ACCUMULATION OF ATMOSPHERIC AND SEDIMENTARY PCBS AND TOXAPHENE IN A GREAT LAKES FOOD WEB

Heather M. Stapleton[1], Peggy Ostrom[2], Colleen Masterson[2], John Skubinna[2], and Joel Baker[1]

[1]Chesapeake Biological Laboratory, University of Maryland, P.O. Box 38, Solomons, Maryland, USA
[2]Michigan State University, East Lansing, Michigan, USA

Introduction

It is important to understand the relative importance of the atmosphere and historically-contaminated sediments as current sources of persistent organic pollutants to aquatic food webs because these two environmental reservoirs respond differently to reductions in POPs loadings. Recent analyses suggest that POPs levels in the Great Lakes surface waters are buffered by the overlying atmospheric POPs pool, and that, therefore, the long-term rate of declines in water column POPs inventories are controlled by loadings to and cycling within the atmosphere. Alternatively, chronic release of POPs from contaminated sediments may support water column levels. Predicting future POPs level in Great Lakes fish requires a quantitative understanding of the atmospheric and sedimentary POPs pathways.

Methods

In this study, we sampled representative members of a Great Lakes food web in northern Lake Michigan monthly during two consecutive years. Contaminant concentrations and profiles were coupled with stable isotope and gut content analyses to determine the dominant routes of PCB exposure to the food web. Samples were separated by species, sampling date, and length, and analyzed for lipid content, stable isotopes on nitrogen and carbon, PCB congeners, and toxaphene components. Organochlorines were determined on homogenized whole organism samples using high resolution gas chromatography with electron capture detection (PCBs) and negative chemical ionization mass spectrometry (toxaphene). Concentrations of PCBs and toxaphene was related to size and lipid content, and their selective enrichment through the food web was studied using stable isotopes to construct trophic structure.

Results and Discussion

Not surprisingly, both PCB and toxaphene concentrations were lowest in the invertebrate shrimp (*Mysis relicta*) and highest in the benthic fish burbot (*Lota lota*), indicating biomagnification of both classes of POPs. Statistical path analysis determined that 60% of the enrichment in POPs in the food web was due to the coincident increase in lipid content, while 40% was attributed to the direct effect of trophic transfer. Unlike previous studies, POPs levels across the food web were poorly correlated to ^{15}N. In this system, ^{15}N levels at the base of the food web varied considerably seasonally due to shifts in the inorganic nitrogen pools utilized by autotrophs, resulting in a 'noisy' ^{15}N signature at the base of the food web. In contrast, we observed a stronger correlation between PCB and toxaphene levels and ^{13}C levels in the food web, suggesting that carbon isotopes may be useful to define trophic interactions in the northern Great Lakes (which are dominated by autochthonous production). Because autochthonous organic matter becomes greatly enriched in ^{15}N , we can use nitrogen isotopes to distinguish two food webs in our study–one based on recently produced organic matter (presumably phytoplankton in surface waters) and the other based on partially degraded seston (*i.e.*, detritus). Biomagnification is similar between these two food webs, but the level of POPs at the base of the food webs differ. Based on this analysis, we conclude that there are two important exposure routes to predator fish in the northern Great Lakes. Suspended seston and algal material assimilate PCBs from the atmosphere *via* surface waters and expose pelagic organisms through trophic transfer. Rapidly settling organic material supplies POPs to the benthic environment. These results suggest that direct transfer of POPs from contaminated sediments is of minor importance in these deep systems.