Application of Biofilm-Based Inoculum Delivery System for Organohalide Respiration of Polychlorinated Biphenyls (PCBs) in Sediments

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Background/Objectives. Polychlorinated biphenyls (PCBs) have been used for industrial purposes since the 1920s (Lauby-Secretan et al., 2016). Properties such as electrically insulating and chemical persistence at high temperatures made PCBs commonly used components in cooling liquids for electronic equipment (Kajiwara et al., 2017). However, PCBs are highly toxic with undesirable effects on the environment including humans (Cheng and Hu, 2010). They can cause chronic effects by bioaccumulation in the food chain due to their high affinity for organic material and have shown to bioaccumulate in tissue, blood, and breast milk due to exposure routes such as consumption of meat, fish, and dairy products (Stohs, 2016). Recently, studies reported that PCBs can enter wastewater treatment plants (WWTP) through sewer systems and discharge into an aquatic environment through discharged wastewater effluent (Darling et al., 2004; Katsoyiannis and Samara, 2004). Biofilms have a polymeric matrix which can concentrate the hydrophobic-organic contaminants such as PCBs. In addition, a highly organic porous surface of the activated carbon have high affinities for simultaneous attraction of biofilm forming by organohalide-respiring microorganisms and adsorption of PCB molecular. Both processes are essential components for the implementation of this biofilm approach in which the activated carbon as a foundation for biofilm formation and subsequent delivery systems for bioaugmentation of PCBs. Therefore, the objective of this study is to inoculate the biofilm formation of the existing organohalide-respiring microorganisms, i.e., *Dehalobium chlorocoercia* DF-1 on the surface of activated carbon and to evaluate its organohalide performance on the PCB-contaminated sediments.

Approach/Activities. In this study, mesocosms will be conducted with biofilm-based inoculum with Quantico Creek and Shiawassee River sediments to test their potential enhancement of PCB organohalide respiration. Firstly, *Dehalobium chlorocoercia* DF-1 biofilm is inoculated with 10 ppm PCE on the surface of the selected materials, i.e., activated carbon TOG-NDS and pinewood biochar. Acetate (5.9 g), propionate (7.3 g), and butyrate (8.8 g) stock solutions are prepared in 100 ml of boiling water in a flume hood under N_2 flow as mix carbon sources for biofilm formation. After that, 187.5 µL of this mixed carbon source stock solution is added to the culture at a final concentration of 2.5 mM (of each fatty acid). Chemical requirements for microbial growth include trace elements such as iron, copper, and zinc. A gas chromatography will be used to determine the bioactivity by detecting if the organohalide respiration products are generated by measuring their concentration in the head space. Positive control experiments are also set up for these two different materials with 10 ppm of PCB-116 and DF-1 biofilm under the same conditions. After that, the PCE in the mesocosms will be purged out by using N_2 gas and the biofilm covered materials are inoculated with the sediments contaminated by weathered PCBs and the transformation of weathered PCBs as a result of organohalide respiration is evaluated. A gas chromatography (GC) analysis for the individual mesocosms are established to assess whether a statistically significant transformation of weathered PCBs occurred. All mesocosm culture will be set up in triplicates. 70 g of sediment samples with 25 ml of E-CL medium and DF-1 biofilm inoculum are added into the 160 ml of serum bottles. Finally, the bottles are sealed with Teflon® septa and secured with aluminum crimp caps and incubated in the dark at 30 ºC. Abiotic control experiments are also set up for each experiment under the same conditions but with sodium azide killed -biosolid inoculation. A negative control using 70 g

of sediment samples with 25 mL of E-CL medium is also set up to determine the organohalide respiration of the natural species in the sediments.

Results/Lessons Learned. Removal of PCBs from sediments in environment is a priority because of their ability to enter the food chain and their toxic and carcinogenic properties. The major bottleneck of the PCB bioremediation is the anaerobic processes, particularly the low rate of the organohalide respiration. To overcome this challenge, this study seeks to apply the organohalide-respiring bacterial biofilms on activated carbon particles to treat weathered PCBs in the sediment samples. This biofilm inoculum delivery system could be essential for the future application to WWTP sites contaminated with low-concentration PCBs. In addition, this approach can provide an efficient method for inoculating microorganisms for PCB bioaugmentation thereby increasing the potentials for a long-term bioaugmentation.