

Beneficial Bacteria

Researchers identify naturally occurring bacteria that can detoxify PCB contamination.

By Jane M. Sanders

Researchers have identified a group of bacteria that can detoxify a common type of environmental contaminant, polychlorinated biphenyls (PCBs). These toxic chemicals have contaminated more than 250 sites in the United States, including river and lake sediments.

The discovery is a first step toward a new bioremediation strategy that would naturally detoxify the chemicals without risky removal of the sediments in which they persist. The research results were reported in April 2007 in the journal *Applied and Environmental Microbiology*.

Researchers have known for more than two decades that naturally occurring microorganisms could slowly dechlorinate PCBs, which were banned from production in the United States in 1977 because of their toxicity to wildlife.

In research funded by the National Science Foundation and General Electric, a PCB expert at Rensselaer Polytechnic Institute (RPI) collaborated with microbiologists at the Georgia Institute of Technology to study microbial degradation in Aroclor 1260, a common PCB mixture.

RPI Professor of Biology Donna Bedard collected PCB-contaminated sediment samples from the Housatonic River in Massachusetts. In microcosm studies in her lab, Bedard found that Aroclor 1260 was indeed being degraded by native sediment microbes, and she developed sediment-free enrichment cultures.

She then worked with Georgia Tech researchers Frank Loeffler and Kirsti Ritalahti to further characterize these Aroclor 1260-dechlorinating enrichment cultures. Through a series of experiments, the team was able to determine that bacteria in the *Dehalococcoides* (Dhc) group were responsible for the detoxification of Aroclor 1260. These microbes replace the chlorine atoms in Aroclor 1260 with hydrogen, which fuels their growth and initiates the PCB degradation process, explains Loeffler, an associate professor in the Georgia Tech School of Civil and Environmental Engineering and the School of Biology.

The research indicates that the Dhc bacteria active in the enrichment cultures also contribute to PCB dechlorination in situ. Once Dhc bacteria dechlorinate Aroclor 1260 to a specific level, other microbes will degrade it further and completely detoxify PCBs, Loeffler adds.

"Identifying the bacteria responsible for the initial reactions of Aroclor degradation represents a crucial step. Now we can start to design tools to look for these microbes in sediments and then develop engineering approaches to stimulate their growth and activity in river or lake sediments," Loeffler says. "Then the decontamination will occur more rapidly. Instead of taking decades, the microbes might be able to degrade the PCBs in a few years."

Loeffler is optimistic about a bioremediation strategy for PCBs because of his lab's earlier success in



Photo: Gary Meek

Researcher Frank Loeffler is studying the activity of bacteria that help break down polychlorinated biphenyls.

identifying microbes that degrade the common solvents tetrachloroethene (PCE) and trichloroethene (TCE). These toxic compounds, which contaminated subsurface environments and groundwater decades ago when their use was unregulated, were primarily used in dry-cleaning operations and degreasing of metal components.

Following Loeffler's discovery, it took less than five years for scientists and engineers to develop and implement bioremediation strategies that use these microbes to detoxify PCE and TCE.

"The situation with PCBs is a little more complicated because they are in river and lake sediments instead of groundwater and subsurface environments, but in principle, the same sequence of events could occur," Loeffler notes. "We need industry, engineers and scientists to work together to develop a bioremediation approach for PCBs."

Development of bioremediation technologies for PCB cleanup would offer an alternative to sediment dredging and disposal in landfills, which is the most commonly used method for removing PCBs. Dredging is controversial because of the invasive nature of this technology and the risk of spreading contaminants.

"Now, because of our research, regulators know these microbes exist, that they are native to certain environments and that natural degradation processes are at work," Loeffler says. "Maybe this will influence decision-making processes, and bioremediation will be implemented. This could save millions of dollars spent on controversial dredging projects."

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