Bioaccumulation of Methylmercury in a Marine Plankton Ecosystem

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Methylmercury is greatly bioconcentrated and biomagnified in marine plankton ecosystems, and these communities form the basis of marine food webs. Therefore, the evaluation of the potential exposure of methylmercury to higher trophic levels, including humans, requires a better understanding of its distribution in the ocean and the factors that control its biomagnification. In this study, a coupled physical/ecological model is used to simulate the trophic transfer of monomethylmercury (MMHg) in a marine plankton ecosystem. The model includes phytoplankton, a microbial community, herbivorous zooplankton (HZ), and carnivorous zooplankton (CZ). The model captures both shorter food chains in oligotrophic regions, with small HZ feeding on small phytoplankton, and longer chains in higher nutrient conditions, with larger HZ feeding on larger phytoplankton and larger CZ feeding on larger HZ. In the model, trophic dilution occurs in the food webs that involve small zooplankton, as the grazing fluxes of small zooplankton are insufficient to accumulate more MMHg in themselves than in their prey. The model suggests that biomagnification is more prominent in large zooplankton and that the microbial community plays an important role in the trophic transfer of MMHg. Sensitivity analyses show that with increasing body size, the sensitivity of the trophic magnification ratio to grazing, mortality rates, and food assimilation efficiency (AEC) increases, while the sensitivity to excretion rates decreases. More predation or a longer zooplankton lifespan may lead to more prominent biomagnification, especially for large species. Because lower AEC results in more predation, modeled ratios of MMHg concentrations between large plankton are doubled or even tripled when the AEC decreases from 50% to 10%. This suggests that the biomagnification of large zooplankton is particularly sensitive to food assimilation efficiency.