Contamination of Baltimore Harbor Sediment with PCBs Has Increased over the Last Century: Is Bioremediation Possible?

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Background/Objectives. Sediment contamination is one of the major environmental issues in the U.S. coastal areas due to the potential toxic effects of contaminant residing in sediments on biota and human health. Baltimore Harbor (BH), Maryland, USA, is designated by the U.S. EPA as one of three Regions of Concern in Chesapeake Bay due to contamination of sediments with a complex mixture of metals, polychlorinated biphenyls (PCBs), and other organic contaminants resulting from centuries long industrial discharges and disposal practices, shipping-related activities, urban storm water runoff, atmospheric deposition, and discharges from municipal facilities. Characterizing and delineating areas of sediment contamination and toxicity are important goals of coastal resource management in terms of ecological and economical perspectives. Therefore, BH sediment contamination profile and toxicity profile, and microbial community analysis were performed for core and surficial sediment samples. The dechlorination potential of indigenous PCB dehalorespiring bacteria was investigated by activity assays of PCB116.

Approach/Activities. Surficial (0-5 cm) and core sediment samples (0-200 cm) sectioned into seventeen 2.5 cm intervals, in 2006 and 2004, respectively, were collected from five locations (four being only surficial and one core) distributed across BH. Sediment dating was performed on the sediment core. All sediment samples were stored anaerobically at 4ºC in the dark prior to analysis. PCB extraction and analysis of sediment core samples using the Soxhlet or liquid-liquid extraction method and congener-specific PCB analysis was carried out according to previously published methods and analyzed with an Agilent 6890 GC/ECD. A competitive PCR (cPCR) assay was used to enumerate the indigenous putative dehalorespiring bacteria in the sediment samples. The diversity of the dehalorespiring communities was examined using denaturing high-pressure liquid chromatography (DHPLC). DHPLC fractions were sequenced on an ABI 3130 XL automated capillary DNA sequencer (Applied Biosystems, CA) by the BioAnalytical Services Lab (IMET, Baltimore, USA).

Results/Lessons Learned. Total PCB concentration in core samples ranged from 3.9 to 225.6 ng/g decreasing with depth, while PCB content of surficial sediments samples ranged between 353.2 and 1213.7 ng/g. Analysis of PCB congener profile patterns indicated historical Aroclor 1260 contamination in BH. Potential risk associated with the dioxin-like PCB congeners was significantly reduced by 94% with depth via reductive dechlorination. Dechlorination rates in surficial sediment microcosms ranged between 1.83 and $13.2 \cdot 10^{-3}$ mol% PCB116·day^{-1}, while significantly ($p<0.05$) lower dechlorination rates ranging from 0.67 to $4.33 \cdot 10^{-3}$ mol% PCB116·day^{-1}occurred in core sediment samples. Strong positive correlation was found between PCB concentration in sediments and PCB116 dechlorination rates. Dechlorination was achieved mainly through the removal of chlorines from *meta* followed by *para*chlorine removal with significant *ortho*dechlorination ($p>0.1$). Findings of this study indicated an increase in the contamination of BH sediments with PCBs over the last century, but, the detection of indigenous PCB dehalorespiring bacteria in the sediments and increase in the lightly chlorinated PCBs indicated possibility of bioremediation.