; Chen, LG	Transcriptomic Interaction between Young Fecal Transplantation and Perfluorobutanesulfonate in Aged Zebrafish Gonads	2022	Toxics. 2022 Nov;10(11):631. doi: 10.3390/toxics10110631.	The transfer of young fecal microbiota has been found to significantly refresh the reproductive endocrine system and effectively ameliorate the toxicity of perfluorobutanesulfonate (PFBS) in aged zebrafish recipients. However, the mechanisms underlying the antagonistic action of young fecal microbiota against the reproductive endocrine toxicity of PFBS remain largely unknown. In this study, the aged zebrafish were transplanted with feces from young donors and then exposed to PFBS for 14 days. After exposure, the shift in the transcriptomic fingerprint of the gonads was profiled by using high-throughput sequencing, aiming to provide mechanistic clues into the interactive mode of action between young fecal transplantation and PFBS's innate toxicity. The results showed that the gene transcription pattern associated with protein and lipid synthesis in the gonads of the aged individuals was quite different from the young counterparts. It was intriguing that the transplantation of young feces established a youth-like transcriptomic phenotype in the elderly recipients, thus attenuating the functional decline and maintaining a healthy aging state of the gonads. A sex specificity response was clearly observed. Compared to the aged females, more metabolic pathways (e.g., glycine, serine, and threonine metabolism; glyoxylate and dicarboxylate metabolism; pyrimidine metabolism) were significantly enriched in aged males receiving young feces transplants. PFBS dramatically altered the transcriptome of aged testes, while a much milder effect was observable in aged ovaries. Accordingly, a suite of biological processes related to germ cell proliferation were disrupted by PFBS in aged males, including the ECM-receptor interaction, retinol metabolism, and folate biosynthesis. In aged ovaries exposed to PFBS, mainly the fatty acid and arginine biosynthesis pathway was significantly affected. However, these transcriptomic disorders caused by PFBS were largely mitigated in aged gonads by transferring young feces. Overall, the present findings highlighted the potential of young fecal transplantation to prevent the functional compromise of gonads resulting from aging and PFBS.				1				C	C		PFBS のゼブラフィッシュを用いた試験。高齢ゼブラフィッシュに若年ゼブラフィッシュの糞を移植するなど、ヒトで起こる何に結びつくのか不明。環境汚染に重点を置いていると考えられるため、今回の評価には使用できないと判断した。
D1293	実験動物（生殖発生毒性）	Xu, XH; Ni, H; Guo, YJ; Lin, YF; Ji, J; Jin, CY; Yuan, FC; Feng, MX; Ji, N; Zheng, YX; Jiang, QX	Hexafluoropropylene oxide dimer acid (HFPO-DA) induced developmental cardiotoxicity and hepatotoxicity in hatchling chickens: Roles of peroxisome proliferator activated receptor alpha*	2021	Environ. Pollut. 2021 Dec:290:118112. doi: 10.1016/j.envpol.2021.118112.	Hexafluoropropylene oxide dimer acid (HFPO-DA) is a perfluorooctanoic acid (PFOA) substitute. In the current study, potential developmental cardiotoxicity and hepatotoxicity following HFPO-DA exposure in chicken embryo has been investigated, focusing on the roles of peroxisome proliferator activated receptor alpha (PPAR alpha), the major molecular target in PFOA-induced toxicities. HFPO-DA was exposed to fertile chicken eggs via air cell injection, morphology and function of the target organs (heart and liver) in hatchlings were investigated with histopathology and electrocardiography, and the serum levels of HFPO-DA had been measured with quadrupoletime of flight liquid chromatograph-mass spectrometer (Q-TOF LC/MS). Additionally, lentivirus-mediated in ovo PPAR alpha silencing was used to assess the roles of PPAR alpha in HFPO-DA induced developmental toxicities. The results indicated that developmental exposure to HFPO-DA induced developmental cardiotoxicity, including thinned right ventricular wall and elevated heart rates, similar to those observed with PFOA exposure, as well as developmental hepatotoxicity in the form of steatosis. Silencing of PPAR alpha alleviated such effects, suggesting participation of PPAR alpha in HFPO-DA induced developmental toxicities in chicken embryo. Moreover, enhanced expression of PPAR alpha downstream genes, cluster of differentiation 36 (CD36) and enoyl-CoA hydratase and 3hydroxyacyl CoA dehydrogenase (EHHADH), were observed in HFPO-DA exposed animal heart tissues, which can be abolished by PPAR alpha silencing. On the other hand, liver-type fatty acid binding protein (L-FABP) and CD36 expression were effectively enhanced in exposed liver tissues, but not EHHADH, suggesting differential mechanism of toxicity in heart and liver tissues. In summary, developmental exposure to HFPO-DA induced developmental cardiotoxicity and hepatotoxicity in hatchling chickens similar to PFOA, and PPAR alpha still participates in such toxicities, with some differential downstream gene regulations in different organs. Further investigation on HFPO-DA-induced developmental toxicities is guaranteed.					1			C	C		HFPO-DA（GenX）のニワトリ受精卵を用いた試験。PPARαが関連した毒性発現機序に焦点を当てている。非哺乳類を使用した、非生殖ノルキサシン試験であるため、評価に使用できないと判断した。
D1294	実験動物（生殖発生毒性）	Gong, S; McLamb, F; Shea, D; Vu, JP; Vasquez, MF; Feng, ZY; Bozinovic, K; Hirata, KK; Gersberg, RM; Bozinovic, G	Toxicity assessment of hexafluoropropylene oxide-dimer acid on morphology, heart physiology, and gene expression during zebrafish (Danio rerio) development	2023	Environ. Sci. Pollut. Res. 2023 Mar:30(12):32320-32336. doi: 10.1007/s11356-022-24542-z.	Hexafluoropropylene oxide-dimer acid (HFPO-DA) is one of the emerging replacements for the forever carcinogenic and toxic long-chain PFAS. HFPO-DA is a polymerization aid used for manufacturing fluoropolymers, whose global distribution and undetermined toxic properties are a concern regarding human and ecological health. To assess embryotoxic potential, zebrafish embryos were exposed to HFPO-DA at concentrations of 0.5-20,000 mg/L at 24-, 48-, and 72-h post-fertilization (hpf). Heart rate increased significantly in embryos exposed to 2 mg/L and 10 mg/L HFPO-DA across all time points. Spinal deformities and edema phenotypes were evident among embryos exposed to 1000-16,000 mg/L HFPO-DA at 72 hpf. A median lethal concentration (LC50) was derived as 7651 mg/L at 72 hpf. Shallow RNA sequencing analysis of 9465 transcripts identified 38 consistently differentially expressed genes at 0.5 mg/L, 1 mg/L, 2 mg/L, and 10 mg/L HFPO-DA exposures. Notably, seven downregulated genes were associated with visual response, and seven upregulated genes were expressed in or regulated the cardiovascular system. This study identifies biological targets and molecular pathways affected during animal development by an emerging, potentially problematic, and ubiquitous industrial chemical.					1			C	C		HFPO-DA（GenX）のゼブラフィッシュを用いた試験。胚毒性の可能性は示唆できるだろうが、それ以上ではない。遺伝子発現解析も行っているが、魚類であることもあり評価に使用できるとは思えない。
D1295	実験動物（生殖発生毒性）	Wang, YH; Jiang, SN; Wang, BB; Chen, X; Lu, GH	Comparison of developmental toxicity induced by PFOA, HFPO-DA, and HFPO-TA in zebrafish embryos	2023	Chemosphere. 2023 Jan;311(Pt 1):136999. doi: 10.1016/j.chemosphere.2022.136999.	Hexafluoropropylene oxide dimer acids (HFPO-DA) and hexafluoropropylene oxide trimer acids (HFPO-TA) are alternatives to perfluorooctanoic acid (PFOA). However, little information on the comparison of their toxicities is available. Here, zebrafish embryos were exposed to PFOA, HFPO-DA, and HFPO-TA with exposure concentra-tions of 5 and 500 mu g/L. Behavioral abnormal, enzyme activities and gene expression profiles in zebrafish em-bryos were determined. Results showed that exposure to PFOA and its alternatives increased heart rates and inhibited locomotor activity of zebrafish embryos. Further, their exposures changed the enzyme activities (acetylcholinesterase and oxidative stress-related enzymes), ATP content, and expressions of genes related to hypothalamic-pituitary-thyroid (HPT) axis, apoptosis, and lipid metabolism. Comparison analyses found that PFOA, HFPO-TA, and HFPO-DA exposures induced different effects on the embryonic development of zebrafish, which indicates the different modes of action. The HFPO-DA exposure induced specific effects on the disorder of lipid metabolism, HPT axis, and neurodevelopment. The HFPO-TA exposure also induced different effects from the PFOA exposure, which focused on lipid metabolism. The current data shows that the HFPO-DA and HFPO-TA might not be safe alternatives to PFOA. This study provides a new understanding of the biological hazards of PFOA alternatives in aquatic organisms, which can guide their usage.					1			C	C		HFPO-DA（GenX）とHFPO-TA bゼブラフィッシュを持ちた試験。生物学的な危険性は示唆しているのだろうが、哺乳類へ外挿できるのか甚だ疑問。
D1296	実験動物（生殖発生毒性）	Peng, BX; Li, FF; Mortimer, M; Xiao, X; Ni, Y; Lei, YY; Li, MJ; Guo, LH	Perfluorooctanoic acid alternatives hexafluoropropylene oxides exert male reproductive toxicity by disrupting blood-testis barrier	2022	Sci. Total Environ. 2022 Nov:846:157313. doi: 10.1016/j.scitotenv.2022.157313.	As alternatives to perfluorooctanoic acid (PFOA), hexafluoropropylene oxide (HFPO) homologues, including hexafluoropropylene oxide dimer acid (HFPO-DA), hexafluoropropylene oxide trimer acid (HFPO-TA), and hexafluoropropylene oxide tetramer acid (HFPO-TeA), have attracted widespread attention recently due to their environ-mental ubiquity and high potential for bioaccumulation and toxicity. In the present study, a set of in vivo mouse and in vitro mouse testicular Sertoli TM4 cell experiments were employed to explore the male reproductive toxicity and underlying mechanisms of HFPO homologues on blood-testis barrier. Tissue and permeability analyses of mice testes after 28-day treatment with 5 mg/kg/day HFPO-DA or PFOA, or 0.05 mg/kg/day HFPO-TA or HFPO-TeA indicated that there was an increase in the degradation of TJ protein occludin in mice with a disrupted blood-testis barrier (BTB). Following expo-sure to 100 mu M HFPO-DA, HFPO-TA or 10 mu M PFOA, HFPO-TeA, transepithelial electrical resistance measurements of TM4 cells also indicated BTB disruption. Additionally, as a result of the exposure, matrix metalloproteinase-9 expression was enhanced through activation of p38 MAPK, which promoted the degradation of occludin. On the whole, the results indicated HFPO homologues and PFOA induced BTB disruption through upregulation of p-p38/p38 MAPK/MMP-9 path-way, which promoted the degradation of TJ protein occludin and caused the disruption of TJ.					1			C	C		HFPO-DA、HFPO-TA、PFOA、HFPO-TeA のマウスを用いた in vivo および in virro（培養セルトリセル使用）試験。血液精巣関門への影響に焦点を当てているが、包括的生殖発生毒性試験ではない。機能解析の論文としても価値は高くないと判断した。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1297	実験動物（生殖発生毒性）	Thunga, P; Truong, L; Rericha, Y; Du, JL; Morshead, M; Tanguay, RL; Reif, DM	Utilizing a Population-Genetic Framework to Test for Gene-Environment Interactions between Zebrafish Behavior and Chemical Exposure	2022	Toxics. 2022 Dec;10(12):769. doi: 10.3390/toxics10120769.	Individuals within genetically diverse populations display broad susceptibility differences upon chemical exposures. Understanding the role of gene-environment interactions (GxE) in differential susceptibility to an expanding exposome is key to protecting public health. However, a chemical's potential to elicit GxE is often not considered during risk assessment. Previously, we've leveraged high-throughput zebrafish (Danio rerio) morphology screening data to reveal patterns of potential GxE effects. Here, using a population genetics framework, we apportioned variation in larval behavior and gene expression in three different PFHxA environments via mixed-effect modeling to assess significance of GxE term. We estimated the intraclass correlation (ICC) between full siblings from different families using one-way random-effects model. We found a significant GxE effect upon PFHxA exposure in larval behavior, and the ICC of behavioral responses in the PFHxA exposed population at the lower concentration was 43.7%, while that of the control population was 14.6%. Considering global gene expression data, a total of 3746 genes showed statistically significant GxE. By showing evidence that heritable genetics are directly affecting gene expression and behavioral susceptibility of individuals to PFHxA exposure, we demonstrate how standing genetic variation in a heterogeneous population such as ours can be leveraged to test for potential GxE.		1						C	C		PFHxA のゼブラフィッシュを用いた試験。哺乳類（ヒト・げっ歯類）の毒性を考察するには不適。
D1298	実験動物（生殖発生毒性）	Robarts DR, Paine-Cabrera D, Kotulkar M, Venneman KK, Gunewardena S, Corton JC, Lau C, Foquet L, Bial G, Apte U.	Identifying Human Specific Adverse Outcome Pathways of Per- and Polyfluoroalkyl Substances Using Liver-Chimeric Humanized Mice	2023	bioRxiv. 2023 Feb 3:2023.02.01.526711. doi: 10.1101/2023.02.01.526711. Preprint.	Background: Per- and polyfluoroalkyl substances (PFAS) are persistent organic pollutants with myriad adverse effects. While perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) are the most common contaminants, levels of replacement PFAS, such as perfluoro-2-methyl-3-oxahexanoic acid (GenX), are increasing. In rodents, PFOA, PFOS, and GenX have several adverse effects on the liver, including nonalcoholic fatty liver disease. Objective: We aimed to determine human-relevant mechanisms of PFAS induced adverse hepatic effects using FRG liver-chimeric humanized mice with livers repopulated with functional human hepatocytes. Methods: Male humanized mice were treated with 0.067 mg/L of PFOA, 0.145 mg/L of PFOS, or 1 mg/L of GenX in drinking water for 28 days. Liver and serum were collected for pathology and clinical chemistry, respectively. RNA-sequencing coupled with pathway analysis was used to determine molecular mechanisms. Results: PFOS caused a significant decrease in total serum cholesterol and LDL/VLDL, whereas GenX caused a significant elevation in LDL/VLDL with no change in total cholesterol and HDL. PFOA had no significant changes in serum LDL/VLDL and total cholesterol. All three PFAS induced significant hepatocyte proliferation. RNA-sequencing with alignment to the human genome showed a total of 240, 162, and 619 differentially expressed genes after PFOA, PFOS, and GenX exposure, respectively. Upstream regulator analysis revealed inhibition of NR1D1, a transcriptional repressor important in circadian rhythm, as the major common molecular change in all PFAS treatments. PFAS treated mice had significant nuclear localization of NR1D1. In silico modeling showed PFOA, PFOS, and GenX potentially interact with the DNA-binding domain of NR1D1. Discussion: These data implicate PFAS in circadian rhythm disruption via inhibition of NR1D1. These studies show that FRG humanized mice are a useful tool for studying the adverse outcome pathways of environmental pollutants on human hepatocytes in situ.					1			C	C		私が何かやらかしたのかもしれませんが、機械翻訳が D1299 のもの（と同じもの）になっていましたので、英文 Abst から判断させていただきました。 GenX の雄ヒト化マウスを用いた非生殖発生毒性試験。肝臓への毒性の発生機序を検討した試験であるが、生殖発生毒性試験ではない。
