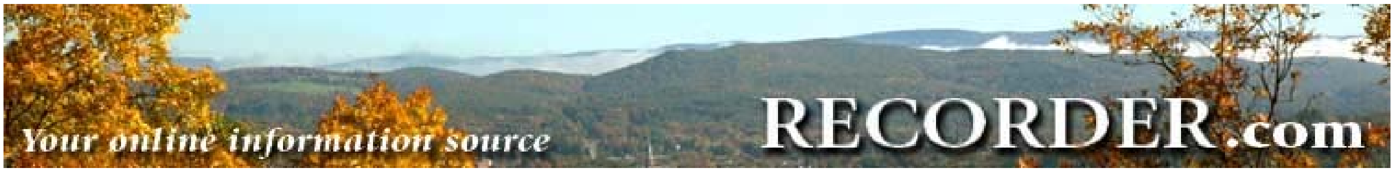

Little Geobacter still sparks discoveries after 20 years

By RICHIE DAVIS Recorder Staff

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Derek Lovley was mucking around in the muddy bottom of the Potomac River just downstream from Washington, D.C., in search of the microscopic creature he believed was interacting with subsurface iron oxide to make phosphorous.

What he discovered was a reddish micro-organism that breathes in iron oxide the way we inhale oxygen. But the creatures -- so tiny that 25,000 lined up end-to-end would take up just an inch -- might as well have been gold.

Lovley's discovery 20 years ago of a microbe dubbed *Geobacter metallireducens* has brought more than $50 million in research funding to the University of Massachusetts over the past dozen years. The doormat at the microbiology department on Morrill Science Center's fourth floor points the way to the Web site for the little microbes that pay for most of the north wing: "www.geobacter.org"

A Leyden resident who's been a professor here at UMass since 1995, Lovley has a bright red stuffed-animal version of the bacteria on his office desk, a prop that was used for display purposes when the PBS Science Investigators program featured the microbe in a segment in January on "Bug Powered Batteries."

Lovley has a boyish face and the enthusiasm of a kid still excited after all these years about all that these bugs can do. For one thing, they can eat soil and groundwater contaminants like benzene and the gasoline additive MBTE -- even in an oxygen-free environment. So they're at work cleaning up Boston Harbor.

Geobacter -- which have been found to even live in dentists' spit sinks -- also flourish in uranium-contaminated sites, converting soluble radioactive material to one that's insoluble in groundwater, so it's easier to isolate for cleanup. Lovley smiles when asked if the microbes can actually decontaminate the radioactivity.

"No, that would be alchemy," he says.

Most exciting, he says, is that when they breathe in iron oxide, Geobacter exhale electricity through 20 to 30 hair-like structures, just 3 to 5 nanometers in diameter. Those structures, lined up along one side of Lovley's plush demonstration model Geobacter, just as in real life, could find a very practical application in the electronics industry if they were grown in the laboratory instead of making nanowires from expensive materials like metals or silica, he says.

There's hardly enough microbe-produced electricity generated to solve the world's energy problems -- a fuel cell measuring a cubic meter would generate just 2 kilowatts -- although some engineers are talking about powering sewage treatment plants with a Geobacter harvesting off the sewage itself.

He imagines Geobacter fuel cells in medical devices implanted in the body, with the microorganisms feeding off blood sugar like a tiny version of the Eveready Bunny.

"You'd never have to have the batteries replaced," he said.

With major funding from the U.S. Department of Defense and Department of Energy, as well as Toyota and the National Science Foundation, the UMass Geobacter Project has also led to the microbes powering ocean-bottom monitoring devices deployed by the Office of Naval Research -- replacing lithium batteries that would have to be replaced periodically.

"If we have a perpetual system harvesting energy out of the environment, it's much more preferable and cheap," says

Lovley, who made his initial Geobacter discovery as a U.S. Geological Survey scientist looking for microorganisms that use iron oxide, as a way of controlling phosphate.

Twenty years, and more than 230 research papers later, he still glows as he talks about the latest twists his research is taking.

"I don't think there's ever been any evolutionary pressure on these organisms to make electricity," says Lovley, who found a way to expedite the Geobacter's cleanup of chemical contaminants by speeding up its metabolism.

It was the genetic sequencing done on the Geobacter, first reported in Science magazine in 2003, that gave Lovley and other researchers an insight into how the microorganism produced electricity, and showed them that it could also get around.

"As soon as we got the first genome sequence, we learned all kinds of things we didn't know about Geobacter. We'd never seen it swim in the lab," he said. "One of the first things we could see (through the genome research) was the flagella gene."

Replicating the proper lab conditions to produce flagella so Geobacter could move on to more iron and avoid suffocation was one of the outcomes of the genome studies. Another was finding the gene that limited electricity production, so that it could be boosted.

"Electricity production is what I'm really enamored with right now," says Lovley, "because the biology is so cool. We're still trying to understand how the electrons get onto electrode surface. Even though they're small and have only 3,000 genes, there are a lot of unknowns. There are caveats to everything, and you find something later and you were wrong."

As articles in Business Week, Space Daily and dozens of other publications show, the entrepreneurial possibilities for the microscopic creature seem endless. Yet Lovley is happy after 20 years to be still doing basic research and making discoveries about his tiny find.

"Maybe I could make more money," he says, "but I doubt I could have more fun."

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