Food web structures focising on macrobenthos in Minamata Bay and pollution pathway of Hg

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The consumption of contaminated fish is the main source of Hg exposure to humans. Hg pollution of fish is also caused by their food sources containing Hg, which is ultimately derived from the bioconcentration by primary producers. In coastal waters, phytoplankton is the main primary producer in general. It fuels not only surface production but also benthic productions falling to bottom layer. However, in shallow subtidal zones, the contribution of microphytobenthos is sometimes not negligible. The relative contribution of phytoplankton and microphytobenthos to the secondary and tertiary production differs among sites and species, and fishes often depend on multiple food sources having different degrees of pollution. Food web analyses is therefore essential to understand Hg pollution of fish.
Minamata Bay, located at southern Yatsushiro Sea, western coast of Kumamoto Prefecture, Japan, was exposed to the methylmercury in the 1950s. Although residual mercury in sediment is relatively high compared with other near regions, THg (total Hg content) in most fish has now become safe for consumption, and fishery has reopened since 1997. However, there is little information on the current subtidal macrobenthos, which are food sources of demersal fish and play a significant role for transferring Hg derived from primary producers to fish.
Here we studied food web structures using carbon and nitrogen stable isotopes in Minamata Bay, mainly on benthic compartment. We seasonally collected macrobenthos, particulate organic matter (POM) at 2 m deep from the surface water as phytoplankton sample, attached microalgae by brushing off the cobble in the intertidal zone as a substitute for microphytobenthos from July 2018 to July 2019. Fishes were sampled using a gillnet one month later of macrobenthos sampling, and their gut contents were also observed under dissecting microscope.
Benthic community in Minamata Bay was very poor in abundance and species richness, and small annelids, such as lumbrinerid, sigalionid, glycerid worms mostly constituted the community all the year around. Isotope analysis showed that food web structures were overall fueled by microphytobenthos, and the contribution of pelagic phytoplankton was low to both macrobenthos and fish in any season. THg of both macrobenthos and fishes also tended to increase with carbon isotope values (δ^{13}C), suggesting that THg of fish became high as they fed more preys that were fueled by microphytobenthos. While fish preyed on organisms of many taxa including fish (mainly Japanese anchovy), fish preying on benthic crustaceans such as crabs and shrimps tended to accumulate high THg. Meanwhile, THg contents of flounders and lizardfish inhabiting bottom, whose substrata (i.e. sediment) potentially contain high THg, were relatively low, and they mainly fed on Japanese anchovy. These results suggest that food sources are more important than habitats for Hg pollution and the main Hg pollution pathway to fish in Minamata Bay is benthic food chain, especially linked with benthic crustaceans, fueled by microphytobenthos.

Keywords: mercury, macrobenthos, stable isotope

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