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Microorganisms Are Cleaning Up Boston Harbor, UMass Study Finds

AMHERST, Mass. – Microorganisms are cleaning up contaminants in the mud beneath Boston Harbor, and if humans prevent future fuel spills and leaks, the harbor could potentially cleanse itself within the next 10 to 20 years, according to research conducted at the University of Massachusetts Amherst. The findings are detailed in the Nov. 15 issue of the journal Environmental Science and Technology. The work was funded by the Office of Naval Research.

Scientists had previously determined that these contaminants, called polycyclic aromatic hydrocarbons, or PAHs, could biodegrade if suspended in water. But it was also believed that once PAHs sank into the silt at the bottom of the harbor, they could not be oxidized or degraded – a theory that the new study challenges.

"This is important because it demonstrates that the self-purification capacity of the harbor is much greater than previously recognized," said UMass microbiologist Derek Lovley, a co-author on the paper. "Furthermore, if future spills of contaminants can be eliminated, the harbor may get cleaned up in large part due to natural activity without the requirement for expensive remediation strategies. It does give us hope for the longer term, if practices change."

Marine harbors are frequently polluted with contaminants from fuel spills, industrial waste, shipping activities, runoff, soot, and creosote-treated pilings, Lovley said. Although some chemical portions of these contaminants readily degrade, PAHs tend to accumulate in the sediment. "They're not very soluble in water, and they don't react chemically with many other compounds," said Lovley, "so they collect in the mud at the bottom of the harbor." Previous research has shown that PAHs accumulate in fish and other aquatic animals, and are often associated with cancers in some fish. Some PAHs are highly toxic, and are suspected carcinogens in humans.

The UMass team was prompted to study the issue after earlier research by Lovley found that benzene degrades in the absence of oxygen, in certain conditions. PAHs are essentially groups of two to five benzene rings, Lovley noted. His collaborators on the Boston Harbor project were Mary Rothermich, a former postdoctoral researcher at UMass who is now at Harvard University, and Lory Hayes, a former graduate student who now works in industry.

The key component in the microbial action appears to be the existence of sulfate in the water, said Lovley. "As long as there is sulfate in the water, the PAHs can degrade slowly." Sulfate is a salt of sulfuric acid, and is naturally abundant in seawater, according to Lovley. These microorganisms use sulfate the same way that humans use oxygen. Whereas we use oxygen to oxidize the food that we consume, these microorganisms can oxidize PAHs and their other food sources with sulfate. In this way they can remain active in the mud at the bottom of the harbor where there is no oxygen.

In addition to Boston Harbor, the team also studied marine contaminants in San Diego, Calif., and in Latvia. For the local portion of the project, Boston Harbor sediments were pulled from the harbor near a former coal-tar plant in an area of Everett known as Island End. Coal-tar works had been in production in the area from the late 1800s to about 1960, according to Lovley. The sediments used in the study overlaid the site of a leaking underground storage tank that had been removed in the 1980s, he said.

Scientists monitored the sediment samples in the lab, replenishing the samples with fresh harbor water roughly once a month. They found that the PAHs in the collected sediments broke down 20-25 percent over 338 days – a little less than a year. "In a way, it seems slow, but if you're thinking about the alternatives, it's not bad to have some patience," Lovley said.

He noted that other alternatives for removing the contaminants, including dredging, are expensive and disruptive to the marine environment. Dredging also creates the additional problem of how to dispose of the contaminated mud. "Of course, you don't want to say, 'Oh, it's okay to keep dumping this stuff.' The fact that it's even there shows that the spillage rate is too fast for nature to keep up with. You have to actively protect the environment."

Editor's Note: The original news release can be found here.
