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Mercury and other pollutants of global concern

Research is largely focused on the occurrence and fate of mercury in the Antarctic environment in the context of climate change. In order to reduce the negative effects of mercury on humans and ecosystems, the Minamata Convention was adopted in 2013, to which almost all countries in the world are signatories, and most have ratified it. However, a number of open questions remain, notably the methodology for monitoring the effectiveness of this Convention. Slovenia is very active in these efforts, mainly due to the heritage of mercury in Idrija in Slovenia, where it was the second largest mercury mine in the world.

With knowledge linking all segments of the environment and biological systems, we could thus better understand the impact of climate change on the cycling of mercury in the highly vulnerable environment of Antarctica. I have briefly written down some of the goals in this document. We have the knowledge and equipment and very enthusiastic researchers, but of course we would need access to Antarctica. We would be most happy to take part in research expeditions. I hope that the path to one of the most interesting and so far least researched environments in the world will be opened for Slovenian researchers.

In collaboration with German, Swedish and Italian researchers, we have conducted some preliminary studies the biogeochemical cycling of toxic and essential chemical elements as a result of climate change (T, water salinity, ecosystem changes) with an emphasis on mercury. Mercury is a global pollutant, which means that this toxic metal is deposited far away from sources of pollution. Like other volatile and persistent organic pollutants, mercury is deposited in polar environments. Larger deposition is observed in the Arctic environment, while there is little data on the deposition of mercury in Antarctica. It is known that mercury deposited through the atmosphere on the surface of ice and water can be methylated to form monomethyl mercury(MeHg), which readily passes into biological systems and accumulates in organisms at the top of the food chain. MeHg is an extremely toxic form of mercury, so it is necessary to know the dynamics of its formation and uptake into biological systems.

We have already published joint publications indicating an increase in the mercury content in the water column and organisms. Research is continuing in the direction of understanding biological and chemical processes and forecasting in the future, taking into account global resources and measures to reduce emissions into the global atmosphere (in the context of the implementation of measures imposed by the Minamata Convention). Namely, melting ice contains nutrients and mercury, which are released into the water during constant melting. In the following, we want to direct research in the following directions:

- **Monitoring of methylation processes (identification of bacteria responsible for the process of methylation, demethylation and reduction of Hg)**
- **Monitoring of oxidation and reduction processes (installation of devices for continuous measurement of volatile forms of Hg (Hg0) and dimethyl mercury)**
- **Use of DGT devices as passive dosimeters for monitoring the presence of various forms of Hg in seawater**
- **By measuring the ratio of the isotopic ratio of Hg to stable isotopes, determine the proportion of Hg present due to global anthropogenic sources.**
- **Study of the protective role of selenium in the accumulation of Hg in organisms, especially at the top of food chains (mammals, witnesses)**
- **Use and application of global biogeochemical models with which we want to simulate the fate of mercury due to climate change.**

In this context, we propose combined measurements of **mercury speciation**, whole and methylated, with **metagenomic analysis** of whole community microbial DNA from Antarctic snow, brine, sea ice, and seawater to elucidate potential routes of methylation and evaporation of mercury in polar marine environments. In particular, we would study the marine microaerophilic bacterium *Nitrospina* as a potential mercury methylator in sea ice. Anaerobic bacteria, known to methylate mercury, were not present in sea ice metagenomes. We suggest that Antarctic sea ice in the Southern Ocean may contain a microbial source of methylmercury.

With this work, we will significantly contribute to the measures of implementation of the Minamata Convention, signed by the EU and Slovenia, as well as the countries of South America.

Attention would also be paid to other toxic and essential elements, persistent organic pollutants, and those that are persistent and highly mobile; and in particular those on **the EU's priority program.** Pollution is harmful to our health and the environment. It is the biggest environmental cause of many mental and physical illnesses and premature deaths, especially among children, people with certain health problems and the elderly. In addition to the fact that pollution affects human health, it is one of the main reasons for the loss of biodiversity. It reduces the ability of ecosystems to provide services such as sequestration and carbon decontamination. In 2021, the European Commission adopted an action plan " Towards zero air, water and soil pollution - building a healthier planet for healthier people "(**Green Deal”**).

We also suggest to focus our research on **Penguins**, which are suitable indicators of Antarctic contamination for several reasons; they are endemic and long-lived, easy to observe and sample, breed in large colonies, are at the top of food chains, return to the same nesting colony each year. high tropical positions, making them susceptible to high levels of biomagnifying pollutants such as Hg. As pointed out, differences in ecology (diet), physiology, and sex can lead to differences in exposure levels within the same or between different species of penguins. However, there are no data on the influence of genetic background on exposure variability. Therefore, it should be assessed how genetic differences in genes that are directly or indirectly related to the metabolism or biological effects of various pollutants or essential nutrients (such as selenium) may affect the sensitivity or potential adaptability (tolerance) of penguins to exposure. Such information would help assess the extent to which penguin species are endangered due to pollution of their local environment. Suitable areas for studying gene-environmental interactions would be **King George Island** areas due to the known high pollution with various pollutants (e.g. Hg, Pb, Cd, POPs), rich penguin colonies (Adelie, Chinstrap and Gentoo species) and relatively good accessibility.

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