New Bacterial Behavior Discovered

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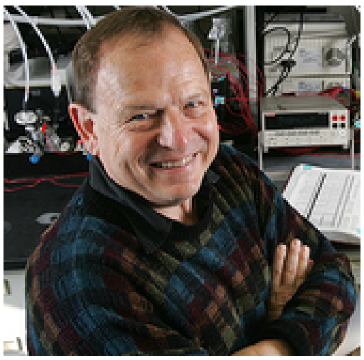

Study co-author Kenneth Nealson

(PhysOrg.com) -- Bacteria dance the electric slide, officially named electrokinesis by the USC geobiologists who discovered the phenomenon.

Their study, published online today in Proceedings of the National Academy of Sciences *Early Edition*, describes what appears to be an entirely new bacterial behavior.

The metal-metabolizing Shewanella oneidensis microbe does not just cling to metal in its environment, as previously thought. Instead, it harvests electrochemical energy obtained upon contact with the metal and swims furiously for a few minutes before landing again.

Electrokinesis is more than a curiosity. Laboratory director and co-author Kenneth Nealson, the Wrigley Professor of Geobiology at USC and discoverer of Shewanella, hopes to boost the power of microbe-based fuel cells enough to produce usable energy.

The discovery of electrokinesis does not achieve that goal directly, but it should help researchers to better tune the complex living engines of microbial fuel cells.

"To optimize the bacteria is far more complicated than to optimize the fuel cell," Nealson said.

Electrokinesis was discovered in 2007 by Nealson's graduate student Howard Harris, an undergraduate at the time.

Nealson had given Harris what seemed an ideal assignment for a double major in cinema and biophysics.

"I had asked him if he would just take some movies of these bacteria doing what they do," Nealson said.

Filming through a microscope is hardly simple, but with the help of co-author and biophysics expert Moh El-Naggar, assistant professor of physics and astronomy at USC, Harris was able to make a computer analysis of a time-lapse sequence of bacteria near metal oxide particles.

"Every time the bacteria were around these particles … there was a great deal of swimming activity," Nealson recalled.

Harris then discovered that bacteria displayed the same behavior around the electrode of a battery. The swimming stopped when the electrode turned off, suggesting that the activity was electrical in origin.

As is often true with discoveries, this one raises more questions than it answers. Two in particular intrigue the researchers:

- Why do the bacteria expend valuable energy swimming around?
- How do the bacteria find the metal and return to it? Do they sense it through an electric field or the behavior of other bacteria?

Nealson and his team so far have only educated guesses.

For the first question, Nealson believes that the bacteria may swim away from the metal because they have too many competitors.

Bacteria get energy in two steps: by absorbing dissolved nutrients and then by converting those nutrients into biologically useful forms of energy through respiration, or the loss of electrons to an electron acceptor such as iron or manganese (humans also respire through the loss of electrons to oxygen, one of the most powerful electron acceptors).

"If electrons don't flow, it doesn't matter how much food you have," Nealson said.

However, he added, "in some environments, the food is much more precious than the electron acceptors."

If a metal surface became too crowded for bacteria to absorb nutrients easily, they might want to swim away and come back.

For the second question, Harris and co-author Mandy Ward, assistant professor of research in earth sciences at USC, are planning other experiments to understand exactly how Shewanella find electron acceptors.

They expect the experiments to keep Harris busy through his doctoral thesis.

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