Modelling metal-gill interactions and metal toxicity to fish: The influence of natural organic matter source

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Natural organic matter (NOM) binds metals, decreasing the amount of metal binding to fish gills and therefore decreasing metal toxicity to fish. Work from my laboratory has shown that optically darker, more allochthonous NOM binds metals like Cu, Pb, and Al better than does optically lighter, autochthonous-like NOM, as judged by metal binding to gills of rainbow trout (*Oncorhynchus mykiss*) and by metal toxicity to trout. In these experiments, NOM was isolated by reverse osmosis from diverse sources and added at up to 10 mg C/L. A good index of NOM source is the Specific Absorbance Coefficient (e.g., SAC_{340}). Excitation-Emission matrix spectroscopy is also a good method to characterize NOM. In contrast to the results with Cu, Pb, and Al, NOM source appears to have minimal influence on the degree of inorganic Hg, Ag, and Cd binding to fish gills. The pattern appears to be that metals which bind more strongly to fish gills (higher metal-gill log *K* values) than to NOM (lower metal-NOM log *K* values) are not influenced as much by NOM source. These results have important implications for developing Biotic Ligand Models, which integrate water chemistry and organism physiology to better predict metal interactions with aquatic organisms.

References

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Metal-organic matter interaction: Ligands as a functional group in oceanic DOM

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There is little understanding of ecological roles of oceanic dissolved organic matter (DOM) except one of food chain of marine bacteria. Chemical speciation studies revealed that trace metals (Cu, Fe, Zn an others) dissolved in seawater form complexes with binding sites (ligands) in DOM. However, we have no information about why most of the dissolved trace metals are associated with dissolved organic ligands (DOLs). In order to have better understanding of ecological roles of metal complexes in seawater, it is necessary to know chemical forms of DOLs in seawater. According to present knowledge of the DOLs being bound with metals in seawater, two classes of the DOLs coexist in seawater, which are classified as type-I (DTPA) and type II (EDTA) ligands.

We carried out speciation of the DOLs using estimated conditional stability constants of metal complexes with the DOLs in seawater. The results reveal that major part of the DOLs in seawater exist as complexed form, in which major species of the EDTA type ligand are Ca and Mg complexes. Therefore, only several percents of total ligand concentrations in sea water are present as non metal-binding forms. This finding suggests that free ligand concentrations in seawater, which are linearly related to the total ligand concentrations, show no drastic change due to variations of the ligand and trace metal concentrations because of constancy of Ca and Mg concentrations in seawater. To be controlled the free ligand concentrations in seawater means that free trace metal concentrations in seawater are controlled at optimal levels in growth of marine organisms.