D1299	実験動物（生殖発生毒性）	Dong Q, Guo Y, Yuan J, Zhong S, Ni H, Liu J, Zhang M, Sun J, Yuan S, Yu H, Zhong Y, Jiang Q.	Hexafluoropropylene oxide tetramer acid (HFPO-TeA)-induced developmental toxicities in chicken embryo: Peroxisome proliferator-activated receptor Alpha (PPARα) is involved	2023	Ecotoxicol Environ Saf. 2023 Mar 15;253:114671. doi: 10.1016/j.ecoenv.2023.114671. Epub 2023 Feb 21.	Hexafluoropropylene oxide tetramer acid (HFPO-TeA) is an emerging environmental contaminant, with environmental presence but limited toxicological information. To investigate its potential developmental toxicities, various doses of HFPO-TeA exposure were achieved in chicken embryos via air cell injection, and the exposed embryos were incubated until hatch. Within 24 h of hatch, the hatchling chickens were assessed with electrocardiography and histopathology for toxicological evaluation. For mechanistic investigation, in ovo silencing of PPARα was achieved via lentivirus microinjection, then the morphological/functional endpoints along with protein expression levels of PPARα-regulated genes were assessed. HFPO-TeA exposure in chicken embryo resulted in developmental cardiotoxicity and hepatotoxicity. Specifically, decreased right ventricular wall thickness, increased heart rate and hepatic steatosis were observed, whereas silencing of PPARα resulted in alleviation of observed toxicities. Western blotting for EHHADH and FABPs suggested that developmental exposure to HFPO-TeA effectively increased the expression levels of both targets in hatchling chicken heart and liver tissue samples, while PPARα silencing prevented such changes, suggesting that PPARα and its downstream genes are playing critical roles in HFPO-TeA induced developmental toxicities.					1			C	D		HFPO-TeAのニワトリ胚を用いた試験。ニワトリ胚を使用した毒性試験の経験がなく、空気細胞注入（気室注入）法による暴露がどういうものなのか不明。心毒性と肝毒性が観察され、PPAR αの関与も検討している。 ニワトリ胚を使っている時点で不要だとは思いますが、何をやっているのか、実系が私では理解できないので判断できません。
D1300	in vitro（発がん性）	Pierozan, P; Cattani, D; Karlsson, O	Tumorigenic activity of alternative per- and polyfluoroalkyl substances (PFAS): Mechanistic in vitro studies	2022	Sci. Total Environ. 2022 Feb:808:151945. doi: 10.1016/j.scitotenv.2021.151945.	Environmental contaminants including long-chain per- and polyfluoroalkyl substances (PFAS) have been linked to cancer, which is a central cause of mortality in humans and many wildlife species. Today shorter-chain PFAS are extensively used as replacement compounds and commonly found in the environment. Mechanistic studies are important for a better understanding of their toxicological potential and possible role in cancer etiology. Here, we treated normal human breast epithelial cells (MCF-10A) with 500 pM to 500 mu M of perfluorohexane sulfonate (PFHxS), undecafluorohexanoic acid (PFHxA), hexafluoropropylene oxide-dimer acid (GenX), perfluoro 3,6 dioxaoctanoic acid (PFO2OA), heptafluorobutyric acid (HFBA) and perfluorobutanesulfonic acid (PFBS) for 72 h to investigate potential effects on cell proliferation and neoplastic transformation. PFHxA, GenX, PFO2OA, HFBA and PFBS induced no alterations compared to controls at any of the concentrations tested. Exposure to 100 mu M PFHxS on the other hand was shown to affect important regulatory cell-cycle proteins (cyclin D1, CDK6, p27, p53 and ERK) and induced cell proliferation, at least in part through activation of the constitutive androstane receptor (CAR) and the peroxisome proliferator-activated receptor alpha (PPAR alpha). PFHxS also altered histone modifications and induced cell malignance by reducing the levels of adhesion proteins (E-cadherin and beta-integrin) and promoting cell migration and invasion. These results demonstrate that five out of six alternative PFAS tested are clearly less harmful to MCF-10A cells than previously studied PFOS and PFOA, but raise concerns about PFHxS that also has been associated with breast cancer in epidemiological studies.		1	1		1			B	-		
D1301	in vitro（酸化ストレス）	Solan, ME; Koperski, CP; Senthilkumar, S; Lavado, R	Short-chain per- and polyfluoralkyl substances (PFAS) effects on oxidative stress biomarkers in human liver, kidney, muscle, and microglia cell lines	2023	Environ. Res. 2023 Apr:223:115424. doi: 10.1016/j.envres.2023.115424.	Long-chain per-and polyfluoralkyl substances (PFAS) are ubiquitous contaminants implicated in the induction of intracellular reactive oxygen species (ROS), compromising antioxidant defense mechanisms in vitro and in vivo. While a handful of studies have assessed oxidative stress effects by PFAS, few specifically address short-chain PFAS. We conducted an evaluation of oxidative stress biomarkers in vitro following exposures to low (1 nM) and high (1 mu M) concentrations of five short-chain PFAS compounds: perfluorobutanesulfonic acid (PFBS), perfluorohexanoic acid (PFHxA), [undecafluoro-2-methyl-3-oxahexanoic acid (HFPO-DA)], 6:2 fluorotelomer alcohol (6:2 FTOH) and perfluorohexanesulfonic acid (PFHxS). We conducted experiments in human kidney (HEK293-hTLR2), liver (HepaRG), microglia (HMC-3), and muscle (RMS-13) cell lines. Fluorescence microscopy measurements in HepaRG cells indicated ROS generation in cells exposed to PFBS and PFHxA for 24 h. Anti-oxidant enzyme activities were determined following 24 h short-chain PFAS exposures in HepaRG, HEK293-hTLR2, HMC-3, and RMS-13. Notably, exposure to PFBS for 24 h increased the activity of GPX in all four cell types at 1 mu M and 1 nM in HepaRG and RMS-13 cells. Every short-chain PFAS evaluated, except for PFHxS, increased the activity of at least one antioxidant enzyme. To our knowledge, this is the first study of its kind to explore antioxidant defense alterations to microglia and muscle cell lines by PFAS. The findings of this study hold great potential to contribute to the limited understanding of short-chain PFAS mechanisms of toxicity and provide data necessary to inform the human health risk assessment process.		1		1	1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1302	in vitro（酸化ストレス）	Liu, CC; Zhu, XY; You, LH; Gin, KYH; Chen, H; Chen, BL	Per/polyfluoroalkyl substances modulate plasmid transfer of antibiotic resistance genes: A balance between oxidative stress and energy support	2023	Water Res. 2023 Jul:240:120086. doi: 10.1016/j.watres.2023.120086.	Emerging contaminants can accelerate the transmission of antibiotic resistance genes (ARGs) from environmental bacteria to human pathogens via plasmid conjugation, posing a great challenge to the public health. Although the toxic effects of per/polyfluoroalkyl substances (PFAS) as persistent organic pollutants have been understood, it is still unclear whether and how PFAS modulate the transmission of ARGs. In this study, we for the first time reported that perfluorooctanoic acid (PFOA), perfluorododecanoic acid (PFDoA) and ammonium perfluoro (2-methyl-3-oxahexanoate) (GenX) at relatively low concentrations (0.01, 0.1 mg/L) promoted the conjugative transfer of plasmid RP4 within Escherichia coli, while the plasmid conjugation was inhibited by PFOA, PFDoA and GenX at relatively high concentrations (1, 10 mg/L). The non-unidirectional conjugation result was ascribed to the co-regulation of ROS overproduction, enhanced cell membrane permeability, shortage of energy support as well as L-arginine pool depletion. Taking the well-known PFOA as an example, it significantly enhanced the conjugation frequency by 1.4 and 3.4 times at relatively low concentrations (0.01, 0.1 mg/ L), respectively. Exposure to PFOA resulted in enhanced cell membrane permeability and ROS overproduction in donor cells. At high concentrations of PFOA (1, 10 mg/L), although enhanced oxidative stress and cell membrane permeability still occurred, the ATP contents in E. coli decreased, which contributed to the inhibited conjugation. Transcriptome analysis further showed that the expression levels of genes related to arginine biosynthesis (argA, argC, argF, argG, argI) and transport (arti, artM, artQ) pathways were significantly increased. Intracellular Larginine concentration deficiency were observed at high concentrations of PFOA. With the supplementary exogenous arginine, it was demonstrated that arginine upregulated conjugation transfer- related genes (trfAp, trbBp) and restores the cell number of transconjugants in PFOA-treated group. Therefore, the inhibited conjugation at high concentrations PFOA were attributed to the shortage of ATP and the depletion of L-arginine pool. These findings provide important insights into the effect environmental concentrations of PFAS on the conjugative transfer of ARGs, and update the regulation mechanism of plasmid conjugation, which is critical for the management of antibiotic resistance in aquatic environments.					1			C	-		
D1303	実験動物（その他）	Wasel, O; Thompson, KM; Freeman, JL	Assessment of unique behavioral, morphological, and molecular alterations in the comparative developmental toxicity profiles of PFOA, PFHxA, and PFBA using the zebrafish model system	2022	Environ. Int. 2022 Dec:170:107642. doi: 10.1016/j.envint.2022.107642.	Perfluoroalkyl substances (PFAS) are a class of synthetic chemicals that are persistent in the environment. Due to adverse health outcomes associated with longer chain PFAS, shorter chain chemicals were used as replacements, but developmental toxicity assessments of the shorter chain chemicals are limited. Toxicity of three per-fluoroalkyl acids (PFAAs) [perfluorooctanoic acid (PFOA), composed of 8 carbon (C8), perfluorohexanoic acid (PFHxA, C6), and perfluorobutanoic acid (PFBA, C4)] was compared in developing zebrafish (Danio rerio). LC50s at 120 h post fertilization (hpf) assessed potency of each PFAA by exposing developing zebrafish (1-120 hpf) to range of concentrations. Zebrafish were then exposed to sublethal concentrations (0.4-4000 ppb, mu g/L) throughout embryogenesis (1-72 hpf). Effects of the embryonic exposure on locomotor activities was completed with the visual motor response test at 120 hpf. At 72 hpf, morphological changes (total body length, head length, head width) and transcriptome profiles to compare altered molecular and disease pathways were determined. The LC50 ranking followed trend as expected based on chain length. PFOA caused hyperactivity and PFBA hypoactivity, while PFHxA did not change behavior. PFOA, PFHxA, and PFBA caused morphological and tran-scriptomic alterations that were unique for each chemical and were concentration-dependent indicating different toxicity mechanisms. Cancer was a top disease for PFOA and FXR/RXR activation was a top canonical pathway for PFBA. Furthermore, comparison of altered biological and molecular pathways in zebrafish exposed to PFOA matched findings reported in prior epidemiological studies and other animal models, supporting the predictive value of the transcriptome approach and for predicting adverse health outcomes associated with PFHxA or PFBA exposure.	1	1						C	-		
D1304	in vitro（神経毒性）	Wu, SC; Xie, JK; Zhao, H; Sanchez, O; Zhao, XH; Freeman, JL; Yuan, CL	Pre-differentiation GenX exposure induced neurotoxicity in human dopaminergic-like neurons	2023	Chemosphere. 2023 Aug:332:138900. doi: 10.1016/j.chemosphere.2023.138900.	GenX, also known as hexafluoropropylene oxide dimer acid (HFPO-DA) was introduced as a safer alternative to perfluorooctanoic acid (PFOA) in 2009. After nearly two decades of applications there are increasing safety concerns about GenX due to its association with various organ damages. Few studies, however, have system-atically assessed the molecular neurotoxicity of low-dose GenX exposure. Here, we evaluated the effects of pre-differentiation exposure of GenX on dopaminergic (DA)-like neurons using SH-SY5Y cell line; and assessed changes in epigenome, mitochondrion, and neuronal characteristics. Low dose GenX exposure at 0.4 and 4 mu g/L prior to differentiation induced persistent changes in nuclear morphology and chromatin arrangements, man-ifested specifically in the facultative repressive marker H3K27me3. We also observed impaired neuronal network, increased calcium activity along with alterations in Tyrosine hydroxylase (TH) and alpha-Synuclein (alpha Syn) after prior exposure to GenX. Collectively, our results identified neurotoxicity of low-dose GenX exposure in human DA-like neurons following a developmental exposure scheme. The observed changes in neuronal char-acteristics suggest GenX as a potential neurotoxin and risk factor for Parkinson's disease.					1			B	-		
D1305	実験動物（急性毒性）	Chowdhury, MI; Sana, T; Panneerselvan, L; Dharmarajan, R; Megharaj, M	Acute Toxicity and Transgenerational Effects of Perfluorobutane Sulfonate on Caenorhabditis elegans	2021	Environ. Toxicol. Chem. 2021 Jul:40(7):1973-1982. doi: 10.1002/etc.5055.	Perfluorobutane sulfonate (PFBS), due to its increasing use as an alternative to perfluooctane sulfonate (PFOS), is widely detected in humans and the environment, necessitating the evaluation of its potential ecotoxicological risk. We assessed the toxicity and bioaccumulation potential of PFBS in Caenorhabditis elegans, using lethality, locomotion, reproduction, life span, growth, and chemotactic behavior as the effect parameters. In addition, a total of 6 generations of exposed parent animals were monitored for locomotion, brood, and life span behaviors. Life span and brood size were significantly reduced in parent nematodes (P0) following exposure to >= 0.1 mM PFBS, but these negative effects did not transfer to the progeny. Although there was no remarkable effect on reproduction and life span in parent worms exposed to <= 0.01 mM PFBS, multigenerational exposure at 0.0005 mM significantly affected the F4 and F5 progeny. Furthermore, 0.01 to 2.0 mM of PFBS substantially retarded the locomotion behavior of P0 worms. At higher concentrations such as 1.0 mM, this negative effect on locomotion was transferred to the next generation (F1) but later recovered from F2 progeny onward. Our findings demonstrate for the first time that chronic exposure to PFBS at higher concentrations can cause behavioral toxicity and could be transferred to the progeny. These findings have significant implications for the environmental risk assessment of PFBS.								C	-		
D1306	実験動物（発がん性）	Temkin, AM; Hocevar, BA; Andrews, DQ; Naidenko, OV; Kamendulis, LM	Application of the Key Characteristics of Carcinogens to Per and Polyfluoroalkyl Substances	2020	Int. J. Environ. Res. Public Health. 2020 Mar;17(5):1668. doi: 10.3390/ijerph17051668.	Per- and polyfluoroalkyl substances (PFAS) constitute a large class of environmentally persistent chemicals used in industrial and consumer products. Human exposure to PFAS is extensive, and PFAS contamination has been reported in drinking water and food supplies as well as in the serum of nearly all people. The most well-studied member of the PFAS class, perfluorooctanoic acid (PFOA), induces tumors in animal bioassays and has been associated with elevated risk of cancer in human populations. GenX, one of the PFOA replacement chemicals, induces tumors in animal bioassays as well. Using the Key Characteristics of Carcinogens framework for cancer hazard identification, we considered the existing epidemiological, toxicological and mechanistic data for 26 different PFAS. We found strong evidence that multiple PFAS induce oxidative stress, are immunosuppressive, and modulate receptor-mediated effects. We also found suggestive evidence indicating that some PFAS can induce epigenetic alterations and influence cell proliferation. Experimental data indicate that PFAS are not genotoxic and generally do not undergo metabolic activation. Data are currently insufficient to assess whether any PFAS promote chronic inflammation, cellular immortalization or alter DNA repair. While more research is needed to address data gaps, evidence exists that several PFAS exhibit one or more of the key characteristics of carcinogens.								C	-		
