Use of Hg Stable Isotopes to Track Environmental Methylmercury Sources of Estuarine Fish

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Background

- Estuarine fish obtain methylmercury (MeHg) from diverse environmental sources including rivers/watershed inputs, atmospheric deposition, water column methylation, and benthic sediment production.
- Hg stable isotope signatures can be a powerful tool to trace processes and sources of Hg in the environment:
  - Large mass-independent fractionation (MIF) of the odd-mass-number isotopes of Hg (199Hg, 201Hg) occurs primarily during photochemical reactions.
  - Positive Δ199Hg in MeHg/Hg II in remaining water and aquatic organism.
  - No MIF observed along food chain (Δ199Hg constant over trophic transfer).
  - Mass-dependent fractionation (MDF) but no MIF occur during microbial methylation and demethylation/reduction.
  - No MDF observed along food chain up to fish (Δ202Hg does not change).

- Objectives: This study uses mercury (Hg) stable isotopes to help refine our understanding of environmental sources of MeHg uptake in estuarine fish.

Hypothesis

Various estuarine fish species receiving their MeHg exposures from multiple environmental sources are reflected by their stable Hg isotope signatures (Fig.1).

Methods

We compared Hg stable isotopic compositions among different fish species caught in three locations (red circles) from an estuarine fjord (Lake Melville) in Labrador, Canada.

Results

We observed wide ranges of Δ199Hg values (0.6°-3.4‰) and relatively narrow ranges of δ202Hg values (-0.8°-0.8‰) in the estuarine fish.

- Fish species living in surface water have higher Δ199Hg values than those of benthic species (Fig.4).
- Large variability of Hg isotope ratios in some benthic species (sucker and flatfish), indicating strong pelagic-benthic coupling in shallow water column.

- δ202Hg values gradually increase from species spending most of their lifetime in freshwater to those with foraging habitat in the open ocean (Fig.5). These data suggest both microbial demethylation/reduction and photodegradation of MeHg occur in the estuary prior to incorporation of MeHg into food web.

- Observed large variations in the isotopic composition in some fish species (e.g. flatfish) can be explained by their food and habitat preferences in different life stages (Fig.6).

Coming up...

- More fish Hg isotope data, seals and human hair...
- C,N data to elucidate predation-prey relationship which helps to identify the dominant Hg sources for each species
- Sediment Hg isotopic analysis: explore whether variability of sediment can possibly explain large variation in Δ199Hg of benthic species

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