Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.9042

Internal dynamics of mercury in the Antarctic penguin, the potential bioindicator for mercury at remote regions

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Since the implementation of the Minamata Convention, there has been substantial growth in the literature, which characterized sources and internal processes governing the level and speciated mercury (Hg) body burdens in various types of biota (i.e., terrestrial insects, birds, mammals, freshwater fish). While bioindicator species for Hg in freshwater and terrestrial environments are generally well characterized, bioindicator species in remote environments such as the Antarctic is yet to be investigated. Here, we measured concentration and stable isotope ratios of Hg in five different tissues in Adelie and Emperor penguins collected from four regions near the Ross Sea in the Antarctic. We chose penguins as a potential bioindicator for mercury because they are located at high trophic positions and have a long lifespan. The tissue-specific comparison of mercury isotopes revealed consistent δ^{199}Hg across the tissues, confirming the absence of modifications in δ^{199}Hg via internal processes. The δ^{202}Hg of the tissues showed significant positive relationships with the fraction of total mercury present as methylmercury (% MeHg) in all penguins, with the muscle and liver exhibiting the highest and lowest δ^{202}Hg, respectively. We attribute the low δ^{202}Hg in the liver to the hepatic demethylation, resulting in a lower δ^{202}Hg in the product inorganic mercury relative to MeHg subject to redistribution to the muscle. Given the absence of δ^{199}Hg changes via internal processes, we used the muscle δ^{199}Hg to explain the interspecific difference in the bioaccumulate source of mercury in penguins. The Emperor penguins displayed measurably lower δ^{199}Hg (1.21 to 1.31‰) compared to Adelie penguins (1.31 to 1.66‰) across the four regions of the Antarctic. We attribute the low δ^{199}Hg in the Emperor penguins to the deeper diving depths and the consumption of mesopelagic prey. Adelie penguins feeding primarily in the surface water consume epipelagic prey (i.e., plankton, krill), which have bioaccumulated MeHg that has undergone extensive photo-degradation. Our study is essential in determining the appropriate isotopic indicator and penguin tissues for mercury source monitoring in the remote Antarctic and for distinguishing ecological characteristics between two species in penguins.