D1307	実験動物（急性致死毒性および多世代亜致死毒性）	Tominaga, N; Kohra, S; Iguchi, T; Arizono, K	Effects of perfluoro organic compound toxicity on nematode Caenorhabditis elegans fecundity	2004	J. Health Sci. 2004 Oct:50(5):545-550. doi: 10.1248/jhs.50.545.	Toxicity studies using the nematode Caenorhabditis elegans (C elegans) as a model organism have shown that perfluoro organic compounds have sub-lethal toxicity at the 10 pM-100 nM range on multi-generation assays. We examined the acute lethal toxicity and multi-generational sublethal toxicity (fecundity and reproduction) of perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and salts of perfluoro-1-octansulfonic acid (PFOS) using 1.7 % agar Nematode Growth Medium (NGM) plates. The fluorine compounds affected the fecundity of C. elegans at concentrations 10(5)- to 10(8)-fold lower than the median effective concentrations (EC50). In particular, worm abundance during the first generation did not differ significantly from controls, while in contrast, the number of worms in the fourth generation at 10 pM PFOS-tetraethylammonium (TEA) decreased significantly to about 50% of control ($p < 0.01$) and the number of eggs and worms in the fourth generation at 1 nM PFNA decreased significantly to about 30% of control ($p < 0.01$). However, no dose-response relationship was observed in this study. We confirmed that perfluoro organic compounds strongly disrupt fecundity in C elegans.								C	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1308	実験動物（神経毒性）	Min, EK; Lee, HYJ; Sung, EJ; Seo, SW; Song, MYH; Wang, SJ; Kim, SS; Bae, MA; Kim, TY; Lee, SKY; Kim, KT	Integrative multi-omics reveals analogous developmental neurotoxicity mechanisms between perfluorobutanesulfonic acid and perfluorooctanesulfonic acid in zebrafish	2023	J. Hazard. Mater. 2023 Sep:457:131714. doi: 10.1016/j.jhazmat.2023.131714.	The molecular mechanism of perfluorobutanesulfonic acid (PFBS), an alternative to legacy perfluorooctanesulfonic acid (PFOS), is not fully understood yet. Therefore, we conducted a developmental toxicity evaluation on zebrafish embryos exposed to PFBS and PFOS and assessed neurobehavioral changes at concentrations below each point of departure (POD) determined by embryonic mortality. Using transcriptomics, proteomics, and metabolomics, biomolecular perturbations in response to PFBS were profiled and then integrated for comparison with those for PFOS. Although PFBS (7525.47 μM POD) was approximately 700 times less toxic than PFOS (11.42 μM POD), altered neurobehavior patterns and affected kinds of endogenous neurochemicals were similar between PFBS and PFOS at the corresponding POD-based concentrations. Multi-omics analysis revealed that the PFBS neurotoxicity mechanism was associated with oxidative stress, lipid metabolism, and glycolysis/glucogenesis. The commonalities in developmental neurotoxicity-related mechanisms between PFBS and PFOS interconnected by knowledge-based integration of multi-omics included the calcium signaling pathway, lipid homeostasis, and primary bile acid biosynthesis. Despite being less toxic than PFOS, PFBS exhibited similar dysregulated molecular mechanisms, suggesting that chain length differences do not affect the intrinsic toxicity mechanism. Overall, carefully managing potential toxicity of PFBS can secure its status as an alternative to PFOS.				1				B	-	ゼブラフィッシュ	
D1309	実験動物（神経毒性）	Liu, S; Qiu, WH; Li, RZ; Chen, B; Wu, X; Magnuson, JT; Xu, BT; Luo, SS; Xu, EG; Zheng, CM	Perfluorononanoic Acid Induces Neurotoxicity via Synaptogenesis Signaling in Zebrafish	2023	Environ. Sci. Technol. 2023 Mar:57(9):3783-3793. doi: 10.1021/acs.est.2c06739.	Perfluorononanoic acid (PFNA), commonly used as an alternative polyfluorinated compound (PFC) of perfluorooctanoic acid (PFOA), has been widely detected in the aquatic environment. Previous ecotoxicological and epidemiological results suggested that some neurobehavioral effects were associated with PFC exposure; however, the ecological impacts and underlying neurotoxicity mechanisms remain unclear, particularly in aquatic organisms during sensitive, early developmental stages. In this study, zebrafish embryos were exposed to environmentally relevant concentrations of PFNA for 120 h, and the neurological effects of PFNA were comprehensively assessed using transcriptional, biochemical, morphological, and behavioral assays. RNA sequencing and advanced bioinformatics analyses predicted and characterized the key biological processes and pathways affected by PFNA exposure, which included the synaptogenesis signaling pathway, neurotransmitter synapse, and CREB signaling in neurons. Neurotransmitter levels (acetylcholine, glutamate, 5-hydroxytryptamine, gamma-aminobutyric acid, dopamine, and noradrenaline) were significantly decreased in zebrafish larvae, and the Tg(gad67:GFP) transgenic line revealed a decreased number of GABAergic neurons in PFNA-treated larvae. Moreover, the swimming distance, rotation frequency, and activity degree were also significantly affected by PFNA, linking molecular-level changes to behavioral consequences.			1					B	-	ゼブラフィッシュ	
D1310	実験動物（神経毒性）	Rericha, Y; Truong, L; Leong, C; Cao, DP; Field, JA; Tanguay, RL	Dietary Perfluorohexanoic Acid (PFHxA) Exposures in Juvenile Zebrafish Produce Subtle Behavioral Effects across Generations	2022	Toxics. 2022 Jul;10(7):372. doi: 10.3390/toxics10070372.	Ubiquitous anthropogenic contaminants of concern, per- and polyfluoroalkyl substances (PFAS) are frequently detected in the environment and human populations around the world. Diet is a predominate route of human exposure, and PFAS are frequently measured in food. Manufacturing trends have shifted from legacy PFAS to shorter-chain alternatives that are suggested to be safer, such as perfluorohexanoic acid (PFHxA). However, the current amount of data to support safety assessments of these alternatives is not yet sufficient. The present study investigated the effects of a 42-day dietary exposure to 1, 10, or 100 ng/g PFHxA in juvenile zebrafish. The zebrafish model was leveraged to interrogate morphometrics, fecundity, and numerous behavior endpoints across multiple generations. Dietary PFHxA exposure did not result in measurable body burden and did not affect growth, fecundity, adult social perception behavior, or associative learning. PFHxA exposure did induce abnormal adult anxiety behaviors in the F0 generation that persisted transgenerationally in the F1 and F2. Abnormal larval and juvenile behavior was observed in the F1 generation, but not in the F2. PFHxA juvenile dietary exposure induced subtle and multigenerational behavior effects that warrant further investigation of this and other alternative short-chain PFAS.		1						B	-	ゼブラフィッシュ	
D1311	実験動物（発達神経毒性）	Guo, XC; Zhang, SN; Liu, XH; Lu, SY; Wu, Q; Xie, P	Evaluation of the acute toxicity and neurodevelopmental inhibition of perfluorohexanoic acid (PFHxA) in zebrafish embryos	2021	Ecotox. Environ. Safe. 2021 Dec:225:112733. doi: 10.1016/j.ecoenv.2021.112733.	Perfluorohexanoic acid (PFHxA), a widely used emerging alternative for 8-carbon PFAAs, has been detected at a high level in the water environment. While its toxicity and environmental health risk are still largely unknown in aquatic life. The present study aimed to evaluated the possible developmental neurotoxicity induced by PFHxA exposure (0, 0.48, 2.4, and 12 mg/L for 120 h) in the zebrafish embryo. Here, both developmental endpoints, neurotransmitters concentrations, locomotor behavior were analyzed. No significant effects on mortality, malformation rate, and growth delay were detected in the low dose treatment groups except for in the high dose group (12 mg/L). A significant increase in swimming speed were noted in the 0.48 mg/L group. Other changes including neurotransmitters concentrations and green fluorescent protein (GFP) expression in Tg (HuC-GFP) zebrafish larvae were significantly increased in 12 mg/L group. Beyond that, genes related to neurodevelopment were significantly decreased in larvae. Moreover, downregulations of protein expression levels of alpha 1-tubulin, elavl3, and gap43 were identified. These results demonstrate that the PFAAs alternative PFHxA have no significant neurodevelopmental effects on zebrafish larvae under acute low-dose exposure, while, it is important to note that PFHxA perform inhibiting effects on neurotransmitter and central nervous system under a relatively high dose. This in vivo study could provide reliable toxicity information for risk assessments of PFHxA on aquatic ecosystems. Capsule: PFHxA have no significant neurodevelopmental effects on zebrafish larvae under acute low-dose exposure, while exposed with relatively high-dose, could induced the alternations of neurotransmitter concentrations as well as the genes involved in the early developmental stages of zebrafish, leading to the impairment of the nervous system in zebrafish larvae.		1						B	-	ゼブラフィッシュ	
D1312	実験動物（発がん性）	Wei, Y; He, HB; Han, T; Wang, B; Ji, P; Wu, XZ; Qian, J; Shao, PF	Environmental explanation of prostate cancer progression based on the comprehensive analysis of perfluorinated compounds	2023	Ecotox. Environ. Safe. 2023 Sep:263:115267. doi: 10.1016/j.ecoenv.2023.115267.	Perfluorinated compounds (PFCs) are man-made chemicals used in the manufacture of many products with water and dirt repellent properties. Many diseases have been proved to be related to the exposure of PFCs, including breast fibroadenoma, hepatocellular carcinoma, breast cancer and leydig cell adenoma. However, whether the PFCs promote the progression of prostate cancer remains unclear. In this work, through comprehensive bioin-formatics analysis, we discovered the correlation between the prostate cancer and five PFCs using Comparative Toxicogenomics Database (CTD), Gene Expression Omnibus (GEO) and The Cancer Genome Atlas (TCGA) da-tabases. In addition, further analysis showed that several PFCs-related genes demonstrated strong prognostic value for prostate cancer patients. The survival analysis and receiver operating characteristic (ROC) curves revealed that PFCs-related genes based prognostic model held great predictive value for the prognosis of prostate cancer, which could potentially serve as an independent risk factor in the future. In vitro experiments verified the promotive role of perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) in the growth of prostate cancer cells. This study provided novel insights into understanding the role of PFCs in prostate cancer and brought attention to the environmental association with cancer risks and progression.			1				1	A	-	Online database解析	
D1313	実験動物（発がん性）	Rae, JMC; Craig, L; Slone, TW; Frame, SR; Buxton, LW; Kennedy, GL	Evaluation of chronic toxicity and carcinogenicity of ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate in Sprague-Dawley rats	2015	Toxicol. Rep. 2015:2:939-949. doi: 10.1016/j.toxrep.2015.06.001	Ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate, developed for use as a polymerization processing aid in the manufacture of fluoropolymers, was tested for its potential chronic toxicity and carcinogenicity in a 2-year oral dosing study in Sprague-Dawley rats. Male rats were given daily doses of either 0, 0.1, 1 or 50 mg/kg; females were given either 0, 1, 50 or 500 mg/kg. Body weights, food consumption and clinical signs were monitored daily; clinical pathology was conducted at designated intervals and animals were given a complete pathological evaluation after 12 months and 24 months of dosing. Normal survival was seen in all groups, no abnormal clinical signs were seen, and body weight gain was reduced only in female rats at 500 mg/kg. Both sexes at the high dose had mild decreases in red cell mass which were somewhat more pronounced in females. Clinical pathology indicative of liver injury was present in males that received 50 mg/kg and correlated with histomorphological liver changes that included both hypertrophic and degenerative/necrotic lesions. Similar histomorphological lesions were seen in the livers of females at 500 mg/kg. Previous shorter term toxicity studies have identified this chemical as a PPAR alpha agonist and the finding of benign tumors of the liver, pancreas and/or testes in males at 50 mg/kg and females at 500 mg/kg is consistent with the rat response to peroxisome proliferators and is of questionable human relevance. Changes in the kidney, tongue, and stomach were observed only at the highest dose of 500 mg/kg in females. The no-observed-adverse-effect-level in this study lies between 1 and 50 mg/kg for males and between 50 and 500 mg/kg for females.						No. 653と重複		A	-		
D1314	実験動物（反復投与毒性）	Weatherly, LM; Shane, HL; Lukomska, E; Baur, R; Anderson, SE	Systemic toxicity induced by topical application of perfluoroheptanoic acid (PFHpA), perfluorohexanoic acid (PFHxA), and perfluoropentanoic acid (PFPeA) in a murine model	2023	Food Chem. Toxicol. 2023 Jan:171:113515. doi: 10.1016/j.fct.2022.113515.	Per-and polyfluoroalkyl substances (PFAS) are a class of synthetic structurally diverse chemicals incorporated into industrial and consumer products. PFHpA, PFHxA, and PFPeA are carboxylic PFAS (C7, C6, C5, respectively) labeled as a safer alternative to legacy carboxylic PFAS due to their shorter half-life in animals. Although there is a high potential for dermal exposure, these studies are lacking. The present study conducted analyses of serum chemistries, immune phenotyping, gene expression, and histology to evaluate the systemic toxicity of a sub -chronic 28-day dermal exposure of alternative PFAS (1.25-5% or 31.25-125 mg/kg/dose) in a murine model. Liver weight (% body) significantly increased with PFHpA, PFHxA, and PFPeA exposure and histopathological changes were observed in both the liver and skin. Gene expression changes were observed with PPAR isoforms in the liver and skin along with changes in genes involved in steatosis, fatty acid metabolism, necrosis, and inflammation. These findings, along with significant detection levels in serum and urine, support PFAS-induced liver damage and PPAR alpha, delta, and gamma involvement in alternative PFAS systemic toxicity and immunological disruption. This demonstrates that these compounds can be absorbed through the skin and brings into question whether these PFAS are a suitable alternative to legacy PFAS.		1						B	-	経皮曝露	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1315	実験動物（神経毒性）	Khan, EA; Bertotto, LB; Dale, K; Lille-Langoy, R; Yadetie, F; Karlsen, OA; Goksoyr, A; Schlenk, D; Arukwe, A	Modulation of Neuro-Dopamine Homeostasis in Juvenile Female Atlantic Cod (Gadus morhua) Exposed to Polycyclic Aromatic Hydrocarbons and Perfluoroalkyl Substances	2019	Environ. Sci. Technol. 2019 Jun:53(12):7036-7044. doi: 10.1021/acs.est.9b00637.	The dopaminergic effect of PAH and PFAS mixtures, prepared according to environmentally relevant concentrations, has been studied in juvenile female Atlantic cod (Gadus morhua). Benzo[a]pyrene, dibenzothiophene, fluorene, naphthalene, phenanthrene, and pyrene were used to prepare a PAH mixture, while PFNA, PFOA, PFOS, and PFTrA were used to prepare a PFAS mixture. Cod were injected intraperitoneally twice, with either a low (1x) or high (20x) dose of each compound mixture or their combinations. After 2 weeks of exposure, levels of plasma 17 beta-estradiol (E2) were significantly elevated in high PAH/high PFAS treated group. Brain dopamine/metabolite ratios (DOPAC/dopamine and HVA+DOPAC/dopamine) changed with E2 plasma levels, except for high PAH/low PFAS and low PAH/high PFAS treated groups. On the transcript levels, th mRNA inversely correlated with dopamine/metabolite ratios and gnrh2 mRNA levels. Respective decreases and increases of drd1 and drd2a after exposure to the high PAH dose were observed. Specifically, high PFAS exposure decreased both drds, leading to high plasma E2 concentrations. Other studied end points suggest that these compounds, at different doses and combinations, have different toxicity threshold and modes of action. These effects indicate potential alterations in the feedback signaling processes within the dopaminergic pathway by these contaminant mixtures.			1					C	-	大西洋マダラ（Gadus morhua）の雌の幼魚	
