Hg transformations in sediments and biofilms from high altitude lakes

SYLVAIN BOUCHET[1], D. AMOUROUX[1], M. GONI-URRIZA[2], M. MONPERRUS[1], R. GUYONNEAUD[2], P. FERNANDEZ[3], E. TESSIER[1], D. ACHA CORDERO[3]

[1] IPREM/LCABIE, University of Pau, France
[2] IPREM/EEM, University of Pau, France
[3] LCA, Universidad Mayor de San Andres, Bolivia

In aquatic ecosystems, the neurotoxic Hg compound, monomethylmercury (MMHg), can be produced in many compartments including sediments, water column, biofilms and periphytons. Here, we concomitantly investigated Hg methylation and demethylation in these compartments from high altitude tropical lakes located in the Titicaca hydrosystem (Bolivian Altiplano, 3600-3800 m a.s.l.). Five sites representative of the different settings of these lakes (shallow vs deep, pristine vs eutrophicated or contaminated) were selected to constrain the role of sediments, periphytic biofilms (periphyton) associated to aquatic plants (Totoras) or green algae (Characeæ) and benthic biofilms in MMHg cycling. Incubation experiments with enriched isotopic tracers were carried out during two field campaigns at the end of the rainy and dry seasons in 2014. Organisms involved in Hg transformations were first constrained by using inhibitors targeting specific biological activities (sulfate-reduction, photosynthesis and methanogenesis). The diversity of active bacterial communities was then evaluated in time-course experiments together with extracellular sulfides and low molecular weight (LMW) thiols acting as ligands regulating Hg transformations. Intense MMHg production was found in benthic biofilm and periphyton associated to green algae with methylation rate constants (Km) up to 0.2 and 0.1 d^{-1}, respectively. On the contrary, Km in sediments and plant periphyton remains low (0.01 and 0.001 d^{-1}, respectively). Demethylation rate constants (Kd) vary between compartments and conditions but overall remains in the same range (0.2 - 0.6 d^{-1}). Sulfate reducers were clearly identified as the main methylators in these lakes and the variability in Km observed between the different compartments is first explained by the presence or absence of methylating bacteria. In addition, the high Km measured in benthic biofilms and periphyton associated to green algae are related to the presence of specific LMW thiols known to promote Hg availability for methylating organisms. This study provides a first assessment of the relative importance of each compartment for MMHg production and demonstrates the combined influence of bacterial activities and extracellular ligands on the transformations of Hg species.