Cataloguing invisible life: Microbe genome emerges from lake sediment

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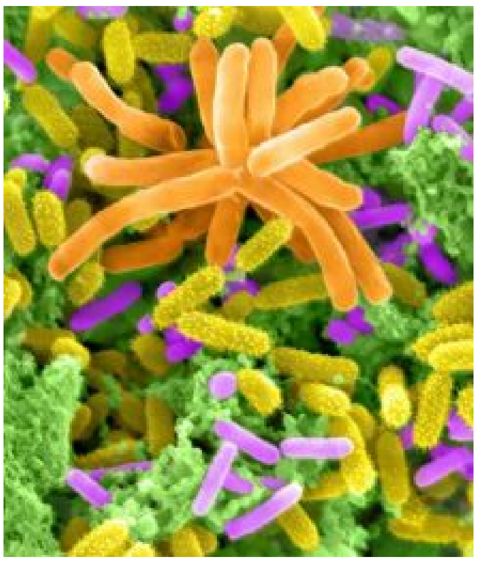

Microorganisms from a mud sample collected in Lake Washington. The purple and orange organisms are relatives of Methylotenera mobilis, whose complete DNA sequence is now published. Photo © Dennis Kunkel Microscopy, Inc. (Color by Ekaterina Latypova)

When entrepreneurial geneticist Craig Venter sailed around the world on his yacht sequencing samples of seawater, it was an ambitious project to use genetics to understand invisible ecological communities. But his scientific legacy was disappointing – a jumble of mystery DNA fragments belonging to thousands of unknown organisms.

Now a team led by a University of Washington scientist has studied lake mud, which contains microbial communities even more complex than those in seawater, and homed in on bacteria that perform the ecological task of eating methane. The study, published Sunday (Aug. 17) in the journal *Nature Biotechnology,* shows a way to sequence unidentified life.

"This work demonstrates that we can get a complete genome for a totally unknown organism," said lead author Ludmila Chistoserdova, a UW research scientist in chemical engineering. "We extracted a complete genome from a very complex community, and this is something novel."

Only 1 percent of microbes survive in the laboratory, Chistoserdova said, and the remaining 99 percent are undiscovered. Genetics can bypass the laboratory to help reveal microscopic communities, but most genetic tools use short stretches of known genetic code. Researchers look for these short stretches and copy, or amplify, them from the environment.

"You can only use amplification when you know what you're trying to get. And that's the problem," Chistoserdova said. "When you want to discover something unknown, amplification is a very deficient technique because you keep discovering the things you already know. So how can you discover the unknown?"

The researchers targeted a particular ecological function, in this case eating single-carbon compounds such as methane. First they collected samples of mud from the bottom of Lake Washington, a typical freshwater lake of moderate temperature and average levels of compounds such as methane, produced by decomposing organisms, in the sediment. Then they mixed the mud with five different samples of food labeled with carbon-13, a heavier isotope of carbon. Over time, organisms that ate the lab food incorporated the heavy carbon into their cells and their DNA. For five different single-carbon food sources, the scientists then separated the DNA by weight, knowing that the heavier pieces must belong to organisms that ate the lab-catered food.

Chistoserdova estimates the original mud sample contained about 5,000 different microbes, but the five batches of enriched DNA each contained only a dozen or so organisms. Researchers then were able to piece together carbon-13 DNA fragments to create one entire genome for Methylotenera mobilis, a microbe that eats methylamine, a form of ammonia. (This microbe was already known, though the team did not use that knowledge to create the sequence.) They also produced a partial genome for Methylobacter tundripaludum, a methane-eating microbe that so far resists cultivation in the lab.

The project was funded by the National Science Foundation and the Department of Energy.

Discovering an organism's entire genetic sequence has many uses. For example, the genetic code may produce clues for growing the microbe in the lab, which would allow scientists to study it and perhaps harness it for practical applications. Other research groups could look for the DNA in the environment as a telltale sign that the same microbe is present elsewhere. And knowing the identity of the most ecologically important organisms would help understand ecological cycles and monitor microbial population shifts, for instance due to climate change.

Chistoserdova's team was looking at methylotrophs, organisms that eat single-carbon compounds. Methane in the atmosphere, generated by decomposing plants and animals, is a greenhouse gas 25 times more potent than carbon dioxide. Unseen methylotrophs on land and in water keep the amount of methane reaching the atmosphere in check.

"These are the bacteria that maintain the Earth's health. Some of the methane escapes – in some parts of the lake you can see the bubbles. But whatever doesn't escape as bubbles, these bacteria do a very good job of eating it," Chistoserdova said.

Her group will continue to study the role of methane-eating freshwater bacteria.

For more information on the project, see depts.washington.edu/microobs
.

Source: University of Washington