D1316	in vitro（その他）	Rainieri, S; Conlledo, N; Langerholc, T; Madorran, E; Sala, M; Barranco, A	Toxic effects of perfluorinated compounds at human cellular level and on a model vertebrate	2017	Food Chem. Toxicol. 2017 Jun:104:14-25. doi: 10.1016/j.fct.2017.02.041	This work aims at deepening the understanding of the mode of action of some of the most prominent perfluorinated compounds (PFCs) by detecting in a realistic way their effects. To this end, after adjusting the exposure media taking into account the biological model employed and the physico-chemical properties of PFCs, we evaluated the toxic effects of PFOA, PFOS and PFNA in a human macrophage cell line (TLT cells) and in zebrafish embryos. We performed such evaluation on individual compounds and mixtures. Acute toxicity was greater for PFOS in zebrafish; however, it was greater for PFNA in TLT cells. PFNA was also the compound producing the greatest levels of oxidative stress, both in zebrafish and TLT cells. Additionally, in both biological systems, it showed a much stronger effect on mixtures in comparison to the others PFCs tested in this work. Mixture studies in zebrafish showed that acute toxicity depended on the concentration and that the mixture was far more toxic than the individual compounds. This study highlights the importance of studying PFCs in realistic conditions on various biological models.			1					C	-	ゼブラフィッシュ	
D1317	実験動物（酸化ストレス）	Yang, SL; Liu, SC; Ren, ZM; Jiao, XD; Qin, S	Induction of oxidative stress and related transcriptional effects of perfluorononanoic acid using an in vivo assessment	2014	Comp. Biochem. Physiol. C-Toxicol. Pharmacol. 2014 Mar:160:60-65. doi: 10.1016/j.cbpc.2013.11.007	Perfluorononanoic acid (PFNA) is an organic pollutant ubiquitous in the environment. However, the potential toxicity of PFNA remains largely unknown in teleost fish. This study defined the oxidative stress and related transcriptional effects of PFNA at various concentrations on zebrafish larvae. Activities of superoxide dismutase were induced in PFNA-treated groups but attenuated with exposure to higher concentration. Catalase activity and lipid peroxidation were significantly inhibited or increased at the highest concentration, respectively. To test the apoptotic pathway, several genes related to cell apoptosis were examined using real-time PCR. The expression of p53, apoptosis-inducing factor (AIF) and c-Jun NH (2)-terminal kinase (JNK) was partially increased, while Bcl-2, an anti-apoptotic gene, was reduced, with no significant effects on Bax and caspase-3 during the exposure period. The effect of PFNA on lipid beta-oxidation system was investigated by examining the activity of peroxisome fatty acyl-COA oxidase (ACOX) and the expression of peroxisome proliferating activating receptors (PPARs). ACOX activity was moderately elevated with marginal significance and was not a significant consequence of PPAR alpha and PPAR gamma expression. The overall results suggest that turbulence of oxidative stress and apoptotic pathway is involved in PFNA-induced toxicity in zebrafish larvae, and the gene expression patterns are able to reveal some potential mechanisms of developmental toxicity.			1					C	-	ゼブラフィッシュ	
D1318	実験動物（急性毒性）	Godfrey, A; Abdel-moneim, A; Sepulveda, MS	Acute mixture toxicity of halogenated chemicals and their next generation counterparts on zebrafish embryos	2017	Chemosphere 2017 Aug:181:710-712. doi: 10.1016/j.chemosphere.2017.04.146	Perfluorinated chemicals and flame retardants are halogenated compounds commonly used in food packaging and in clothing and electronics, respectively. Due to the hazardous effects of many of these chemicals, manufacturers are developing next generation potential less toxic alternatives. The objective of this study was to assess the toxicity of potentially safer alternatives, singly and in mixtures, in relation to their first generation counterparts. We used zebrafish embryos as our model organism due to its high structural and functional homology to other vertebrates and its suitability for early developmental studies. We tested three well studied halogens, perfluorooctanoic acid (PFOA), tris (1,3-dichloro-2-propyl) phosphate (TDCPP) and tetrabromobisphenal A (TBBPA), and two less-studied next generation chemicals, 9,10-Dihydro-9-oxa-10-phosphaphenanthrene 10-oxide (DOPO) and perfluorobutyric acid (PFBA). First, we identified their lethal concentration (LC50) under 96 h exposures using zebrafish embryos; chemical LC50 values ranged from 1.3 to 13,795 ppm. Next, we tested the toxicity of tertiary mixtures containing the estimated LC50 values for each chemical which ranged from 126 to 5,094 ppm. We found that chemicals within these mixtures displayed concentration addition suggesting a similar mode of toxic action. Importantly, next generation chemicals were less acutely toxic singly and in mixtures than their first generation counterpart.	1							C	-	ゼブラフィッシュ	
D1319	実験動物（神経毒性）	Liu, MY; Song, SW; Hu, CY; Tang, LZ; Lam, JCW; Lam, PKS; Chen, LG	Dietary administration of probiotic Lactobacillus rhamnosus modulates the neurological toxicities of perfluorobutanesulfonate in zebrafish	2020	Environ. Pollut. 2020 Oct;265(Pt B):114832. doi: 10.1016/j.envpol.2020.114832.	Perfluorobutanesulfonate (PFBS), an aquatic pollutant of emerging concern, is found to disturb the neural signaling along gut-brain axis, whereas probiotic additives have been applied to improve neuroendocrine function of teleosts. Both PFBS and probiotics can commonly target nervous system. However, whether and how probiotic bacteria can modulate the neurotoxicities of PFBS remain not explored. It is thus necessary to elucidate the probiotic modulation of PFBS neurotoxicity, which can provide implications to the application of probiotic bacteria in aquaculture industry. In the present study, adult zebrafish were exposed to 0, 10 and 100 mu g/L PFBS with or without dietary administration of probiotic Lactobacillus rhamnosus. Interaction between PFBS and probiotic along gut-brain axis was examined, covering three dominant pathways (i.e., neurotransmission, immune response and hypothalamic-pituitary-adrenal (HPA) axis). The results showed that, compared to the single effects, PFBS and probiotic coexposure significantly altered the acetylcholinesterase activity and neurotransmitter profiles in gut and brain of zebrafish, with mild effects on neuronal integrity. Neurotransmitters closely correlated reciprocally in intestines, which, however, was distinct from the correlation profile in brains. In addition, PFBS and probiotic were combined to impact brain health through absorption of bacterial lipopolysaccharides and production of inflammatory cytokines. Relative to neurotransmission and immune signaling, HPA axis was not involved in the neurotoxicological interaction between PFBS and probiotic. Furthermore, it needs to point out that interactive modes between PFBS and probiotic varied a lot, depending on exposure concentrations, sex and toxic indices. Overall, the present study provided the first evidence that probiotic supplement could dynamically modulate the neurotoxicities of PFBS in teleost.				1				C	-	ゼブラフィッシュ	
D1320	実験動物（視覚毒性）	Hu, CY; Li, J; Liu, MY; Lam, PKS; Chen, LG	Young fecal transplantation modulates the visual toxicity of perfluorobutanesulfonate in aged zebrafish recipients	2022	Aquat. Toxicol. 2022 Oct:251:106295. doi: 10.1016/j.aquatox.2022.106295.	Perfluorobutanesulfonate (PFBS) is an emerging pollutant of potent toxicity to impair visual system. Previous studies highlighted the applicability of gut microbiota manipulation to mitigate the toxicities of PFBS. However, it remains unknown whether transplantation of whole fecal microbiota to PFBS-disturbed gut can restore the health of the recipient animals, especially for aged fish that are of high susceptibility. In the present study, aged zebrafish of 3 years old were first transplanted with feces from young counterparts and then exposed to environmentally relevant concentrations of PFBS. After exposure, toxic effects of PFBS on visual system of aged zebrafish were elucidated based on transcriptional, proteomic, biochemical, histological, and behavioral evidences. In addition, interaction between young fecal transplant and innate visual toxicity of PFBS was further explored in the aged. The results showed that PFBS singular exposure induced lipid peroxidation (by 1.9-fold) in aged male eyes, which were alleviated by young fecal transplantation. PFBS also disturbed the retinal structure of the aged, which was characterized by increases in plexiform layers, but decreases in ganglion neuron number (by 26.8% and 26.0% in males and females, respectively) and optic nerve width (by 14.1% and 12.7% in males and females, respectively). It was unexpected that young fecal transplant was very potent in re-organizing the histological assembly of aged eyes regardless of PFBS coexposure, underlining the intimate interplay between gut and retina. Proteomic profiling provided more clues about the visual toxicology mechanism of PFBS, which was found to typically interfere with synaptic neurotransmission occurring in plexiform layers. However, proteome perturbation of aged eyes by PFBS exposure was effectively shifted by the transplantation of young feces towards the control phenotype, suggesting the high ameliorative potential of young fecal transplantation along the gutretina axis. Overall, the present study pinpoints the potent visual toxicity of PFBS in aged animals and highlights the efficacy of young fecal transplant to regulate the inherent toxicity of PFBS. Future studies are necessitated to sequence the gut microbiota and unveil the underlying interactive routes between gut microbes and visual system.				1				C	-	ゼブラフィッシュ	

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D1321	実験動物（反復投与毒性）	Han, JS; Jang, S; Son, HY; Kim, YB; Kim, Y; Noh, JH; Kim, MJ; Lee, BS	Subacute dermal toxicity of perfluoroalkyl carboxylic acids: comparison with different carbon-chain lengths in human skin equivalents and systemic effects of perfluoroheptanoic acid in Sprague Dawley rats	2020	Arch. Toxicol. 2020 Feb:94(2):523-539. doi: 10.1007/s00204-019-02634-z.	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are used in various fields but raise concerns regarding human health and environmental consequences. Among PFASs, perfluorooctanoic acid (PFOA) and short-chain perfluoroalkyl carboxylic acids (SC PFCAs) are detectable in skin-contact consumer products and have dermal absorption potential. Here, we investigated the effects of dermal exposure to PFOA and SC PFCAs using in vitro and in vivo models. Human skin equivalents were topically treated with 0.25 mM and 2.5 mM PFOA and SC PFCAs (perfluoropentanoic acid, PFPeA; perfluorohexanoic acid, PFHxA; and perfluoroheptanoic acid, PFHpA) for 6 days, and cell viability, interleukin (IL)-1 alpha, oxidative stress markers (malondialdehyde, MDA; and 8-hydroxydeoxyguanosine, 8-OHdG), and histopathology were examined. MDA levels were significantly higher in the PFASs groups than in controls. Compared with SC PFCAs, 2.5 mM PFOA caused more IL-1 alpha ($p < 0.001$) release, decreased skin thickness and microscopic abnormalities. To evaluate systemic effects, Sprague Dawley (SD) rats were dermally treated with 250 and 1000 mg/kg PFHpA for 2 weeks and clinical and anatomic pathology were assessed. At 1000 mg/kg, 83% of the rats died, with severe ulcerative dermatitis at the application site. Adverse PFHpA-treated systemic changes were observed in the kidney, liver and testes, and histopathologic lesions such as renal tubular necrosis, hepatocellular necrosis, and germ cell degeneration were seen at 250 and 1000 mg/kg. Our study suggests that SC PFCAs have fewer effects on the skin than PFOA, but SC PFCAs can have adverse effects on major organs with systemic exposure at high concentrations.		1						C	-	経皮曝露	
D1322	in vitro（発がん性）	Panwalkar, P; Tamrazi, B; Dang, DR; Chung, C; Sweha, S; Natarajan, SK; Pun, M; Bayliss, J; Ogrodzinski, MP; Pratt, D; Mullan, B; Hawes, D; Yang, FS; Lu, C; Sabari, BR; Achreja, A; Heon, J; Animasahun, O; Cieslik, M; Dunham, C; Yip, S; Hukin, J; Phillips, JJ; Bornhorst, M; Griesinger, AM; Donson, AM; Foreman, NK; Garton, HJL; Heth, J; Muraszko, K; Nazarian, J; Koschmann, C; Jiang, L; Filbin, MG; Nagrath, D; Kool, M; Korshunov, A; Pfister, SM; Gilbertson, RJ; Allis, CD; Chinnaiyan, AM; Lunt, SY; Bluml, S; Judkins, AR; Venneti, S	Targeting integrated epigenetic and metabolic pathways in lethal childhood PFA ependymomas	2021	Sci. Transl. Med. 2021 OCT 6;13(614):eabc0497. doi: 10.1126/scitranslmed.abc0497.	Childhood posterior fossa group A ependymomas (PFAs) have limited treatment options and bear dismal prognoses compared to group B ependymomas (PFBs). PFAs overexpress the oncohistone-like protein EZHIP (enhancer of Zeste homologs inhibitory protein), causing global reduction of repressive histone H3 lysine 27 trimethylation (H3K27me3), similar to the oncohistone H3K27M. Integrated metabolic analyses in patient-derived cells and tumors, single-cell RNA sequencing of tumors, and noninvasive metabolic imaging in patients demonstrated enhanced glycolysis and tricarboxylic acid (TCA) cycle metabolism in PFAs. Furthermore, high glycolytic gene expression in PFAs was associated with a poor outcome. PFAs demonstrated high EZHIP expression associated with poor prognosis and elevated activating mark histone H3 lysine 27 acetylation (H3K27ac). Genomic H3K27ac was enriched in PFAs at key glycolytic and TCA cycle-related genes including hexokinase-2 and pyruvate dehydrogenase. Similarly, mouse neuronal stem cells (NSCs) expressing wild-type EZHIP (EZHIP-WT) versus catalytically attenuated EZHIP-M406K demonstrated H3K27ac enrichment at hexokinase-2 and pyruvate dehydrogenase, accompanied by enhanced glycolysis and TCA cycle metabolism. AMPK alpha-2, a key component of the metabolic regulator AMP-activated protein kinase (AMPK), also showed H3K27ac enrichment in PFAs and EZHIP-WT NSCs. The AMPK activator metformin lowered EZHIP protein concentrations, increased H3K27me3, suppressed TCA cycle metabolism, and showed therapeutic efficacy in vitro and in vivo in patient-derived PFA xenografts in mice. Our data indicate that PFAs and EZHIP-WT-expressing NSCs are characterized by enhanced glycolysis and TCA cycle metabolism. Repurposing the antidiabetic drug metformin lowered pathogenic EZHIP, increased H3K27me3, and suppressed tumor growth, suggesting that targeting integrated metabolic/epigenetic pathways is a potential therapeutic strategy for treating childhood ependymomas.								C	-	PFASと関係ない論文	
D1323	in vitro（発がん性）	Pan, YF; Qin, H; Zheng, L; Guo, Y; Liu, W	Disturbance in transcriptomic profile, proliferation and multipotency in human mesenchymal stem cells caused by hexafluoropropylene oxides	2022	Environ. Pollut. 2022 Jan;292(Pt B):118483. doi: 10.1016/j.envpol.2021.118483.	As alternatives to perfluorooctanoic acid (PFOA), hexafluoropropylene oxide dimer acid (HFPO-DA) and hexafluoropropylene oxide trimer acid (HFPO-TA) have raised concerns of their potential health risks. Human bone marrow mesenchymal stem cell was employed as an in vitro model to investigate the molecular targets and the adverse effects of HFPOs in stem cells in concentrations range starting at human relevant levels. Unsupervised transcriptomic analysis identified 1794 and 1429 DEGs affected by HFPO-TA and HFPO-DA, respectively. Cell cycle-associated biological processes were commonly altered by both chemicals. 18 and 35 KEGG pathways were enriched in HFPO-TA and HFPO-DA treatment group, respectively, among which multiple pathways were related to cancer and pluripotency. Few genes in PPAR signalling pathway were disturbed by HFPOs suggesting the involvement of PPAR-independent toxic mechanism. HFPO-TA promoted cell proliferation with significance at 1 mu M mRNA levels of CDK and MYC were down-regulated by HFPOs, suggesting the negative feedback regulation to the abnormal cell proliferation. Decreased expression of CD44 protein, and ENG and THY1 mRNA levels demonstrated HFPOs-caused changes of hBMSCs phenotype. The osteogenic differentiation was also inhibited by HFPOs with reduced formation of calcium deposition. Furthermore, gene and protein expression of core pluripotency regulators NANOG was enhanced by HFPO-TA. The present study provides human relevant mechanistic evidence for health risk assessment of HFPOs, prioritizing comprehensive carcinogenicity assessment of this type of PFOA alternatives.					1			B	-		
