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Collaborative REsearch: Microbial Recutive dechlorination of polychlorinated biphenyls (PCBs) in estuarine and marine coastal sediments

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6. AUTHOR(S)

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13. ABSTRACT (Maximum 200 words)

For many years researchers have tried to identify and monitor PCB dechlorinating bacteria. Strains o-17 and DF-1 are the first PCB dechlorinating bacteria to be identified. These organisms have proven to be very difficult to grow in pure culture thus far. However, for the first time molecular approaches (16S rDNA analysis) has been combined with enrichment culture technique to identify these organisms. This is a significant breakthrough that will advance the application of bioremediation and it proves that such an approach can be used to identify difficult to culture environmental microorganisms, which is to say most microorganisms. Now for the first time these organisms can be monitored in order to better understand their physiology and to track the organisms in situ, before, during and after active and passive remediation attempts.

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PCBs, sediments, anaerobes, 16S rDNA

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FINAL PROGRESS REPORT

GRANT NUMBERS: N000014-99-1-0101 (KS)/ N00014-99-1-0078 (HM)

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GRANT TITLE: Collaborative Research: Microbial Reductive Dechlorination of Polychlorinated Biphenyls (PCBs) in Estuarine and Marine Coastal Sediments

AWARD PERIOD: 1 October 1998 - 30 September 2001 (36 months)

OBJECTIVE: The overall objective of this research is to identify and characterize microbes that catalyze polychlorinated biphenyl (PCB)-dechlorinating processes in the environment. The specific objectives include characterizing the biocatalytic processes that transform PCBs and to developing molecular (DNA) probes that can be used to monitor and assess the effectiveness of natural or bioaugmented PCB-dechlorination in situ.

APPROACH: The approach is as follows: (i) use selective enrichment and molecular probes to further define microbial populations associated with specific PCB dechlorination pathways; (ii) isolate and characterize PCB-dechlorinating microorganisms which can be used for mechanistic studies and bioaugmentation of contaminated sites; (iii) develop screening methods for rapid molecular monitoring of PCB dechlorinating potential and activity in the laboratory and in situ. Dr. Kevin Sowers (PI) and Dr. Joy Watts (postdoc), both of UMBI, developed much of the molecular screening tools used in this study. Dr. Harold May (PI), Dr. Leah Cutter (Ph.D. student - graduated in 2001) and Dr. Qingzhong Wu, all of MUSC, have carried out much of the enrichment and isolation studies and have contributed to the identification of PCB dechlorinating bacteria.

ACCOMPLISHMENTS: Research accomplishments for the duration of the grant include: i) characterization of microbial community that specifically removes chlorines that are doubly flanked by other chlorine on a PCB molecule, ii) a determination of the carbon isotope selection by PCB dechlorinating bacteria, iii) development and comparison of PCR-ARDRA, PCR-trFLP and PCR-DGGE for the comparative analysis of PCB dechlorinating microbial communities, iv) determination of the roles of acetate and hydrogen in ortho PCB dechlorination, v) demonstration for the first time that the growth of a single microorganism is linked to PCB dechlorination, and vi) the first identification of two distinct PCB dechlorinating bacteria (one ortho dechlorinating, bacterium o-17, and the other restricted to double flanked chlorines of PCBs, bacterium DF-1).

CONCLUSIONS: For many years researchers have tried to identify and monitor PCB dechlorinating bacteria. Strains o-17 and DF-1 are the first PCB dechlorinating bacteria to be identified. These organisms have proven to be very difficult to grow in pure culture thus far. However, for the first time molecular approaches (16S rDNA analysis) has been combined with enrichment culture technique to identify these organisms. This is a significant breakthrough that will advance the application of bioremediation and it
proves that such an approach can be used to identify difficult to culture environmental microorganisms, which is to say most microorganisms. Now for the first time these organisms can be monitored in order to better understand their physiology and to track the organisms in situ, before, during and after active and passive remediation attempts.

SIGNIFICANCE: The results from this proposal, the first comprehensive study of microbial dechlorination processes in the marine environment, have provided a basic understanding of the dehalogenating processes extant in coastal sediments using PCBs as a model system. The work has: 1) provided information on the identity of microbes that catalyze the process in marine sediments, 2) provided preliminary information on factors that enhance and limit the process, 3) demonstrated the feasibility of screening for the PCB-dechlorinating potential in sediments using species-specific probes. The combined results provide tools to begin to assess which portion(s) of the degradative process are potentially amenable to biotechnological enhancement. Ultimately, the information and research tools developed in this research with further refinement will facilitate Navy management decisions concerning both remedial site prioritization and appropriate remedial strategies, e.g. assessment of natural attenuation.

PATENT INFORMATION: (Disclosures filed)


AWARD INFORMATION: HM was promoted to Assoc. Professor in 2000.

PUBLICATION ARTICLES (for total period of grant):

JOURNAL ARTICLES


ABSTRACTS


