Paired microbes eliminate methane using sulfur pathway

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Anaerobic microbes in the Earth's oceans consume 90 percent of the methane produced by methane hydrates – methane trapped in ice – preventing large amounts of methane from reaching the atmosphere. Researchers now have evidence that the two microbes that accomplish this feat do not simply reverse the way methane-producing microbes work, but use a sulfur compound instead.

"The dominant role anaerobic oxidation of methane plays in regulating marine methane makes it a significant component of the global methane and carbon cycles," the researchers report in the current issue of *Environmental Microbiology*. "Its importance in these cycles highlights the need to close gaps in the current understanding of the specific interaction between the microbial groups that work in consort to mediate anaerobic oxidation of methane."

In this case, the microbial consortia consist of an Archaea – a single cell organism – that consumes methane for energy and bacteria that reduce sulfates to obtain energy. The assumption has been that these microbes simply use reverse methanogenesis, the process in which methanogenic bacteria produce methane in the first place.

"Our research suggests that methyl sulfide is the intermediary used by these microbes," says Christopher H. House, associate professor of geosciences. "The Archaea take in the methane and produce a methyl sulfide, and then the sulfur-reducing bacteria eat the methyl sulfide and reduced it to sulfide."

The two single-celled organisms that live in the consortia arrange themselves in a cluster of about 100 cells 10 to 15 microns across. The microbes that consume methane are on the inside while those microbes-reducing sulfur are on the outside. These consortia live in the sediments on the ocean bottom around methane seeps.

Understanding how these symbiotic organisms remove methane from the oceans is important because, House notes that without these microbes, the atmospheric temperature would likely be warmer by about 14 degrees Fahrenheit.

House, working with James J. Moran, graduate student in geosciences now at McMaster University; Emily J. Beal, graduate student in geosciences; Jennifer M. Vrentas, a Penn State undergraduate at the time; Katherine Freeman, professor of geosciences, all at Penn State, and Victoria J. Orphan, assistant professor of geobiology, California Institute of Technology, first investigated the assumption that reverse methanogenesis was the method used by the microbes. They provided hydrogen to the consortium and checked to see if methane oxidation decreased. If hydrogen were the interspecies transfer molecule, than an abundance of hydrogen would turn off the methane oxidation.

"We observed a minimal reduction in the rate of methane oxidation, and conclude that hydrogen does not play an interspecies role in anaerobic oxidation of methane," the researchers say.

They then tried the methyl sulfides, methanethiol (methyl mercaptan) and dimethyl sulfide, to see if they reduced methane oxidation. The researchers found that methanethiol reduced oxidation. The researchers also substituted carbon monoxide for methane and found that the Archaea could oxidize that as well and produce these sulfur compounds.

"In climate models, researchers generally only consider the methane produced in bogs and lakes as dominant greenhouse gases," says House. "They do not need to consider ocean methane because these microbes destroy most of it before it is released from the sediments."

Source: Penn State

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