D1324	in vitro（その他）	Chaousis, S; Leusch, FDL; Nouwens, A; Melvin, SD; van de Merwe, JP	Changes in global protein expression in sea turtle cells exposed to common contaminants indicates new biomarkers of chemical exposure	2021	Sci. Total Environ. 2021 Jan:751:141680. doi: 10.1016/j.scitotenv.2020.141680.	Non-targeted protein expression at the cellular level can provide insights into mechanistic effects of contaminants in wildlife, and hence new and potentially more accurate biomarkers of exposure and effect. However, this technique has been relatively unexplored in the realm of in vitro biomarker discovery in threatened wildlife, despite the vulnerability of this group of animals to adverse sublethal effects of contaminant exposure. Here we examined the usefulness of non-targeted protein expression for biomarker discovery in green sea turtles (Chelonia mydas) by investigating differences in the response of primary cells from five different tissue types that were exposed to three contaminants known to accumulate in this species. Cells derived from C. mydas skin, liver, kidney, ovary and small intestine were exposed to 100 mu g/L of either polychlorinated biphenyl 153 (PCB153), perfluorononanoic acid (PFNA) or phenanthrene for 24 h. The global protein expression was then quantitatively evaluated using sequential window acquisition of all theoretical mass spectra (SWATH-MS). Comparison of the global protein profiles revealed that, while a majority of proteins were mutually expressed in controls of all tissue types (similar to 90%), the response to exposure in terms of protein expression strength was significantly different between tissue types. Furthermore, a comparison to known markers of chemical exposure in sea turtles from the literature indicated that in vitro response can reflect known in vivo responses. In particular, markers such as heat shock protein (HSP) 60, glutathione S-transferases (GSTs) and superoxide dismutases (SODs), cytochrome P450 and catalase were dysregulated in response to exposure. Furthermore, potential new markers of exposure were discovered such as annexin, an important protein in cell signalling processes. While this methodology proved promising further studies are required to confirm the accuracy of in vitro protein expression as a tool for biomarker discovery in wildlife.			1					C	-	アオウミガメ（Chelonia mydas）	
D1325	実験動物（神経毒性）	Rericha, Y; Cao, DP; Truong, L; Simonich, M; Field, JA; Tanguay, RL	Behavior Effects of Structurally Diverse Per- and Polyfluoroalkyl Substances in Zebrafish	2021	Chem. Res. Toxicol. 2021 Jun:34(6):1409-1416. doi: 10.1021/acs.chemrestox.1c00101.	Per- and polyfluoroalkyl substances (PFAS) are ubiquitously detected in the environment, and some pose significant human and environmental health concerns globally. While some PFAS induce adverse health effects, relatively few toxicological studies adequately address the broad structural diversity of this chemical class. In the current study, we evaluated 58 individual PFAS spanning 14 structural subclasses and 2 mixtures at single concentrations for developmental toxicity in zebrafish using highly sensitive behavior endpoints. Following developmental exposure to PFAS, zebrafish were assessed for mortality and challenged with an embryonic photomotor response (EPR) assay at 24 h postfertilization (hpf) and with larval photomotor response (LPR) and larval startle response assays at 120 hpf. We found that none of the tested PFAS exposures elicited significant mortality or aberrant EPR; however, exposure to 21 individual PFAS from multiple structural subclasses and 1 mixture induced aberrant larval behavior. We then evaluated developmental toxicity across a concentration range of 0-100 mu M for 10 perfluoroalkyl carboxylic acids (PFCAs; 4-carbon perfluorobutanoic acid through the 13-carbon perfluorotridecanoic acid). Exposure to the PFCAs did not cause significant mortality or morphological effects, with the exception of perfluorooctanoic acid and perfluorononanoic acid, and did not induce aberrant EPR. All PFCAs, except for longer-chain perfluorododecanoic acid caused abnormal LPR following exposure to at least one concentration. In this study, we evaluated a broad set of PFAS not previously assessed for in vivo sublethal behavior endpoints and confirmed previous findings that exposure to some PFAS induces abnormal behavior in developing zebrafish. The data from this study will guide the selection of PFAS for which to investigate modes of toxic action.	1		1					C	-	ゼブラフィッシュ	

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							PFBA	PFHxA	PFNA	PFBS	GenX						
D1326	in vitro（発がん性）	Coperchini, F; De Marco, G; Croce, L; Denegri, M; Greco, A; Magri, F; Tonacchera, M; Imbriani, M; Rotondi, M; Chiovato, L	PFOA, PFHxA and C6O4 differently modulate the expression of CXCL8 in normal thyroid cells and in thyroid cancer cell lines	2023	Environ. Sci. Pollut. Res. 2023 May:30(23):63522-63534. doi: 10.1007/s11356-023-26797-6.	Industrial chemical PFAS are persistent pollutants. Long chain PFAS were taken out of production due to their risk for human health, however, new congeners PFAS have been introduced. The in vitro effects of the long-chain PFOA, the short-chain PFHxA and the new-generation C6O4 were evaluated in normal and in thyroid cancer cell lines in terms of cell viability and proliferation, and secretion of a pro-tumorigenic chemokine (CXCL8), both at the mRNA and at the protein level. The Nthy-ory 3-1 normal-thyroid cell line, the TPC-1 and the 8505C (RET/PTC rearranged and BRAFV600e mutated, respectively) thyroid-cancer cell lines were exposed to increasing concentrations of each PFAS in a time-course. We evaluated viability using WST-1 (confirmed by AnnexinV/PI) and proliferation using the cristal-violet test. To evaluate CXCL8 mRNA we used RT-PCR and measured CXCL8 in the supernatants by ELISA. The exposure to none PFAS did not affect thyroid cells viability (except for a reduction of 8505C cells viability after 144 h) or proliferation. Individual PFAS differently modulated CXCL8 mRNA and protein level. PFOA increased CXCL8 both at mRNA and protein level in the three cell lines; PFHxA increased CXCL8 mRNA in the three cell lines, but increased the protein only in TPC-1 cells; C6O4 increased the CXCL8 mRNA only in thyroid cancer cell lines, but never increased the CXCL8 protein. The results of the present study indicate that the in vitro exposure to different PFAS may modulate both at the mRNA and secreted protein levels of CXCL8 in normal and cancer thyroid cells. Strikingly different effects emerged according to the specific cell type and to the targeted analyte (CXCL8 mRNA or protein).		1						B	-		
D1327	神経毒性	Foguth, R; Sepulveda, MS; Cannon, J	Per- and Polyfluoroalkyl Substances (PFAS) Neurotoxicity in Sentinel and Non-Traditional Laboratory Model Systems: Potential Utility in Predicting Adverse Outcomes in Human Health	2020	Toxics. 2020 Jun;8(2):42. doi: 10.3390/toxics8020042.	Per- and polyfluoroalkyl substances (PFAS) are a class of chemicals that were widely used in manufacturing and are now present in the environment throughout the world. It is known that various PFAS are quantifiable in human in blood, but potential adverse health outcomes remain unclear. Sentinel and non-traditional model species are useful to study potential toxicity of PFAS in order to understand the relationship between environmental and human health. Here, we present a critical review of studies on the neurotoxicity of PFAS in sentinel and non-traditional laboratory model systems, including Caenorhabditis elegans(nematode),Dugesia japonica(planarian),Rana pipiens(frogs),Danio rerioand Oryzias melastigma(fish), and Ursus maritimus(polar bears). PFAS have been implicated in developmental neurotoxicity in non-traditional and traditional model systems as well as sentinel species, including effects on neurotransmitter levels, especially acetylcholine and its metabolism. However, further research on the mechanisms of toxicity needs to be conducted to determine if these chemicals are affecting organisms in a similar manner. Overall, findings tend to be similar among the various species, but bioaccumulation may vary, which needs to be taken into account in future studies by quantifying target organ concentrations of PFAS to better compare different species. Furthermore, data on the majority of PFAS is lacking in neurotoxicity testing, and additional studies are needed to corroborate findings thus far.								C	-	センチネルや非伝統的なモデル種	
D1328	実験動物（神経毒性）	Foguth, RM; Hoskins, TD; Clark, GC; Nelson, M; Flynn, RW; de Perre, C; Hoverman, JT; Lee, LS; Sepulveda, MS; Cannon, JR	Single and mixture per- and polyfluoroalkyl substances accumulate in developing Northern leopard frog brains and produce complex neurotransmission alterations	2020	Neurotoxicol. Teratol. 2020 Sep:81:106907. doi: 10.1016/j.ntt.2020.106907.	Per- and polyfluoroalkyl substances (PFAS) are present in water and > 99% of human serum. They are found in brains of wildlife; however, little is known about effects on the developing brain. To determine the effects of PFAS on brain and cardiac innervation, we conducted an outdoor mesocosm experiment with Northern leopard frog larvae (Rana pipiens) exposed to control, 10 ppb perfluorooctane sulfonate (PFOS), or a PFAS mixture totaling 10 ppb that mimicked aqueous film forming foam-impacted surface water (4 ppb PFOS, 3 ppb perfluorohexane sulfonate, 1.25 ppb perfluorooctanoate, 1.25 ppb perfluorohexanoate, and 0.5 ppb perfluoro-npentanoate). Water was spiked with PFAS and 25 larvae (Gosner stage (GS) 25) added to each mesocosm (n = 4 mesocosms per treatment). After 30 days, we harvested eight brains per mesocosm and remaining larvae developed to GS 46 (i.e. metamorphosis) before brains and hearts were collected. Weight, length, GS, and time to metamorphosis were recorded. Brain concentrations of all five PFAS were quantified using LC/MS/MS. Dopamine and metabolites, serotonin and its metabolite, norepinephrine, y-aminobutyric acid, and glutamate were quantified using High Performance Liquid Chromatography with electrochemical detection while acetylcholine and acetylcholinesterase activity were quantified with the Invitrogen Amplex Red Acetylcholine Assay. PFOS accumulated in the brain time- and dose-dependently. After 30 days, the mixture decreased serotonin while both PFAS treatments decreased glutamate. Interestingly, acetylcholine increased in PFAS treatments at GS 46. This research shows that developmental environmentally relevant exposure to PFAS changes neuro-transmitters, especially acetylcholine.		1						C	-	ノーザンヒョウガエル（Rana pipiens）の幼生	
D1329	実験動物（急性毒性）	Kinney LA, Chromey NC, Kennedy GL Jr.	Acute inhalation toxicity of ammonium perfluorononanoate	1989	Food Chem Toxicol. 1989 Jul;27(7):465-8. doi: 10.1016/0278-6915(89)90033-1.	Ammonium perfluorononanoate (CAS Registry No. 4149-60-4) is a white powder that can become airborne. Its acute inhalation toxicity in male rats was studied. Male rats were exposed for single 4-hr periods to dust concentrations ranging from 67 to 4600 mg/m3. The LC50 was determined to be 820 mg/m3, with the lowest concentration causing death being 590 mg/m3. Ammonium perfluorononanoate was classified as moderately toxic by the acute inhalation route. Exposure to ammonium perfluorononanoate caused a pronounced increase in liver size. The acute toxicity of ammonium perfluorononanoate appears to be similar to that of its 8-carbon homologue, ammonium perfluorooctanoate, but considerably less than that of the 10-carbon homologue, perfluoro-n-decanoic acid.			1					B	-		
D1330	実験動物（急性毒性）	Kennedy GL Jr.	Increase in mouse liver weight following feeding of ammonium perfluorooctanoate and related fluorochemicals	1987	Toxicol Lett. 1987 Dec;39(2-3):295-300. doi: 10.1016/0378-4274(87)90245-1.	The weight of the mouse liver following feeding of ammonium perfluorooctanoate, ammonium perfluorononanoate, Telomer B ammonium sulfate, and WG-III was increased in a dose-dependent manner. Dietary levels of 3 ppm or greater ammonium perfluorooctanoate for either 14 or 21 days produced a significant elevation in liver weight both on an absolute and on an organ/body weight ratio basis. Similarly, ammonium perfluorononanoate produced significant increases at the lowest level tested, 3 ppm. Telomer B ammonium sulfate and WG-III also produced liver weight increases but at higher feeding levels. The striking increase in liver weight following relatively short-term exposures in mice makes this a useful screening test for comparing the liver-enlarging capacity of ammonium perfluorooctanoate and related fluorochemicals.			1				1	A	-		
D1331	実験動物（反復投与毒性）	National Toxicology Program.	Toxicity studies of perfluoroalkyl carboxylates administered by gavage to Sprague Dawley (Hsd:Sprague Dawley SD) rats (revised)	2019	Toxic Rep Ser. 2019 Aug;(97):NTP-TOX-97. doi: 10.22427/NTP-TOX-97.	Widespread exposure to several per/polyfluorinated alkyl substances (PFAS) is associated with a wide array of toxicities. The National Toxicology Program (NTP) conducted 28-day toxicity studies in male and female Sprague Dawley (Hsd:Sprague Dawley SD) rats (n = 10/dose; five doses) to compare the toxicities of seven PFAS chemicals (three sulfonic acids or salt: perfluorobutane sulfonic acid, perfluorohexane sulfonate potassium salt, and perfluorooctane sulfonic acid; and four carboxylates: perfluorohexanoic acid [PFHxA], perfluorooctanoic acid [PFOA], perfluorononanoic acid [PFNA], and perfluorodecanoic acid [PFDA]) via gavage in deionized water with 2% Tween 80. This report describes the studies of the four carboxylates (PFHxA, PFOA, PFNA, and PFDA); a companion report (NTP Toxicity Study Report 96) describes the studies of the three PFAS sulfonates. Doses were 0 to 1,000 mg/kg/day for PFHxA, 0 to 10 mg/kg/day for PFOA males, 0 to 100 mg/kg/day for PFOA females, 0 to 10 mg/kg/day for PFNA males, 0 to 25 mg/kg/day for PFNA females, and 0 to 2.5 mg/kg/day for PFDA.		1	1	1			1	A	-	PFHxA, PFOA, PFNA, and PFDAのNTP28日間試験報告書	
D1332	実験動物（発がん性）	Liu H, Chen Y, Hu W, Luo Y, Zhu P, You S, Li Y, Jiang Z, Wu X, Li X.	Impacts of PFOA(C8), GenX(C6), and their mixtures on zebrafish developmental toxicity and gene expression provide insight about tumor-related disease	2023	Sci Total Environ. 2023 Feb 1;858(Pt 2):160085. doi: 10.1016/j.scitotenv.2022.160085. Epub 2022 Nov 8.	Concerns about per- and polyfluoroalkyl substances (PFASs) have grown in importance in the fields of ecotoxicology and public health. This study aims to compare the potential effects of long-chain (carbon atoms ≥ 7) and short-chain derivatives and their mixtures' exposure according to PFASs-exposed (1, 2, 5, 10, and 20 mg/L) zebrafish's (Danio rerio) toxic effects and their differential gene expression. Here, PFOAC8, GenXC6, and their mixtures (v/v, 1:1) could reduce embryo hatchability and increase teratogenicity and mortality. The toxicity of PFOAC8 was higher than that of GenXC6, and the toxicity of their mixtures was irregular. Their exposure (2 mg/L) caused zebrafish ventricular edema, malformation of the spine, blood accumulation, or developmental delay. In addition, all of them had significant differences in gene expression. PFOAC8 exposure causes overall genetic changes, and the pathways of this transformation were autophagy and apoptosis. More importantly, in order to protect cells from PFOAC8, GenXC6, and their mixtures' influences, zebrafish inhibited the expression of ATPase and Ca2+ transport gene (atp1b2b), mitochondrial function-related regulatory genes (mt-co2, mt-co3, and mt-cyb), and tumor or carcinogenic cell proliferation genes (laptm4b and ctsbb). Overall, PFOAC8, GenXC6, and their mixtures' exposures will affect the gene expression effects of zebrafish embryos, indicating that PFASs may pose a potential threat to aquatic biological safety. These results showed that the relevant genes in zebrafish that were inhibited by PFASs exposure were related to tumorigenesis. Therefore, the effect of PFASs on zebrafish can be further used to study the pathogenesis of tumors.					1			C	-		
