Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12249

# Methylmercury formation is controlled by mercury speciation and abundance of Hg methylators in stratified brackish waters of Baltic Sea

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Mercury (Hg) is a global pollutant of significant concern caused largely by its metalloorganic species methylmercury (MeHg). MeHg is a neurotoxin, which can bioaccumulate and biomagnify through food webs, posing threats to human health and wildlife. MeHg is formed predominantly by methylation of inorganic divalent mercury ($Hg^{II}$) in oxygen-deficient environments and is mediated by microorganisms carrying the hgcAB gene pair. Oxygen deficiency is spreading in coastal seas and the global ocean, creating redox stratified water columns that potentially opens new habitats for $Hg^{II}$ methylators and shift the availability of $Hg^{II}$ to such microbes. However, the mechanism that how redoxclines in oxygen deficient coastal seas control MeHg formation are not well understood.

In this study, we measured MeHg concentrations and $Hg^{II}$ methylation rate constants across redox stratified water columns in the brackish central Baltic Sea. $Hg^{II}$ chemical speciation (controlling $Hg^{II}$ availability) distribution, and the abundance of hgcAB genes and their expression (i.e., hgc transcripts) were investigated to further unravel MeHg formation mechanisms. We found that the MeHg concentration and $Hg^{II}$ methylation rates increased with decreasing redox potential and reached their highest level in deep euxinic waters, where high dissolved sulfide concentrations were detected, enhancing Hg bioavailability by forming dissolved sulfide-Hg species. Significant relationships were observed between in one hand, *hgcA* gene and transcript, and in another hand, $Hg^{II}$ methylation rates values and MeHg concentrations. Furthermore, when $Hg^{II}$ chemical speciation was combined with *hgcA* gene and transcript abundance in statistical models, the prediction of MeHg formation was improved, suggesting that *hgcA* and $Hg^{II}$ availability jointly control MeHg formation in stratified pelagic waters.

The unraveling of these mechanistic principles governing MeHg formation in oxygen deficient coastal seas is an important step to refine predictive frameworks for MeHg exposure to marine food webs and humans from current and future spread of oxygen deficiency in coastal waters and the global ocean, as well as for MeHg formation in the environment in general.