Magnetic Misfits: South Seeking Bacteria in the Northern Hemisphere

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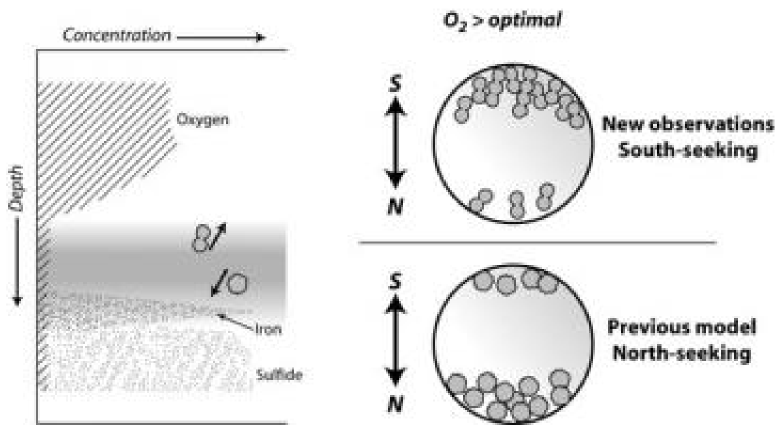

The profile on the left shows the chemistry of Salt Pond in Falmouth, MA in midsummer, when it is chemically stratified. The grey band marks the zone where magnetotactic bacteria are most abundant. On the right is what magnetotactic bacteria would look like under the microscope with a bar magnet. (Illustration by Jack Cook, Woods Hole Oceanographic Institution)

Magnetotactic bacteria contain chains of magnetic iron minerals that allow them to orient in the earth's magnetic field much like living compass needles. These bacteria have long been observed to respond to high oxygen levels in the lab by swimming towards geomagnetic north in the Northern Hemisphere and geomagnetic south in the Southern Hemisphere. In either hemisphere, this behavior would also lead them downward in the water column into areas with their preferred oxygen level. But an unusual bacterium in New England has been found doing just the opposite, a magnetic misfit of sorts.

Scientists have dubbed the bacterium the barbell for its appearance. In a study reported in this week's issue of Science, researchers from the Woods Hole Oceanographic Institution (WHOI) and Iowa State University used genetic sequencing and other laboratory techniques to identify the barbell, which was found coexisting with other previously described magnetotactic bacteria in a local marine pond in Falmouth, MA. They also found dense populations of a small, unidentified rod-shaped bacterium that showed a similar "backwards" behavior.

Magnetotactic bacteria concentrate large amounts of iron within their cells, far more than all other marine bacteria. They could play a significant role in iron cycling in stratified marine environments, particularly ponds and salt marshes.

Lead author Sheri Simmons of the Woods Hole Oceanographic Institution says magnetotactic bacteria are found throughout the world in chemically stratified marine and freshwater environments. They can reach high densities under the right conditions and will swim along the magnetic field axis and up or down in the water column to locate their preferred or ideal living conditions. If oxygen levels are too high or too low, they will seek a layer in the water column where the level is just right.

The scientists collected samples of the barbells and rods at Salt Pond, a marine pond that is seasonally stratified near the Woods Hole Oceanographic Institution on Cape Cod, Massachusetts. Using a rowboat and a new water sampler designed and built by WHOI engineers, the team collected samples at various depths in the pond in the summers of 2003, 2004 and 2005. Much to their surprise, they found high concentrations of bacteria that swim toward geomagnetic south when exposed to high levels of oxygen, the opposite of all previously described swimming behavior in magnetotactic bacteria. They also found magnetotactic bacteria with a mixture of north and south polarities.

The coexistence of magnetotactic bacteria with north and south polarity in the same environment contradicts the currently accepted model of magnetotaxis, which says that all magnetotactic bacteria in the Northern Hemisphere swim north and downward to reach their desired habitat when exposed to high-oxygen conditions.

Simmons and colleagues Dennis Bazylinski of Iowa State University and Katrina Edwards of WHOI studied the bacteria under laboratory conditions, and say the behavior of the bacteria in situ could be different from laboratory behavior. Their results, however, suggest new models are needed to explain how these magnetotactic bacteria behave in the environment.

“Only a few species of magnetotactic bacteria have been cultivated in the lab,” Simmons said. “We need to develop more methods to do that since we cannot observe their behavior directly in the environment. We are also interested in how much iron these bacteria sequester in nature. What is their distribution and abundance, and how does that affect the chemistry of their environment?”

Source: Woods Hole Oceanographic Institution