D1333	ヒト（肝毒性）	Jain, RB; Ducatman, A	Selective Associations of Recent Low Concentrations of Perfluoroalkyl Substances With Liver Function Biomarkers NHANES 2011 to 2014 Data on US Adults Aged >= 20 Years	2019	J. Occup. Environ. Med. 2019 Apr:61(4):293-302. doi: 10.1097/JOM.0000000000001532.	Objective: Perfluoroalkyl substances (PFAS) and liver function biomarkers were reexamined for relatively lower serum concentrations of PFAS observed in recent years. Methods: National Health and Nutrition Examination Survey 2011 to 2014 data were analyzed for obese and nonobese participants for serum perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorodecanoic acid (PFDA), perfluorohexane sulfonate (PFHxS), perfluorononanoic acid (PFNA) as well as four liver function biomarkers in risk-adjusted analysis. Results: Among obese participants only, alanine aminotransferase (ALT) was positively associated with PFOA (beta = 0.07065, P < 0.01), PFHxS (beta = 0.051349, P < 0.01), and with PFNA (beta = 0.072742, P < 0.01). PFOA (beta = 0.07422, P = 0.03) and PFNA (beta = 0.077995, P < 0.01) were associated with gamma glutamyl transferase (GGT) in obese participants. Conclusions: Recent lower levels of PFOA, PFHxS, and PFNA are associated with higher serum liver functions but only among obese participants. The findings are consistent with PFAS animal toxicology concerning steatosis.			1					B	B		米国の肥満者と非肥満者で5種類のPFAS測定した結果、肥満者でのみ肝臓のマーカーが正の関連

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1334	ヒト（肝毒性）	Ma, XQ; Fisher, JA; Pham, TV; Vasiliou, V; Jones, RR	Associations between per- and polyfluoroalkyl substances, liver function, and daily alcohol consumption in a sample of US adults	2023	Environ. Res. 2023 Oct:235:116651. doi: 10.1016/j.envres.2023.116651.	Background and aim: Per-and polyfluoroalkyl substances (PFAS) are ubiquitous in the environment and in the serum of the U.S. population. We sought to evaluate the association of PFAS independently and jointly with alcohol intake on liver function biomarkers in a sample of the U.S. general population.Methods: Using data from the National Health and Nutrition Examination Survey (2003-2016; N = 11,794), we examined the five most historically prevalent PFAS with >75% detection rates. We estimated odds ratios (OR) and 95% confidence intervals (CI) for the association between PFAS (quartiles and log-transformed continuous, ng/mL) and high levels (>95th percentile) of liver injury biomarkers using logistic regression models adjusted for key confounders. We evaluated interactions between PFAS and alcohol consumption and sex via stratified an-alyses and conducted sub-analyses adjusting for daily alcohol intake among those with available drinking history (N = 10,316).Result: Serum perfluorooctanoic acid (PFOA) was positively associated with high levels of alanine transferase (ALT) without monotonic trend (ORQ4vsQ1 = 1.45, CI: 0.99-2.12; p-trend = 0.18), and with increased aspartate transaminase when modeled continuously (OR = 1.15, CI: 1.02-1.30; p-trend = 0.03). Perfluorooctane sulfonate (PFOS) and perfluorohexane sulfonate (PFHxS) were both inversely associated with alkaline phosphatase while a trend was evident only for PFHxS (p = 0.02). A non-monotonic inverse association was observed with PFOA (p -trend = 0.10). The highest quartile of PFOS was associated with high total bilirubin (TB; ORQ4vsQ1 = 1.57, CI: 1.01-2.43, p-trend = 0.02). No significant associations were found between any PFAS and & gamma;-glutamyl trans-peptidase. We found no associations for perfluorodecanoic acid and perfluorononanoic acid. We observed some suggestive interactions with alcohol intake, particularly among heavy drinkers.Conclusion: Consistent with other studies, serum levels of PFOA, PFHxS and PFNA were positively associated with high levels of ALT, and we also observed weak positive associations between some PFAS and TB. Associations observed among heavy drinkers warrant additional evaluation.			1						B	B		米国の4種類のPFAS濃度とアルコール摂取量との関係でALT値がどのように変化するか
D1335	ヒト（肝毒性）	Borghese, MM; Liang, CL; Owen, J; Fisher, M	Individual and mixture associations of perfluoroalkyl substances on liver function biomarkers in the Canadian Health Measures Survey	2022	Environ. Health. 2022 Sep;21(1):85. doi: 10.1186/s12940-022-00892-6.	Background Perfluoroalkyl substances can disrupt hepatic metabolism and may be associated with liver function biomarkers. We examined individual and mixture associations of PFAS on liver function biomarkers in a representative sample of Canadian adults. We explored the potential for effect modification by sex and body mass index, as well as by physical activity level which may attenuate the deleterious effect of PFAS on metabolic disorders. Methods We analyzed data from participants aged 20-74 from the Canadian Health Measures Survey. We used linear regression to examine associations between plasma concentrations of PFOA, PFOS, PFHxS, PFNA, PFDA, and PFUDA on serum concentrations of aspartate aminotransferase (AST), gamma-glutamyltransferase (GGT), alkaline phosphatase (ALP), alanine aminotransferase (ALT) and total bilirubin. We used quantile g-computation to estimate associations with a PFAS mixture for each simultaneous, one-quartile change in PFAS concentrations. Results Each doubling of PFOA, PFOS, PFHxS, or PFNA concentrations was associated with higher AST, GGT, and ALP concentrations. Each doubling of PFOA concentrations was associated with 16.5% (95%CI: 10.4, 23.0) higher GGT concentrations among adults not meeting Canada's physical activity guidelines vs. 6.6% (95%CI: -1.6, 15.5) among those meeting these guidelines. Sex and BMI also modified some associations, though to a lesser extent. We did not observe associations between ALT and PFOA (1.2% change; 95%CI: -2.5, 4.9), PFOS (2.2% change; 95%CI: -0.8, 5.3), or PFHxS (1.5% change; 95%CI: -0.4, 3.4). We also did not observe consistent associations for PFDA and PFUDA or with total bilirubin. In quantile g-computation models, each simultaneous one-quartile increase in the PFAS mixture was positively associated with AST (7.5% higher; 95%CI: 4.0, 10.4), GGT (9.7% higher; 95%CI: 1.7, 17.0), and ALP (2.8% higher; 95%CI: 0.5, 5.4). Conclusion Higher plasma concentrations of PFOA, PFOS, PFHxS, and PFNA - both individually and as a mixture - were associated with higher serum concentrations of liver function biomarkers. These results contribute to emerging evidence suggesting that higher levels of physical activity appear to be protective against the hepatotoxic effects of PFOA. This work contributes to a growing body of evidence supporting the hepatotoxic effects of PFAS.			1						B	B		カナダにおける6種類のPFAS濃度と肝機能検査値
D1336	ヒト（肝毒性）	Liao, Q; Tang, P; Fan, HR; Song, YY; Liang, J; Huang, HS; Pan, DX; Mo, ML; Lin, MR; Chen, JH; Wei, HN; Long, JH; Shao, YT; Zeng, XY; Liu, S; Huang, DP; Qiu, XQ	Association between maternal exposure to per- and polyfluoroalkyl substances and serum markers of liver function during pregnancy in China: A mixture-based approach	2023	Environ. Pollut. 2023 Apr:323:121348. doi: 10.1016/j.envpol.2023.121348.	Previous studies have shown that per-and polyfluoroalkyl substances (PFAS) may have hepatotoxic effects in animals. However, epidemiological evidence in humans, especially pregnant women, is limited. This study aimed to assess the association of single and multiple PFAS exposure with serum markers of liver function in pregnant women. A total of 420 pregnant women from the Guangxi Zhuang Birth Cohort were enrolled from June 2015 to April 2019. Nine PFAS were measured in the maternal serum in early pregnancy. Data for liver function bio-markers, namely, alanine aminotransferase (ALT), aspartate aminotransferase (AST), gamma-glutamyltransferase (GGT), total bilirubin (TBIL), direct bilirubin (DBIL), and indirect bilirubin (IBIL), were obtained from medical records. In generalized linear model (GLM), there was a positive association of per-fluorooctane sulfonate (PFOS) with ALT, perfluorodecanoic acid (PFDA) and perfluorobutanesulfonic acid (PFBS) with GGT, and perfluorohexane sulfonate (PFHxS) with TBIL and IBIL. In contrast, there was a negative association of perfluoroheptanoic acid (PFHpA) with TBIL. There were inverse U-shaped relationships of PFUnA with ALT and AST and PFDA with ALT by restricted cubic spline. The weighted quantile sum (WQS) regression model revealed the positive effects of the PFAS mixture on GGT, TBIL, DBIL, and IBIL. Bayesian kernel machine regression (BKMR) analysis confirmed that the PFAS mixture was positively associated with GGT, and PFBS was the main contributor. In addition, the BKMR model showed a positive association of individual PFBS with GGT, individual PFHxS with TBIL and IBIL, and a negative association of individual PFHpA with TBIL. Our findings provide evidence of an association between individual PFAS, PFAS mixture and maternal serum markers of liver function during pregnancy. Additionally, these findings also enhance concerns over PFAS exposure on maternal liver function and PFAS monitoring in pregnancy, reducing the effect of maternal liver dysfunction on maternal and infant health.				1					B	B		中国におけるPFAS濃度と肝機能検査値
D1337	ヒト（肝毒性）	Limei, E; Zhang, S; Jiang, XB	Association between perfluoroalkyl substances exposure and the prevalence of nonalcoholic fatty liver disease in the different sexes: a study from the National Health and Nutrition Examination Survey 2005-2018	2023	Environ. Sci. Pollut. Res. 2023 Mar:30(15):44292-44303. doi: 10.1007/s11356-023-25258-4.	There is evidence that perfluoroalkyl substances (PFASs) have effects on liver toxicity, and the effects may exhibit sex differences. Our study aims to explore the association between exposure to four PFASs (perfluorooctanoic acid, PFOA; perfluorooctane sulfonate, PFOS; perfluorohexane sulfonate, PFHxS; and perfluorononanoate, PFNA) and the risk of nonalcoholic fatty liver disease (NAFLD) in adults >= 20 years old in the US population. The data were based on the National Health and Nutrition Examination Survey (NHANES) 2005-2018. We used Poisson regression to explore the association between the four PFASs and NAFLD. We included 3464 participants; of these, 1200 (34.64%) individuals were defined as having NAFLD, and the prevalence of NAFLD was 39.52% in men and 30.40% in women. After Poisson regression, among the premenopausal and postmenopausal and total women, PFOA had a significantly positive association with NAFLD ($p < 0.05$). After principal component analysis, the composite PFAS was associated with NAFLD in postmenopausal and total women, and the RRs (95% CIs) were 1.306 (1.075, 1.586) and 1.161 (1.007, 1.339), respectively. In adults, we found that PFASs were associated with NAFLD, and the associations varied by sex, particularly for PFOA and PFNA, which had a positive association with NAFLD in women.				1					B	B		NHANESを活用して4種類のPFASとNAFLDとの関連を調べ、性差はあるものの関連を見出した
D1338	システマティックレビュー（肝毒性）	Costello, E; Rock, S; Stratakis, N; Eckel, SP; Walker, DI; Valvi, D; Cserbik, D; Jenkins, T; Xanthakos, SA; Kohli, R; Sisley, S; Vasiliou, V; La Merrill, MA; Rosen, H; Conti, DV; McConnell, R; Chatzi, L	Exposure to per- and Polyfluoroalkyl Substances and Markers of Liver Injury: A Systematic Review and Meta-Analysis	2022	Environ. Health Perspect. 2022 APR;130(4):46001. doi: 10.1289/EHP10092.	BACKGROUND: Experimental evidence indicates that exposure to certain pollutants is associated with liver damage. Per- and polyfluoroalkyl substances (PFAS) are persistent synthetic chemicals widely used in industry and consumer products and bioaccumulate in food webs and human tissues, such as the liver. OBJECTIVE: The objective of this study was to conduct a systematic review of the literature and meta-analysis evaluating PFAS exposure and evidence of liver injury from rodent and epidemiological studies. METHODS: PubMed and Embase were searched for all studies from earliest available indexing year through 1 December 2021 using keywords corresponding to PEAS exposure and liver injury. For data synthesis, results were limited to studies in humans and rodents assessing the following indicators of liver injury serum alanine aminotransferase (ALT), nonalcoholic fatty liver disease, nonalcoholic steatohepatitis, or steatosis. For human studies, at least three observational studies per PFAS were used to conduct a weighted z-score meta-analysis to determine the direction and significance of associations. For rodent studies, data were synthesized to qualitatively summarize the direction and significance of effect. RESULTS: Our search yielded 85 rodent studies and 24 epidemiological studies, primarily of people from the United States. Studies focused primarily on legacy PEAS: perfluorooctanoic acid (PEOA), perfluorooctanesulfonic acid (PFOS), perfluorononanoic acid (PENA), and perfluorohexanesulfonic acid. Meta-analyses of human studies revealed that higher ALT levels were associated with exposure to PFOA (z-score = 6.20, $p < 0.001$), PFOS (z-score = 3.55, $p < 0.001$), and PFNA (z-score = 2.27, $p = 0.023$). PFOA exposure was also associated with higher aspartate aminotransferase and gamma-glutamyl transferase levels in humans. In rodents, PFAS exposures consistently resulted in higher ALT levels and steatosis. CONCLUSION: There is consistent evidence for PFAS hepatotoxicity from rodent studies, supported by associations of PFAS and markers of liver function in observational human studies. This review identifies a need for additional research evaluating next-generation PEAS, mixtures, and early life exposures.				1					B	B		PFOA, PFOS, PFNAに焦点を当てた肝障害に関するメタアナリシス

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1339	ヒト（肝毒性）	Kim, OJ; Kim, S; Park, EY; Oh, JK; Park, S; Hong, SY; Kim, HJ; Park, B; Park, B; Kim, S; Kim, B	Exposure to serum perfluoroalkyl substances and biomarkers of liver function: The Korean national environmental health survey 2015-2017	2023	Chemosphere. 2023 May:322:138208. doi: 10.1016/j.chemosphere.2023.138208.	Background: Exposure to perfluoroalkyl substances (PFAS) may increase the risk of liver disease by disrupting cholesterol and lipid synthesis/metabolism, leading to higher liver-enzyme concentrations. However, most studies assessing association between PFAS and liver enzymes focused on individual PFAS. Moreover, PFAS concentrations differ based on sex and obesity status, and it remains unclear whether these factors affect asso-ciations with liver function. Therefore, we examined the association between exposure to both individual and combined PFAS and liver-function biomarkers and assessed sex and obesity as effect modifiers in Korean adults.Methods: We measured serum concentrations of the five most abundant PFAS (PFOA, PFOS, PFHxS, PFDA, PFNA) and three liver enzymes (alanine transaminase [ALT], aspartate aminotransferase [AST], gamma-glutamyl transferase [GGT]) in 1404 adults from the Korean National Environmental Health Survey Cycle 3, 2015-2017. We used linear regression to evaluate associations between individual PFAS and liver-function biomarkers, assessing sex and obesity as possible effect modifiers, and performed Bayesian kernel machine regression and quantile g -computation to evaluate the overall effect of PFAS mixture on biomarkers of liver function.Results: Among 1404 Korean adults, all five PFAS were detected. Geometric mean concentration was highest for PFOS (16.11 mu g/L), followed by PFOA (5.83 mu g/L), PFHxS (2.21 mu g/L), PFNA (2.03 mu g/L), and PFDA (1.06 mu g/L). In multivariable linear regression, all PFAS were positively associated with ALT, AST, and GGT; 2-fold increase in each PFAS was associated with 3.4-8.6% higher ALT, 2.4-4.6% higher AST, and 4.6-11.1% higher GGT (all $p < 0.05$). Positive associations for PFOA, PFDA, and PFNA with AST were stronger in men, and positive associations for PFOS with ALT and GGT were stronger in women. Compared to obese participants, nonobese participants had higher average percent changes in each enzyme, particularly GGT, when individual PFAS concentration doubled. Additionally, increased exposure to PFAS mixtures was associated with higher ALT, AST, and GGT. In quantile g -computations, simultaneous quartile increase in all PFAS was significantly associated with 6.9% (95%CI: 3.7, 10.2) higher ALT, 4.5% (95%CI: 2.4, 6.6) higher AST, and 8.3% (95%CI: 3.7, 13.1) higher GGT levels, on average.Conclusions: Exposure to individual and combined PFAS is associated with higher liver enzymes in Korean adults, providing additional evidence for the association between PFAS exposure and risk of liver disease.			1					B	B		KNHANESを用いて5種類のPFASと肝機能障害との関係を調べた
