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Mercury isotope composition in living corals

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Coral reef ecosystem is characterized by rich biodiversity, high primary productivity and rapid material cycling. Up until now, Hg research in coral reef ecosystems is extremely limited, limiting our knowledge about Hg cycling in this important system. The aim of this study is to trace the source, migration and transformation of Hg in living corals by measuring their stable mercury isotope ratios in corals.

In this study, 27 coral samples from different species were collected from Luhuitou coral reef area, Hainan Island, China. The living coral tissues and symbiotic zooxanthellae were separated by centrifugation, and measured for concentrations of total mercury (THg) and methylmercury (MeHg) and mercury isotope ratios.

The average THg of all zooxanthellae samples (n=27) was 18.72 ± 13.98 ng/g, almost twice that of tissues samples (n=23) of 10.38 ± 9.06 ng/g. The MeHg/THg ratios in the samples of tissues (n=3) and zooxanthellae (n=3) were both very low, but this ratio in zooxanthellae was generally higher than that in tissue for the same coral sample. Our observations thus suggest that there is a difference in Hg enrichment efficiency between zooxanthellae and coral tissues, or that there is a detoxification mechanism in coral tissues.

δ^{202}Hg (representing mass dependent fractionation, MDF) ranged from 0.00‰ to -1.99‰ and 0.10‰ to -1.15‰ for coral tissues (n=13) and zooxanthellae (n=20), respectively Δ^{199}Hg (representing odd number isotope mass independent fractionation, odd-MIF) ranged from 0.01‰ to -1.28‰ and 0.07‰ to -1.37‰ for coral tissues (n=13) and zooxanthellae (n=20), respectively. Both δ^{202}Hg and Δ^{199}Hg values of zooxanthellae were close to those of coral tissues in the same sample.

It is interesting to note that most of coral tissues and zooxanthellae have negative odd-MIF values, and Δ^{199}Hg and Δ^{201}Hg are highly correlated with a linear Δ^{199}Hg/Δ^{201}Hg slope of 1.8. Given that coral reefs are located in shallow sea waters with very high light transmission, the negative odd-MIF might be produced during photoreduction of Hg(II) binding to sulfur-containing ligands. Although a small fraction of MeHg exists in coral tissues and zooxanthellae, MeHg photodegradation only produces positive odd-MIF in the aqueous MeHg. Thus, the odd-MIF observed in tissues and zooxanthellae is unlikely produced by MeHg photodegradation. An experimental study shows that gaseous Hg(0) photooxidation process by halogen radicals could produce Hg(II) with more negative MIF than Hg(0), with a Δ^{199}Hg/Δ^{201}Hg slope of 1.64 for Br radical

and 1.89 for Cl radical[1]. However, it is unknown if similar Hg(0) oxidation processes operate in coral ecosystem.

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[1] Sun, G. Y., J. Sommar, X. B. Feng, et al. Mass-Dependent and -Independent Fractionation of Mercury Isotope during Gas-Phase Oxidation of Elemental Mercury Vapor by Atomic Cl and Br[J]. Environmental Science & Technology: 2016, 50 (17): 9232-9241.