Poster #22-3

Ecosystem Controls on Methylmercury Production by Periphyton Biofilms in a Contaminated Freshwater Stream

Grace Schwartz[1*], Todd Olsen[1,2], Katherine Muller[1], and Scott Brooks[1]

[1] Oak Ridge National Laboratory, Oak Ridge TN
[2] Current address: Geosyntec Consultants, 3043 Goal Canal Drive, Suite 100, Rancho Cordova, CA

Contact: brookssc@ornl.gov

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Website: https://www.esd.ornl.gov/programs/rsfa/

Anthropogenic activities have disrupted the natural mercury (Hg) cycle, releasing large amounts of this naturally occurring toxic element. The neurotoxin monomethylmercury (MMHg) is rarely a direct pollutant; rather, it is formed in the environment by a microbially mediated process known as mercury methylation. MMHg can also be demethylated via biotic and abiotic processes. Monomethylmercury (MMHg) produced by periphyton biofilms represents a substantial fraction of the overall MMHg flux in East Fork Poplar Creek (EFPC), an industrially contaminated creek in Oak Ridge, Tennessee (Olsen et al., 2016); but the environmental factors controlling MMHg production in biofilms are poorly understood. In this study, we used Hg stable isotopes to determine periphyton MMHg production rates across four seasons, two EFPC locations, and two light conditions. Mercury-201 and $MM^{202}Hg$ were added to intact periphyton samples from EFPC, and the formation of $MM^{201}Hg$ and loss of $MM^{202}Hg$ were monitored over time. These data were used to calculate methylation and demethylation rate potentials using a transient availability kinetic model (Olsen et al, 2018). For methylation, light exposure and season were significant predictors of rate potential, with greater methylation rate potential in full light exposure and in the summer. For demethylation, season, light exposure, and location were all significant predictors of rate potential. Demethylation rate potentials were highest in dark conditions, in the spring, and at the upstream location (closer to the Hg-contamination source). Net MMHg production, the difference between methylation and demethylation, was driven by light exposure, with positive production occurring in periphyton grown under full light exposure and net loss of MMHg occurring in periphyton grown in the dark. On average, transient availability rate potentials were 15× higher and 9× higher for methylation and demethylation, respectively, compared with first-order rate potentials calculated at 1d. Our data show that light exposure is the controlling factor of periphyton net MMHg production in EFPC, and our results underscore the importance of applying transient availability kinetics to MMHg production data to obtain accurate estimates of MMHg production potential and flux.

References:

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