D1340	ヒト（肝毒性）	Yeung, LWY; Guruge, KS; Taniyasu, S; Yamashita, N; Angus, PW; Herath, CB	Profiles of perfluoroalkyl substances in the liver and serum of patients with liver cancer and cirrhosis in Australia	2013	Ecotox. Environ. Safe. 2013 Oct:96:139-146. doi: 10.1016/j.ecoenv.2013.06.006	The present cross-sectional study investigated 12 perfluoroalkyl substances (PFASs) in serum (n=79) and liver (n=66) samples from patients who had undergone liver transplantation for a range of conditions, such as hepatocellular carcinoma (HCC), cirrhosis due to chronic hepatitis C viral infection (HCV), both HCC and HCV, amyloidosis or acute liver failure. PFAS data from patients were compared to those in control serum (n=25) samples from liver donors with no known liver disease and to those in control liver (n=9) tissues collected during liver resection surgery. All samples showed detectable PFOS (serum: 0.621-126 ng/mL; liver: 0.375-42.5 ng/g wet wt) and PFOA (serum: 0.437-45.5 ng/mL; liver: 0.101-2.25 ng/g wet wt) concentrations. In general, in paired serum and liver samples, serum had higher PFOS, PFHxS, PFDA, PFNA, and PFOA concentrations than those in explanted livers from patients. These findings also suggest that pathological changes in diseased livers alter the distribution of PFASs between liver and serum. The results from control serum (2007-2008) suggested that PFOS, PFHxS, PFOA, and PFNA concentrations were lower than those previously reported from Australia for 2002-2003, and 2006-2007. The present study demonstrates, for the first time, the detection and comparison of a range of PFASs in the liver of patients with liver cancer and/or liver cirrhosis.			1					B	B		肝がん、肝硬変で肝移植を受けた患者の血清と肝臓中の12種類のPFAS濃度の比較。血清＞肝臓
D1341	ヒト（肝毒性）	Attanasio, R	Sex differences in the association between perfluoroalkyl acids and liver function in US adolescents: Analyses of NHANES 2013-2016	2019	Environ. Pollut.2019 Nov;254(Pt B):113061. doi: 10.1016/j.envpol.2019.113061.	Perfluoroalkyl acids (PFAAs) are persistent in the environment, highly bio-accumulative in the body, and likely hepatotoxic in humans. There is evidence of sex-specific physiological responses to PFAA exposure. However, epidemiological studies seldom stratify the analyses by sex. Given the high prevalence of liver disease in general population adolescents, this study was designed to determine whether or not there is association between exposure to PFAAs and biomarkers of liver function in adolescent participants of the 2013-2016 National Health and Nutrition Examination Survey, and whether or not such association is sex-specific. Multivariate linear regressions were performed to examine the association between single PFAAs [perfluorooctane sulfonic acid (PFOS); linear form of perfluorooctanoic acid (PFOA); perfluorohexane sulfonic acid (PFHxS); perfluorononanoic acid (PFNA)], and biomarkers of liver function - gamma glutamyltransferase (GGT), aspartate aminotransferase (AST), alanine aminotransferase (ALT), and total bilirubin. Multivariate logistic regressions were performed to estimate adjusted odd ratios (aOR) of elevated ALT, AST and GGT. The study results show that, in females, there was a positive association of the highest PFOA quartile with increased ALT, AST and GGT, and the highest PFNA quartile with increased ALT and AST. Conversely, in male adolescents there was an association of the highest linear PFOA quartile with decreased ALT, and the highest PFNA quartile with ALT and AST. Females had higher odds of clinically-defined elevated ALT with increased PFOA (aOR = 1.79; 95% CI: 1.05, 3.04) or PFNA (aOR = 2.28; 95% CI: 1.08, 2.28), whereas males had decreased odds of clinically-defined elevated ALT with increased n-PFOA (aOR = 0.43; 95% CI: 0.20, 0.93) or PFNA (aOR = 0.5; 95% CI: 0.28, 0.89). In conclusion, there were sex differences in the association between serum PFAA levels and biomarkers of liver function. These results may provide support for analyzing sex-based adverse effects of PFAAs.			1					B	B		NHANESでの4種類のPFASと肝機能との関係。性差あり
D1342	ヒト（肝毒性）	Wu, ZP; Ouyang, T; Liu, HC; Cao, LL; Chen, WL	Perfluoroalkyl substance (PFAS) exposure and risk of nonalcoholic fatty liver disease in the elderly: results from NHANES 2003-2014	2023	Environ. Sci. Pollut. Res. 2023 May:30(23):64342-64351. doi: 10.1007/s11356-023-26941-2.	This study aimed to investigate the association between perfluoroalkyl substance (PFAS) exposure and the risk of nonalcoholic fatty liver disease (NAFLD) in the elderly. Our sample included 1420 participants (>= 60 years) from the 2003-2014 NHANES study with available serum PFASs, covariates, and outcomes. NAFLD was defined based on the hepatic steatosis index. Weighted binary logistic regression was utilized to calculate the odds ratio (OR) and 95% confidence intervals for each chemical. Results suggested that increase in PFOA concentrations was positively associated with risk of NAFLD in adjusted models. PFNA was also significantly associated with NAFLD development in adjusted linear regression. The effect of PFOA or PFNA on NAFLD development was found to be linear in the trend test. This study added novel evidence that exposure to PFASs (PFOA and PFNA) might be associated with NAFLD development.			1					B	B		NHANESを活用してPFASとNAFLDとの関連を調べた。PFOAとPFNAは関連有り
D1343	ヒト（肝毒性）	Liu, Y; Lin, N; Dai, C; Xu, JL; Zhang, Y; Xu, MX; Wang, F; Li, YJ; Chen, D	Occurrence and distribution of per- and polyfluoroalkyl substances (PFASs) in human livers with liver cancer	2021	Environ. Res. 2021 Nov:202:111775. doi: 10.1016/j.envres.2021.111775.	Per- and polyfluoroalkyl substances (PFASs) are anthropogenic compounds that are widely accumulated in human tissues, and the liver is considered a primary target organ for PFASs exposure. The occurrence and distribution of 21 PFASs in liver tissues with tumors (n = 55) and without tumors (n = 55) are investigated in this study. Eleven perfluorinated carboxylic acids (PFCAs) and five perfluorinated sulfonic acids (PFSAs) were detected at high frequencies (45.5%-100 %), while the detection frequencies of five perfluoroalkyl phosphate (PFPAs) were relatively lower (<= 29.1 %). PFSAs and PFCAs accounted for up to 82.5%-92.7 % of the total PFASs. Although it was not found to be statistically significant, the concentrations of the total PFASs were slightly higher in the tumor liver samples (mean 64.3, range 5.70-303 ng/g) than those in the non-tumor liver samples (mean 62.7, range 4.08-240 ng/g).The perfluorooctanoic acid (PFOA), perfluorotridecanoic acid (PFTrDA), and perfluorobutanesulphonate (PFBS) showed significant differences (p 0.05) between the tumor and non-tumor liver samples, and the different distribution levels of these three PFASs may have been a consequence of oxidative stress. The total concentrations of PFASs in the three age groups were in the decreasing order of middle-aged people (45-60) old people (>60) > young people (<45). The PFASs in females were generally lower than in males, which may have been related to women's special excretion methods (such as childbirth and breastfeeding). The results should be valuable for further mechanistic studies regarding the toxic effects of PFASs in human livers.				1				B	B		肝臓のがん組織と非癌部組織の21種類のPFASを測定
D1344	ヒト（肝毒性）	Attanasio, R	Association between perfluoroalkyl acids and liver function: Data on sex differences in adolescents	2019	Data Brief. 2019 Dec:27:104618. doi: 10.1016/j.dib.2019.104618.	The data herein presented show multivariate linear regressions performed to examine the association between individual serum perfluoroalkyl acids (PFAAs) [perfluorooctane sulfonic acid (PFOS); linear form of perfluorooctanoic acid (PFOA); perfluorohexane sulfonic acid (PFHxS); perfluorononanoic acid (PFNA)], and biomarkers of liver function (Sex Differences in the association between perfluoroalkyl compounds and liver function in US adolescents: analyses of NHANES 2013-2016). Data relate to male and female adolescents (ages 12-19 years) who participated to the 2013-2016 National Health and Nutrition Examination Survey. The outcome of interest was represented by changes in biomarkers of liver function, including alanine aminotransferase (ALT), aspartate aminotransferase (AST), and gamma-glutamyl transferase (GGT). Serum measurement values of ALT, AST and GGT were natural log-transformed. Data represent multivariate regression analyses with the single PFAA as b coefficients (and 95%CI), adjusted by age, race/ethnicity, body weight, education, income-to-poverty ratio, and exposure to smoking. Single PFAAs were used as continuous natural log-transformed predicted variables in males and females. Analyses were performed also with individuals PFAAs categorized via sex-specific weighted quartile, with cutoffs based on the weighted distribution of the single PFAA in the study population. Because the dependent variables (ALT, AST and GGT) were log-transformed, data were re-transformed by exponentiation of the b coefficients, and presented as percent differences estimated by comparing each of the upper three quartiles to the lowest quartile using the formula 100*(e(beta)-1). Together, these data can serve as a basis to analyze associations between liver function and PFAA exposure taking into account sex differences in adolescent populations.			1					B	B		4種類のPFASと肝機能マーカーの関係

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1345	ヒト（肝毒性）	Liu, JJ; Cui, XX; Tan, YW; Dong, PX; Ou, YQ; Li, QQ; Chu, C; Wu, LY; Liang, LX; Qin, SJ; Zeeshan, M; Zhou, Y; Hu, LW; Liu, RQ; Zeng, XW; Dong, GH; Zhao, XM	Per- and perfluoroalkyl substances alternatives, mixtures and liver function in adults: A community-based population study in China	2022	Environ. Int. 2022 May:163:107179. doi: 10.1016/j.envint.2022.107179.	Experimental evidence has shown that per-and polyfluoroalkyl substances (PFAS) alternatives and mixtures may exert hepatotoxic effects in animals. However, epidemiological evidence is limited. This research aimed to explore associations of PFAS and the alternatives with liver function in a general adult population. The study participants consisted of 1,303 adults from a community-based cross-sectional investigation in Guangzhou, China, from November 2018 to August 2019. We selected 13 PFAS with detection rates > 85% in serum samples and focused on perfluorooctane-sulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and their alternatives [6:2 chlorinated polyfluorinated ether sulfonate (6:2 Cl-PFESA), 8:2 Cl-PFESA, and perfluorohexanoic acid (PFHxA)] as predictors of outcome. Six liver function biomarkers (ALB, ALT, AST, GGT, ALP, and DBIL) were chosen as outcomes. We applied regression models with restricted cubic spline function to explore correlations between single PFAS and liver function and inspected the combined effect of PFAS mixtures on liver by applying Bayesian kernel machine regression (BKMR). We discovered positive associations among PFAS and liver function bio-markers except for ALP. For example, compared with the 25th percentile of PFAS concentration, the level of ALT increased by 12.36% (95% CI: 7.91%, 16.98%) for ln-6:2 Cl-PFESA, 5.59% (95% CI: 2.35%, 8.92%) for ln-8:2 Cl-PFESA, 3.56% (95% CI:-0.39%, 7.68%) for ln-PFHxA, 13.91% (95% CI: 8.93%, 19.13%) for ln-PFOA, and 14.25% (95% CI: 9.91%, 18.77%) for ln-PFOS at their 75th percentile. In addition, higher exposed serum PFAS was found to be correlated with greater odds of abnormal liver function. Analysis from BKMR models also showed an adverse association between PFAS mixtures and liver function. The combined effect of the PFAS mixture appeared to be non-interactive, in which PFOS was the main contributor to the overall effect. Our findings provide evidence of associations between PFAS alternatives, PFAS mixtures, and liver function in the general adult population.		1						B	B		中国でのPFASとその代替品血清濃度と肝機能マーカーとの関係、PFOSが主に寄与
D1346	ヒト（肝毒性）	Stratakis, N; Conti, DV; Jin, R; Margetaki, K; Valvi, D; Siskos, AP; Maitre, L; Garcia, E; Varo, N; Zhao, YQ; Roumeliotaki, T; Vafeiadi, M; Urquiza, J; Fernandez-Barres, S; Heude, B; Basagana, X; Casas, M; Fossati, S; Grazuleviciene, R; Andrusaityte, S; Uppal, K; McEachan, RR; Papadopoulou, E; Robinson, O; Haug, LS; Wright, J; Vos, MB; Keun, HC; Vrijheid, M; Berhane, KT; McConnell, R; Chatzi, L	Prenatal Exposure to Perfluoroalkyl Substances Associated With Increased Susceptibility to Liver Injury in Children	2020	Hepatology. 2020 Nov:72(5):1758-1770. doi: 10.1002/hep.31483.	Background and Aims Per- and polyfluoroalkyl substances (PFAS) are widespread and persistent pollutants that have been shown to have hepatotoxic effects in animal models. However, human evidence is scarce. We evaluated how prenatal exposure to PFAS associates with established serum biomarkers of liver injury and alterations in serum metabolome in children. Approach and Results We used data from 1,105 mothers and their children (median age, 8.2 years; interquartile range, 6.6-9.1) from the European Human Early-Life Exposome cohort (consisting of six existing population-based birth cohorts in France, Greece, Lithuania, Norway, Spain, and the United Kingdom). We measured concentrations of perfluorooctane sulfonate, perfluorooctanoate, perfluorononanoate, perfluorohexane sulfonate, and perfluoroundecanoate in maternal blood. We assessed concentrations of alanine aminotransferase, aspartate aminotransferase, and gamma-glutamyltransferase in child serum. Using Bayesian kernel machine regression, we found that higher exposure to PFAS during pregnancy was associated with higher liver enzyme levels in children. We also measured child serum metabolomics through a targeted assay and found significant perturbations in amino acid and glycerophospholipid metabolism associated with prenatal PFAS. A latent variable analysis identified a profile of children at high risk of liver injury (odds ratio, 1.56; 95% confidence interval, 1.21-1.92) that was characterized by high prenatal exposure to PFAS and increased serum levels of branched-chain amino acids (valine, leucine, and isoleucine), aromatic amino acids (tryptophan and phenylalanine), and glycerophospholipids (phosphatidylcholine [PC] aa C36:1 and Lyso-PC a C18:1). Conclusions Developmental exposure to PFAS can contribute to pediatric liver injury.			1					B	B		欧州の母子を対象に母体血の5種類のPFAS濃度と子供の肝機能マーカーとの関係を調べた。正の関連を認めた。
