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'Wonderbug' changes waste into power

By ROBERT S. BOYD
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WASHINGTON - Geobacter, a class of bacteria, is tiny and yet so talented that it can turn deadly uranium waste into harmless muck, generate electricity from rust and garbage, and even run a toy car.

It's a lot to expect from an invisible little bug less than a thousandth of an inch long. But the Energy Department, the Pentagon and the National Science Foundation are exploring the potential of Geobacter and related microorganisms to perform useful work.

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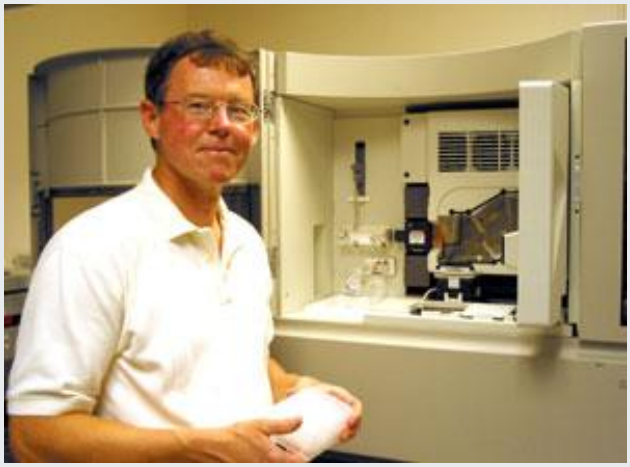

KRT photo courtesy University of Massachusetts

Derek Lovely, a microbiologist at the University of Massachusetts, discovered Geobacter, a class of bacteria.

"Geobacter gives us a cheap and simple alternative to a cleaner, safer environment and the generation of cleaner forms of energy," said Derek Lovley, the biologist who discovered the bacteria in 1987 at the muddy bottom of the Potomac River in Washington. Lovley heads the Geobacter Project, a team of 50 researchers based at the University of Massachusetts in Amherst.

So far, 20 species of the Geobacter genus have been recognized, plus 30 in closely related families. Scientists have identified the genes of several of these species and figured out their inner workings.

The first big job for the clever little microbes is to help clean up billions of gallons of deadly radioactive uranium waste left over from the Cold War. This summer is the third year of an Energy Department test of their abilities at an old uranium waste field at Rifle, Colo.

In the test, Geobacter acts like a tiny deliveryman, shuttling electrons from atoms in a harmless organic substance, such as vinegar, to a species of highly radioactive uranium known as Uranium-6. Compounds containing Uranium-6 easily dissolve in water, contaminate rivers and underground aquifers, and sicken or kill fish, animals and people.

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The addition of two new electrons reduces an atom of Uranium-6 to a safer version called Uranium-4, a solid material similar to natural uranium ore. It sinks to the bottom of the water, where it can be extracted or left safely in place.

"Geobacter is principally responsible for the reduction of Uranium-6 to Uranium-4 and its consequent removal from groundwater," said Philip Long, an environmental geologist at the Pacific Northwest National Laboratory in Richland, Wash. "Because it is less soluble in groundwater, it represents less of a risk in drinking water."

To improve the bacteria's performance, researchers drilled holes in uranium-contaminated ground and poured vinegar down the holes.

"It's good food for Geobacter - simple and inexpensive," said Lovley. In 24 hours, the number of bacteria doubles.

Lovley called this technique "simpler, cheaper and more environmentally friendly than the more commonly used `muck, suck and truck' operations." This method, in which contaminants are laboriously dug or pumped up and transported elsewhere, would take decades and cost billions of dollars.

If Geobacter passes its tests, the Energy Department must decide whether and where to begin large-scale application.

"The technology could be used in the near future," Long said in an e-mail. "However, regulatory and public acceptance will be required prior to widespread use."

Public reaction to widespread use of bacteria, like other genetic experiments, could be hostile. But Lovley contends that Geobacter is harmless. "They're already in the environment," he said. "They've shown no pathogenic (disease-causing) traits. They're everywhere in almost any soil."

Geobacter also can be used to turn toxic petroleum byproducts, such as benzene, into inoffensive carbon dioxide.

Geobacter's ability to make electricity from rust is generating interest. It removes electrons from one type of iron atom, known as Fe-2, and converts it into another form, Fe-3, the basis of ordinary rust. The electrons zip along a wire, from a positive to a negative pole, as in a miniature battery.

Lovley's lab has exploited this bit of energy to light electric bulbs, operate a calculator and power a toy car. In the future, he predicted, bacteria power could be used in less developed countries to charge batteries, run radios, televisions or computers, even light a small hut. You might even be able to use it at home to generate electricity from garbage, he said.

Although Geobacter generates only tiny amounts of electricity in the laboratory, it works more efficiently than the traditional burning of "biomass," meaning wood, cornstalks, trash and the like.

Lovley claims his bacteria can recover 80 to 90 percent of the energy potential locked up in iron, compared with an average of 30 percent of the energy stored in biomass by traditional means.

"We're efficient but slow. We're trying to get efficient but fast," he joked.

The Defense Department also is interested in using the energy in iron-rich mud at the bottom of the sea

to power submarine detectors and other sensors.