Project information

Project title
WP2.1 COPOL - methylmercury in Arctic marine food webs
Year
2013/14
Project leader
Anders Ruus
Participants

Participants from NIVA:

Anders Ruus (Project leader), Katrine Borgå, Hans Fredrik Veiteberg Braaten

Other co-authors of manuscripts produced: Ida B. Øverjordet (SINTEF) Anita Evenset (Akvaplan-niva), Guttorm Christensen (Akvaplan-niva), Eldbjørg S. Heimstad (NILU) Geir W. Gabrielsen (NP), Christopher Harman (NIVA), Thorjørn Larssen (NIVA)

Flagship
Hazardous Substances
Funding Source

Miljøgifter – effekter på økosystemer og helse

Summary of Results

The results from the project so far is best summarized by the abstracts of the two manuscripts prepared in the project (the first being published and the second *in press*):

1. Title: "Effects of sample preparation on methylmercury concentrations in Arctic Organisms" (Published 2014: International Journal of Environmental Analytical Chemistry Volume: 94, Issue: 4, Pages: 381-384)

By: Braaten HFV, Harman C, Øverjordet IB, Larssen T.

The biogeochemical cycling of mercury (Hg) in the marine environment is an issue of global concern, as consumption of marine fish is a major route of human exposure to the toxic specie methylmercury (MeHg). The most widely utilised and accepted technique for preparing biological tissue samples for the analysis of MeHg involves an alkaline digestion of the sample. Recent studies suggest, however, that this technique is inadequate to produce satisfactory recoveries for certain biological samples, including fish, fur, feathers and other 'indicator' tissues which contain relatively high levels of MeHg. Thus an improved acidic extraction method has been proven to produce more satisfactory results for

a wide range of biological tissues. The present study compares the two methods on real sample material from different organisms of an Arctic marine food chain, and shows how this could lead to misinterpretation of analytical results. Results show significantly ($p < 0.05$) lower concentrations for alkaline digestion for large parts of the food chain; especially in fish and birds. The mean differences in concentrations found between the two different methods were 28, 31 and 25% for fish (Polar and Atlantic cod), Little Auk and Kittiwake, respectively. For samples lower in the food chain (i.e. zooplankton and krill) no significant differences were found. This leads to a clear underestimation of the levels of MeHg found higher up in these food chains; the ratio of MeHg to Hg in biological samples; and thus potentially erroneous conclusions drawn from these results concerning the biological cycling of mercury species. We hypothesise that the main reasons for these differences are poor extraction efficiency and/or matrix effects on the ethylation step prior to analysis. This is the first study to examine the effects of these artefacts on real environmental samples covering a complete food chain.

1. Title :“Methylmercury biomagnification in an Arctic pelagic food web” (in press; Environmental Toxicology and Chemistry)

By: Ruus A, Øverjordet IB Braaten HFV, Evenset A, Christensen G, Heimstad ES, Gabrielsen GW, Borgå K.

Mercury (Hg) is a toxic element entering the biosphere from natural and anthropogenic sources, and emitted gaseous mercury enters the Arctic from lower latitudes by long range transport. In aquatic systems, anoxic conditions favour the bacterial transformation of inorganic mercury to methyl mercury (MeHg), which has a greater potential for bioaccumulation than inorganic mercury, and is the most toxic form of Hg. The main objective of this study was to quantify the biomagnification of MeHg in a pelagic food web, comprising species of zooplankton, fish and seabirds, from the Kongsfjorden system (Svalbard, Norway) by use of Trophic Magnification Factors (TMFs). As expected, tissue concentrations of MeHg increased with increasing trophic level in the food web, however, steeper than observed in several earlier studies, especially at lower latitudes. There was good correlation between MeHg and total Hg (totHg) concentrations through the food web as a whole. The concentration of MeHg in kittiwake decreased from May to October, contributing to seasonal differences in TMFs. The ecology and physiology of the species comprising the food web in question may have large influence on the magnitude of the biomagnification. A significant linear relationship was also observed between concentrations of Selenium (Se) and totHg in birds but not in zooplankton, suggesting the importance of Se in Hg detoxification for individuals with high Hg concentrations.

For the Management

As previously mentioned: The analytical work with the samples revealed an interesting additional aspect: The most widely utilized and accepted technique for preparing biological tissue samples for the analysis of MeHg involves an alkaline digestion of the sample. Recent studies suggest however, that this technique is inadequate to produce satisfactory recoveries for certain biological samples, including fish, fur, feathers and other "indicator" tissues which contain relatively high levels of MeHg. Thus an improved acidic extraction method has been proven to produce more satisfactory results for a wide range of biological tissues. A comparison has been made between the two methods and shows how this mismatch could lead to misinterpretation of analytical results.

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Published Results/Planned Publications

Manuscript published:

Title: "Effects of sample preparation on methylmercury concentrations in Arctic Organisms" (Published 2014: *International Journal of Environmental Analytical Chemistry* Volume: 94, Issue: 4, Pages: 381-384), by: Braaten HFV, Harman C, Øverjordet IB, Larssen T.

Manuscript in press:

Title :"Methylmercury biomagnification in an Arctic pelagic food web" (*in press, Environmental Toxicology and Chemistry*), by: Ruus A, Øverjordet IB Braaten HFV, Evenset A, Christensen G, Heimstad ES, Gabrielsen GW, Borgå K.

This work was presented at the SETAC-conference in Glasgow, 2013, and at *Arctic Frontiers* in Tromsø, 2014.

Communicated Results

As mentioned, this work was presented at the SETAC-conference in Glasgow, 2013, and at *Arctic Frontiers* in Tromsø, 2014.

A manuscript showing different results regarding methylmercury concentrations in different samples using common alkaline sample digestion and an improved acidic extraction method, respectively, and how this could lead to misinterpretation of analytical results, is published in *International Journal of Environmental Analytical*

Chemistry.

Interdisciplinary Cooperation

We have benefited from the collaboration with our partners in the COPOL project (and parallel “Flaggskip” initiatives) as we reported in the final report of the COPOL project, the IPY grant gave the participating institutions (each with their expertise) an important foundation for future scientific collaboration. In our opinion, this collaboration is now flourishing, and the “Flaggskip” gives opportunity to follow up on some specific research questions that has come out of our previous activities.

Budget in accordance to results

The budget has been used for the planned activities. It has been crucial for our participation and direct involvement in ongoing activities with Fram Centre collaborators.

The analytical work from this project has also highlighted some methodological aspects that is followed up by internal funding from NIVA.

Could results from the project be subject for any commercial utilization

No

Conclusions

The dynamics of methyl mercury vs. total mercury (and other elements, such as selenium) in the food chain is an aspect that these results will lead to insight in. Furhtermore, preliminary results (analyses of MeHg in bird tissues, performed through this project) indicate that the dynamics of methyl mercury vs. total mercury in bird tissues is an interesting and largely unknown aspect. It is obviously important for interpretation of mercury dynamics in the food chain and highlights the need for knowledge regarding choice of tissue for sampling. We aspire to continue to work on these data.

There is a need for development of current used models with modules for MeHg.

he project has shown how the widely used alkaline sample digestion for methylmercury analysis may lead to misinterpretation of results.