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The mystery of Red Lake

How acid-loving bacteria may put fuel in your tank

Story by Dale Smith | Photo by Rob Hill

Red Lake, located in Rocky Fork Lakes Conservation Area north of Columbia, is a source of acid-loving bacterial enzymes that might speed the biofuel fermentation process and make energy cheaper for everyone.

At first blush, the idea of turning biomass into ethanol and other fuels might sound like a clever alternative to the financial and environmental costs of petroleum. Some of biofuel's manufacturing steps, such as harvest and fermentation, sound as happy as hops at a brewery. But intervening steps that prepare biomass for fermentation create extreme acid conditions, and every step increases the final product's cost. Researcher Gary Stacey, professor of plant sciences at MU, and Melanie Mormile, professor of biological sciences at Missouri University of Science and Technology, are doing some extreme science in hopes of keeping costs down.

In the current process, manufacturers begin by treating biomass with acids to break down its cellulose for fermentation. But then they must treat the biomass with more chemicals to neutralize the acids before adding enzymes that ferment the material into fuel.

If researchers could find enzymes that work in the acid conditions, manufacturers could skip the neutralization step and pass on the savings to consumers. But where does one find acid-loving enzymes?

Enter Mormile, who studies organisms that thrive in extreme conditions and has collected microbes from lakes as far away as Australia. But it turns out that a promising site informally known as Red Lake lies just north of Columbia at the former Peabody Coal mine. Red Lake is a low area where water collects after rain and groundwater travel through coal seams. Along the way, the water picks up not only metals including iron (the red in Red Lake) but also sulphur. When sulphur dissolves in water, the result is sulphuric acid. Key word: acid. The lake's pH is as low as 3.6, compared to a neutral pH of about 7 in humans.

Despite the acid conditions, the old mine's lake supports life, and Mormile went prospecting for these special bacteria and their enzymes. "A lot of biomass, such as leaves and stems, falls into the lake," Mormile says. "It goes away over time, so we know Red Lake has microbes breaking it down and that they are operating under high-acid conditions."

Finding the particular organisms is far easier now than a mere 20 years ago, Stacey says. "We used to isolate single bacterium and then a single gene from that bacterium, which limited what we could get from the environment." But using new metagenomics technology, scientists can sample, say, Red Lake sediment and extract DNA from all the microorganisms in the mud. "After we sequence the DNA, we can identify enzymes. If we find something interesting, we can go back to that DNA and clone it out. This method gives us a much better sense of the diversity of the organisms in that environment."

The Red Lake samples will be sequenced soon, so stay tuned. Ninety percent of microorganisms are still unknown to science. Mormile and Stacey might find a new bacterium whose enzymes makes biofuel cheaper for everyone.

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