abcNEWS

An Ancient Bug Makes Electricity

Scientists Say Tiny Microbe Can Clean Pollution While Generating Current

OPINION By LEE DYE

Aug. 5, 2009 —

The star of the show in Derek Lovley's lab at the University of Massachusetts is a hairy microbe that has been around since the earliest stages of life on earth, but now it has a new task. Geobacter, as the tiny bug is known, could play a leading role in removing toxic wastes and cleaning up polluted waters around the planet, but that's only part of the story.

Geobacter, it turns out, likes a hot lunch. So it produces electricity to help digest iron oxide, and therein lies an astonishing tale. It doesn't make enough power to do much other than dine on sludge and the contaminated waters of the Potomac River, where Lovley and his colleagues discovered it a couple of decades ago.

For years now Lovley, director of environmental biotechnology on the Amherst campus, has tried all sorts of sophisticated tampering, including genetic engineering, in an effort to get the bug to increase its output. The best he could get was a doubling of the current, better, but not good enough.

But recently Lovley's team practically blew their socks off when they came up with a new strain of geobacter that produces eight times the electricity of its predecessor. How did they bring that off?

They just made life a little more difficult for the bug, and it tried a whole lot harder, thus an enormous improvement in yield. By introducing a tiny "pushback" current to the microbe's environment, the bugs adapted to the new challenge, evolving the more productive strain.

The progress, described in the August issue of the journal Biosensors and Bioelectronics, moved microbial fuel cells a significant step closer to mainline electronics. A number of companies are already involved in the technology, because it could potentially solve a wide range of very different problems.

For example, "you need to put in a lot of electricity to treat waste water," Lovley said in a telephone interview, and that makes it almost impossible to clean up water resources in many areas of the world, especially Africa.

But stand back while zillions of geobacters get to work, cleaning up the water while producing enough electricity to power a light bulb or recharge a battery. Two problems, one solution.

The Geobacter's Possible Applications

The Office of Naval Research is supporting the research and electronic sensors are already being produced that

can be placed on the ocean floor and use microbial fuel cells, fed by slime and mud, for power.

But the list of possible applications seems almost endless, and although groundbreaking research like this often leads to blind alleys, Lovley is convinced he will see many of those applications hit the marketplace in his lifetime.

"I have no doubt about that," he said, "and many other people agree." He and his colleagues have recently linked up with researchers at the Massachusetts Institute of Technology who are trying to develop self-powering devices that can be placed permanently in human tissue, including the brain, to combat various afflictions.

"There are all types of potential medical implants that would run off of sugar and blood," he noted. "This would alleviate the need for changing the battery in a pacemaker every four or five years."

It's a lofty new role for a microbe that has remained basically unchanged for billions of years. Lovley's early research, published in Nature in 1987, revealed that geobacter was the force behind the creation of magnetite, an important iron ore that is strongly attracted by a magnet. It was formed in rocks deposited billions of years ago, so geobacter was in on the ground floor.

"It's very likely that microbes growing on iron may have been the first form of life on earth," Lovley said. All this praise for a bug that isn't much to look at. Geobacter is covered with tiny hairs, 20,000 times finer than a human hair, called pili. The hairs are quite strong, and apparently play a key role in the microbe's ability to produce an electric current.

That fact is well known to hundreds of students who have built their own little microbial generator for a science fair. Stick an electrode into slime containing a whole bunch of geobacters, and electrons flow to the anode and can be easily measured.

Geobacter has had that ability throughout it's lifetime, but it's doubtful that it knew it. It had never seen an electrode, but apparently iron oxide fulfilled that function.

Unknown Potential

And over the course of billions of years, it probably had never seen a "pushback" current. Yet it knew what to do - turn up the juice and make Lovley a very happy man.

"Each step along the way has been astonishing," he said. "We started out just trying to understand the processes" by which geobacter devoured the sediments in the Potomac River. "But then we found that geobacter could grow on a variety of radioactive and toxic metals, like uranium."

That has led to a "technically simple and quite inexpensive strategy for cleaning up a lot of contaminated sites."

And that would have been enough to mark this research very successful, but then Lovley pushed geobacter a little harder, making it swim upstream, at least electronically.

It came through like a trooper, and this is still just the beginning.