Introduction

Recent environmental surveys have ascertained the widespread occurrence of perfluorinated alkyl substances (PFAS) in tissues of wildlife from the Arctic, including species occupying high trophic positions in the marine food web. The predominant PFAS reported in arctic biota has been perfluorooctane sulfonate (PFOS), while perfluorobutane sulfonate (PFBS), perfluoroc-tane sulfonamide (PFOSA), and 8 to 15 carbon-chain length perfluorocarboxylic acids (PFPCAs) have also been reported. PFOS and other fluorocarbons are believed to have entered the environment as a result of industrial processes, e.g., in the manufacture of fire-fighting foams. PFOS has been documented in this species. In this study, samples of glaucous gull liver were collected from the Norwegian Arctic.

Aim of this study

To investigate the distributions and levels of a suite of PFAS in plasma, liver, brain, and egg samples collected from adult glaucous gulls (Larus hyperboreus), a marine scavenger-predator species breeding in the Norwegian Arctic.

Experimental Section

Species Studied and Sample Collection

The glaucous gull has previously been reported to accumulate some of the highest tissue/plasma levels of organohalogens of any arctic seabird species and populations. The seasonal/annual distribution of glaucous gulls is entirely within the North Atlantic region, suggesting that the main pathway of contaminant exposure is via long-range atmospheric transport. Several adverse biological effects associated with organohalogen exposure have been documented in this species. In this study, samples of blood (plasma) (n = 20), liver (n = 9), brain (n = 8), and eggs (n = 10) were collected by the Norwegian Polar Institute during the breeding season of 2004 from an equal number of adult male and female glaucous gulls at Svalbard (ice edge) and Bear Island in the Norwegian Arctic (FIGURE I).

Chemical Analyses

Analyses of glaucous gull samples were carried out by two laboratories using different extraction and cleanup procedures based on methods by Hansen et al. [3] and Berger and Haukås [4]. Instrumental quantification was performed using high-performance liquid chromatography-electrospray ionization (HPLC-ESI) method or tandem mass spectrometry (MS) (HPLC-ESI/MS/MS), or HPLC-time-of-flight-high-resolution MS with ESI in the negative ionization mode (HPLC-ESI-Tof-HRMS). An inter-laboratory test based on the analysis of a suite of PFAS in glaucous gull liver samples resulted in mean percent deviation of compound concentrations ranging between 6% and 77%. Data comparison showed, e.g., a non-significant difference in mean PFOS liver concentrations between method A and method B, which was consistent with the other analytes determined. QA/QC included laboratory blanks, duplicate sample extraction, matrix spikes, and calibration standard injections for each block of 5 to 10 samples to monitor changes in instrument sensitivity, and to minimize matrix effects on ESI suppression/enhancement.

Main Findings

- PFAS concentrations co-varied positively with those of PFOS in plasma (FIGURE III).
- Factors such as body compartment/tissue specific carrier protein affinity may play a primary role in the accumulation/dilution dynamics of PFAS versus PFOS in glaucous gulls.

Conclusions

A suite of PFAS is retained in plasma, liver and brain of glaucous gulls from the Norwegian Arctic at concentrations varying to some extent between tissues/bodies compartments. A substantial burden of PFAS is transferred from mother to eggs at the time of ovogenesis. Because the toxicological effects mediated by PFAS exposure are largely unknown in apex avian wildlife and developing embryos, research is warranted to assess the implications of current high levels in glaucous gulls.

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Literature Cited