Bacteria That Degrade PCBs Identified

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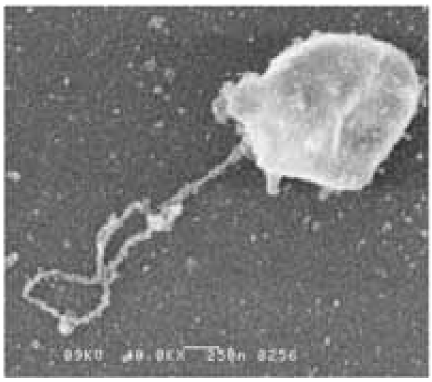

This scanning electron micrograph of Dehalococcoides (Dhc) bacteria shows the GT strain of the microbes that dechlorinated PCB contaminiation in lab tests. Credit: Georgia Institute of Technology

Researchers have identified a group of bacteria that can detoxify a common type of polychlorinated biphenyls (PCBs), which have contaminated more than 250 U.S. sites, including river and lake sediments.

The discovery is a first step toward a bioremediation strategy that would naturally detoxify the chemicals without risky removal of the sediments in which they persist. The research results will be published April 15 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 once commonly used by industry. The compounds were banned from production in the United States in 1977 because of their toxicity to humans and animals.

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. They studied microbial degradation in Aroclor 1260, a common, highly chlorinated 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 dechlorination of Aroclor 1260. These microbes replace the chlorine atoms in Aroclor 1260 with hydrogen, which fuels their growth and initiates the PCB degradation process, explained Loeffler, an associate professor in the *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 (i.e., in the Housatonic River sediment). Once Dhc bacteria dechlorinate Aroclor 1260 to a certain level, other microbial species will degrade it further and completely detoxify PCBs, Loeffler added.

“Identifying the bacteria responsible for 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 said. "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 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, are 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 said. "We need industry, engineers and scientists to work together to develop a bioremediation approach for PCBs."

Loeffler predicts that bioremediation technologies for addressing PCB detoxification will be developed first for lakes, such as PCB-contaminated portions of Lake Hartwell in South Carolina. Then it will be refined to clean up river sediments, where the flow rate is greater and bioremediation may be more difficult to implement, he added.

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 said. “Maybe this will influence decision-making processes, and bioremediation will be implemented. This could save millions of dollars spent on controversial dredging projects.”

In the meantime, Loeffler and his colleagues continue to characterize Dhc bacteria. They hope to develop molecular biology tools to quickly detect the presence of these microbes, their population size and level of activity in the environment, Loeffler said. After that, they will be ready to work with engineers to develop feasible bioremediation strategies.

Source: Georgia Institute of Technology