D1347	ヒト（腎毒性）	Huang, JK; Chuang, YS; Wu, PH; Tai, CJ; Lin, JR; Kuo, MC; Chiu, YW; Hsu, PC; Wu, MT; Salihovic, S; Lin, YT	Decreased levels of perfluoroalkyl substances in patients receiving hemodialysis treatment	2023	Sci. Total Environ. 2023 Oct:896:165184. doi: 10.1016/j.scitotenv.2023.165184.	Perfluoroalkyl substances (PFAS) have been reported to be harmful to multiple organs in the human body. Based on a previous study suggesting that hemodialysis (HD) may be a means of eliminating PFAS from the human body, we aimed to compare the serum PFAS concentrations of patients undergoing regular HD, patients with chronic kidney disease (CKD) and controls. Additionally, we also investigated the correlation between PFAS and biochemical data, as well as concurrent comorbidities. We recruited 301 participants who had been on maintenance dialysis for >90 days, 20 participants with stage 5 non-dialysis CKD, and 55 control participants who did not have a diagnosis of kidney disease, with a mean creatinine level of 0.77 mg/dl. Eight different PFAS, namely perfluorooctanoic acid (PFOA), total and linear perfluorooctanesulfonic acid (PFOS), perfluoroheptanoic acid (PFHpA), perfluorohexanesulfonic acid (PFHxS), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUnDA), were measured using ultra-performance liquid chromatography-tandem mass spectrometry (UPLC-MS/MS). Spearman correlation and multivariable linear regression with 5 % false discovery rate were used to evaluate the relationships between PFAS and clinical parameters in HD patients and controls. Circulating concentrations of seven PFAS, including total and linear PFOS (T-PFOS and L-PFOS) PFDA, PFNA, PFHxS, PFOA, and PFUnDA, were significantly lower in the HD group compared to the CKD and control group. For the interplay between biochemical data and PFAS, all of the studied PFAS were positively correlated with aspartate aminotransferase, alanine aminotransferase, glucose, blood urea nitrogen, ferritin, and vitamin D in the controls, while in HD patients, the PFAS were all positively correlated with albumin, uric acid, iron, and vitamin D. These findings may offer valuable insights for future studies seeking to eliminate PFAS.			1					C	B		中国の透析患者で８種類のPFASを測定した結果、対照群より低かった
D1348	ヒト（腎毒性）	Jain, RB; Ducatman, A	Perfluoroalkyl substances follow inverted U-shaped distributions across various stages of glomerular function: Implications for future research	2019	Environ. Res. 2019 Feb:169:476-482. doi: 10.1016/j.envres.2018.11.033	Data (N = 6844) from National Health and Nutrition Examination Survey for US adults aged >= 20 years for the years 2007-2014 were analyzed to evaluate distributional characteristics of selected perfluoroalkyl substances (PFAS) - perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorodecanoic acid (PFDA), perfluorohexane sulfonate (PFHxS) and perfluorononanoic acid (PFNA) with declining glomerular function. The population was stratified according to the estimated glomerular filtration rates (eGFR) that accompany the stages of kidney disease, designated as glomerular function-1 (GF-1, eGFR > 90 mL/min/1.73 m(2)); GF-2 (eGFR 60-89 mL/min/1.73 m(2)), GF-3A (eGFR 45-59 mL/min/1.73 m(2)), and GF-3B and 4 combined (eGFR 15-44 mL/min/1.73 m(2)). Unadjusted as well as adjusted geometric means for serum PFOA, PFDA, PFHxS, and PFNA increased as expected through stage GF-3A but decreased below the concentrations associated with GF-1 for those who were in GF-3B/4. For example, unadjusted geometric means for PFOA were 2.59, 3.02, 3.01, and 2.22 ng/mL for GF-1, GF-2, GF-3A, and GF-3B/4 respectively. Adjusted geometric means for PFOA were 2.34, 2.83, 2.83, and 1.81 ng/mL for GF-1, GF-2, GF-3A, and GF-3B/4 respectively. Thus, PFAS were found to follow inverted U-shaped distributions across different stages of glomerular function. For females, decreases in adjusted PFAS serum levels were initiated at GF-3A, while decreases for males began as early as GF-2. Usually, females are known to have lower levels of PFAS but when in GF-3A and GF-3B/4, females were found to have higher levels of PFAS than males. Thus, inverted U-shaped curves for males and females intersected between GF-2 and GF-3A for PFOA and PFHxS and at GF-3A for PFOS and PFNA. Associations between PFAS and biomarkers of kidney function may be modified in both magnitude and even in direction as kidney function deteriorates. These findings have implications for studies that evaluate associations between PFAS and disease states that affect kidney function, as well as outcome biomarkers known to be affected by kidney function.			1					B	B	B-minor	米国で６種類のPFAS濃度とeGFRをマーカーとした腎機能との関係を調べた結果、性差があるものの、逆U字型の関係を示した
D1349	ヒト（腎毒性）	Nielsen, C; Hall, UA; Lindh, C; Ekstrom, U; Xu, YY; Li, Y; Holmang, A; Jakobsson, K	Pregnancy-induced changes in serum concentrations of perfluoroalkyl substances and the influence of kidney function	2020	Environ. Health. 2020 Jul;19(1):80. doi: 10.1186/s12940-020-00626-6.	Background: Epidemiological associations between maternal concentrations of perfluoroalkyl substances (PFAS) and birth weight are inconsistent. There is concern that studies based on samples collected in late pregnancy may be confounded by kidney function but studies of the relation between pregnancy-induced changes in PFAS and kidney function are lacking. Our aims were to investigate changes in serum concentrations of perfluorononanoic acid (PFNA), perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS) and perfluorohexane sulfonate (PFHxS) from early to late pregnancy and to explore relations to changes in glomerular filtration rate (GFR) and glomerular pore size. Methods: We conducted the study in a cohort of 73 pregnancies of normal-weight Swedish women without gestational diabetes and preeclampsia, enrolled 2009-2014. Blood was collected in median weeks 11 and 36, respectively, and analysed PFAS using liquid chromatography-tandem-mass-spectrometry. We estimated GFR based on creatinine and cystatin C and used the ratio eGFRcystatin C/eGFRcreatinine to indicate glomerular pore size. We used Wilcoxon signed-rank test to compare early and late measures and partial Spearman rank correlations to explore relations between changes in PFAS and kidney function. Results: Median concentrations of PFNA, PFOA and PFOS decreased by 15-21% but changes were uncorrelated to changes in kidney function (partial R = - 0.06-0.11). The observed increase in median PFHxS concentration of 69% was likely an artefact of systematic measurement error caused by coeluting endogenous inferences. Conclusions: Serum concentrations of PFNA, PFOA and PFOS decrease during pregnancy but the magnitudes of change are unrelated to parallel changes in eGFR and glomerular pore size, suggesting that changes in these indicators of kidney function are not important confounders in studies of PFAS and birth weight in pregnancies without gestational diabetes and preeclampsia.			1					B	B	Inverse causation	妊娠中の腎機能変化が４種類のPFAS濃度に及ぼす影響を調べた結果、妊娠の進行で濃度は減るがeGFRとの関係はなかった

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX						
D1350	ヒト（腎毒性）	Liang, YF; Zhou, H; Zhang, JC; Li, SJ; Shen, WT; Lei, LJ	Exposure to perfluoroalkyl and polyfluoroalkyl substances and estimated glomerular filtration rate in adults: a cross-sectional study based on NHANES (2017-2018)	2023	Environ. Sci. Pollut. Res. 2023 Apr:30(20):57931-57944. doi: 10.1007/s11356-023-26384-9.	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) may be important environmental risk factors affecting renal function. This study aimed to investigate the relationships between PFASs and estimated glomerular filtration rate (eGFR) in univariate exposure and multivariate co-exposure models of PFASs. A total of 1700 people over 18 years from National Health and Nutrition Examination Survey (NHANES) in 2017-2018 were selected as subjects to explore the relationships between eGFR and six PFASs (perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFUA), perfluorodecanoic acid (PFDeA), and perfluorohexane sulfonate (PFHxS)). First, multiple linear regression was used to estimate the association of each PFAS with eGFR, and the joint effect of PFAS mixtures was evaluated by Bayesian kernel machine regression (BKMR). Multiple linear regression analysis showed PFOS (beta = - 0.246, p = 0.026) and PFHxS (beta = 0.538, p = 0.049) were significantly associated with eGFR in total population. In BKMR analysis, there was joint effect between PFOS and PFHxS for eGFR. And there were the joint effects of multiple PFAS on eGFR, especially the significant joint effect between PFHxS and PFDeA/PFNA/PFUA. Future cohort studies need to explore the association of multiple PFASs and health.			1					B	B		6種類のPFASとeGFRとの関係についてNHANESのデータを用いて解析し、PFOSとPFHxSの寄与を見出した。相互作用もあり
D1351	ヒト（腎毒性）	Jain, RB	Synergistic impact of co-exposures to toxic metals cadmium, lead, and mercury along with perfluoroalkyl substances on the healthy kidney function	2019	Environ. Res. 2019 Feb:169:342-347. doi: 10.1016/j.envres.2018.11.037	Impact of co-exposures to toxic metals cadmium, lead, and mercury along with perfluoroalkyl substances on the healthy kidney function was evaluated among US adults aged > = 20 years by analyzing data (N = 7857) from National Health and Nutrition Examination Survey for 2003-2014. Perfluoroalkyl substances selected for analysis were: perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), and perfluorononanoic acid (PFNA). High levels of exposures to Cd, Pb, total Hg, and PFAS were said to occur if their observed levels in blood/serum were greater than 75th percentiles. A healthy kidney function was defined if estimated glomerular filtration rate was found to be > = 60 mL/min/1.73 m(2) and urine albumin creatinine ratio was <= 30 mg/g creatinine. Adjusted odds of a healthy kidney function due to co-exposures to high levels of Cd along with high levels of PFOA, PFOS, and PFNA were found to be 0.713, 0.576, and 0.640 respectively. Adjusted odds of a healthy kidney function due to co-exposures to high levels of Pb along with high levels of PFOA, and PFNA were found to be 0.657, and 0.671 respectively. Co-exposures to high levels of Hg as measured by the total mercury in blood was not found to affect the odds of a healthy kidney function.			1					B	B		4種類のPFASとCd, Pb, Hgとの相互作用がeGFRに及ぼす影響を調べた。Hgは相互作用を示さなかった。
D1352	ヒト（腎毒性）	Scinicariello, F; Buser, MC; Balluz, L; Gehle, K; Murray, HE; Abadin, HG; Attanasio, R	Perfluoroalkyl acids, hyperuricemia and gout in adults: Analyses of NHANES 2009-2014	2020	Chemosphere. 2020 Nov:259:127446. doi: 10.1016/j.chemosphere.2020.127446.	Background: Previous studies have reported a positive association of perfluoralkyl acids (PFAAs), including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), with hyperuricemia. The objective of the study is to investigate whether there is an association between concurrent serum levels of several PFAAs and gout, serum uric acid (SUA) or hyperuricemia in the U.S. adult population as represented by the National Health and Nutrition Examination Survey (NHANES) 2009-2014 sample (n = 4917). The PFAAs investigated include PFOA, perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluorohexane sulfonic acid (PFHxS) and PFOS. Methods: This cross-sectional study used multivariate logistic regressions to analyze the association of single PFAAs with hyperuricemia and self-reported gout; the association with SUA was analyzed by multivariate linear regression. Analyses were adjusted for race/ethnicity, age, sex, education, alcohol consumption, smoking, serum cotinine, BMI, diabetes, hypertension, chronic kidney disease, and SUA (for gout only). Results: Higher quartile values of serum PFOA and PFHxS were associated with increased odds of self-reported gout. There was a positive association of SUA with increased levels of PFOA, PFNA, PFOS, PFHxS and PFDA. Higher quartile values of PFOA, PFNA, and PFHxS were associated with higher odds of hyperuricemia. Conclusions: In this population-based cross-sectional analysis, we found an association between selected PFAAs and self-reported gout. We also confirmed previous reports of an association between several PFAAs and hyperuricemia. Our study suggests that exposure to PFAAs may be a risk factor for hyperuricemia and gout. Published by Elsevier Ltd.			1					B	B		5種類のPFASと痛風、高尿酸血症との関係を調べた結果、性の関連が見られた
D1353	ヒト（腎毒性）	Jain, RB; Ducatman, A	Associations between the concentrations of a-klotho and selected perfluoroalkyl substances in the presence of eGFR based kidney function and albuminuria: Data for US adults aged 40-79 years	2022	Sci. Total Environ.2022 Sep;838(Pt 1):155994. doi: 10.1016/j.scitotenv.2022.155994.	Exposures to per-and polyfluoroalkyl substances (PFAS) cause oxidative stress, a risk factor for tissue damage leading to kidney and cardiovascular diseases. The antiaging protein klotho is known to act as an anti-oxidative agent, and how klotho homeostasis interacts with PFAS has not been reported. This study among 3981 US adults aged 40-79 years old evaluated relationships of internal PFAS contamination to a-klotho across stages of estimated glomerular filtration rate or eGFR-based kidney function and albuminuria defined as urinary albumin creatinine ratio of > 30 mg/g creatinine. In the absence of albuminuria and when eGFR based kidney function was in stage GF-1 (eGFR >= 90 mL/min/1.73 m(2)), statistically significant inverse associations between alpha-klotho and PFNA (beta = -0.04930, p < 0.01), PFDA (beta = -0.03307, p = 0.02), and PFUnDA (beta = -0.03451, p = 0.01), PFHxS (beta = -0.03011, p = 0.04) and PFOS (beta = -0.03126, p = 0.03) were noted. No associations between alpha-klotho and PFAS were observed when kidney function was in stages GF-2 (60 <= eGFR < 90 mL/min/1.73 m(2)) or GF-3A (45 <= eGFR < 60 mL/min/1.73 m(2)) in the presence or absence of albuminuria. Unexpectedly, however, in the absence of albuminuria, with kidney function in stage GF-3B/4 (15 <= eGFR < 45 mL/min/1.73 m(2)), associations were positive between a-klotho and PFOA (beta = 0.20989, p < 0.01), PFNA (beta = 0.18373, p < 0.1), PFDA (beta = 0.20413, p < 0.01), PFUnDA (beta = 0.17660, p < 0.01), and PFOS (beta = 0.14267, p < 0.01). The inverse relationship of PFAS to the antioxidant protein a-klotho in those with healthy kidney function has not been previously reported and should be evaluated in other populations.			1					B	B		6種類のPFAS濃度とKlothoとの関係を調べた結果、負の関連を見出した
D1354	ヒト（腎毒性）	Jain, RB	Perfluoroalkyl acids and their isomers, diabetes, anemia, and albuminuria: Variabilities with deteriorating kidney function	2021	Ecotox. Environ. Safe. 2021 Jan:208:111625. doi: 10.1016/j.ecoenv.2020.111625.	Data for US adults aged >= 20 years from National Health and Nutrition Examination Survey for the years 2003-2014 were analyzed to evaluate how adjusted (N = 8481) and unadjusted (N = 9080) levels of selected perfluoroalkyl acids (PFAA) vary across the different stages of glomerular function (GF) among those who did not have diabetes, anemia, or albuminuria as compared to those who had diabetes only, anemia only, and albuminuria only. PFAAs selected for analyses were: perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorodecanoic acid (PFDA), perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA). Irrespective of GF stage, there was no noticeable evidence to suggest that adjusted levels of PFAA for those with diabetes only are any lower than those with no diabetes, no anemia, and no albuminuria. Those who had anemia only were found to have lower adjusted levels of at least PFOA, PFOS, PFDA, and PFHxS than those who had no diabetes, no anemia, and no albuminuria. These results were seen in the presence (eGFR < 60 mL/ min/1.73 m(2)) as well as the absence of chronic kidney disease. For GF-1 (eGFR > 90 mL/min/1.73 m2), GF-2 (60 <= eGFR <= 90 mL/min/1.73 m(2)), and GF-3B/4 (15 < eGFR <= 45 mL/min/1.73 m(2)), those who had albuminuria only had lower adjusted levels of PFOA, PFOS, and PFHxS than those who had no diabetes, no anemia, and no albuminuria. In general, adjusted levels of those who had albuminuria only were lower than those who had anemia only at GF-3 and more often than not at GF-1 and GF-2. Rise in adjusted levels of PFAA from GF-1 to GF3A (45 < eGFR < 60 mL/min/1.73 m(2)) was faster for those with anemia only than any other comparison group for the total population and females.			1					B	B		5種類のPFAS濃度と糖尿病、貧血、腎機能障害との関連を調査した