Elemental mercury production in seawater by coastal bacterial assemblages

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Elemental mercury (Hg^0) evasion from surface seawater plays a principal role in the marine mercury cycle. Hg^0 production in seawater is mainly controlled by abiotic (photochemical) and biotic (microbial) processes. In this study, we established a method using the gamma-emitting radionuclide Hg-203 as a tracer to evaluate the transformation of Hg^{2+} and methylmercury (MeHg) to Hg^0 in seawater by coastal bacterial assemblages. The method, which used traps containing gold-coated beads to capture Hg^0 released into air from seawater, can provide rapid and reliable Hg^0 measurements that avoid potential contamination. Several natural bacterial assemblages in surface seawater collected 8 km off Southampton, New York, were used in our experiments. These bacterioplankton were contained in seawater collected for years prior to our study and stored in the dark at 4°C. Remarkably, these bacteria were still able to rapidly produce Hg^0 following picomolar additions of $^{203}Hg^{2+}$ or $Me^{203}Hg$ when brought up to 23°C in 2 days. Our results show that Hg^0 production rates were independent of dissolved Hg^{2+} and MeHg concentrations, and were directly a function of bacterioplankton densities. Addition of antibiotics reduced Hg^0 evasion to undetectable levels. These Hg evasion experiments showed that for 1 μm-filtered Long Island coastal waters from the Atlantic with natural bacterial assemblages and bacterial densities of about 1 x 10^6 ml^{-1}, approximately 25% of Hg^{2+} and 18% of MeHg were transformed to Hg^0 in 4 days at ~23°C. In Long Island Sound waters, with 5 x 10^6 bacterial cells ml^{-1}, 60% of Hg^{2+} and 19% of MeHg were converted to Hg^0 and trapped in the air within 4 days. When bacterial assemblages were exposed to Hg^{2+}, the Hg^0 production rate declined after one day, but the rate of Hg^0 evasion from bacterial assemblages exposed to MeHg remained constant over 4 days, suggesting two distinct production pathways. Total Hg^0 production for both Hg^{2+} and MeHg exposures at ~23°C were 6 times those at 4°C, indicating such transformations were mainly driven by metabolic processes.