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Waterborne carbon increases threat of environmental mercury

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Mercury is a potent neurotoxin and a worrisome environmental contaminant, but the severity of its threat appears to depend on what else is in the water.

Researchers at the University of Wisconsin-Madison have found that the presence of dissolved organic material increases the biological risk of aqueous mercury and may even serve as an environmental mercury source.

Mercury is present throughout the environment in small quantities in rocks and in watery environments, including lakes, wetlands and oceans. It accumulates in fish living in mercury-contaminated waters, posing a health risk to animals and humans who eat the tainted fish.

The greatest threat comes from a form called methylmercury, which is more easily taken up by living tissues. The methylation process, therefore, is key to understanding the potential danger posed by environmental mercury, says UW-Madison geomicrobiologist John Moreau.

He presented his research findings at the American Geophysical Union meeting in San Francisco today (Dec. 10).

Environmental mercury is predominantly methylated by naturally occurring bacteria known as sulfate-reducing bacteria. These bacteria - Moreau calls them "little methylmercury factories" - absorb inorganic mercury from the water, methylate it and spit methylmercury back out into the environment.

"The bacteria take mercury from a form that is less toxic to humans and turn it into a form that is much more toxic," Moreau says. "[Methylation] increases mercury's toxicity by essentially putting it on a fast train into your tissue - it increases its mobility."

Many previous studies have focused on the chemical interactions between mercury and sulfur, which is known to bind to inorganic mercury and may regulate how well the bacteria can absorb it. However, scientists do not understand the factors that control the methylation process itself.

"Those studies have related methylation potential to geochemical variables," Moreau says. "We would like to take a bacterium that we know methylates mercury very efficiently and let it tell us what it can methylate and what it can't, under given conditions."

Moreau and colleagues at the U.S. Geological Survey, UW-Madison, the University of Colorado and Chapman University chose to look at the role of dissolved organic carbon (DOC), a richly colored brew created as plants and other organic materials decay into a soup of proteins, acids and other compounds. DOC can tint wetlands and streams shades of yellow to dark brown.

DOC has noticeable effects on bacterial mercury processing. "They seem to methylate mercury better with DOC present," says Moreau.

In the current studies, the scientists looked at the effects of DOC samples collected from two different organic-rich environments, a section of the Suwannee River and Florida's Everglades.

"We found that different DOCs have different positive effects on methylation - they both seem to promote mercury methylation, but to different degrees," Moreau explains.

Because DOC is virtually ubiquitous in aqueous environments, its effect on mercury processing may be an important factor in determining mercury bioavailability.

Moreau and his colleagues are now working to understand how DOC promotes methylation. One possibility is that DOC acts indirectly by increasing bacterial growth, while another is that DOC may directly interact with the mercury itself to boost its ability to enter bacteria.

Although mercury already in the environment is there to stay, Moreau says an understanding of what regulates mercury toxicity is critical for developing ecosystem-level management strategies.

"Strategies to deal with methylmercury production [should] lead to hopefully more efficient ways to reduce human consumption of methylmercury and lead to less potential human health problems," he says.

Source: University of Wisconsin-Madison

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