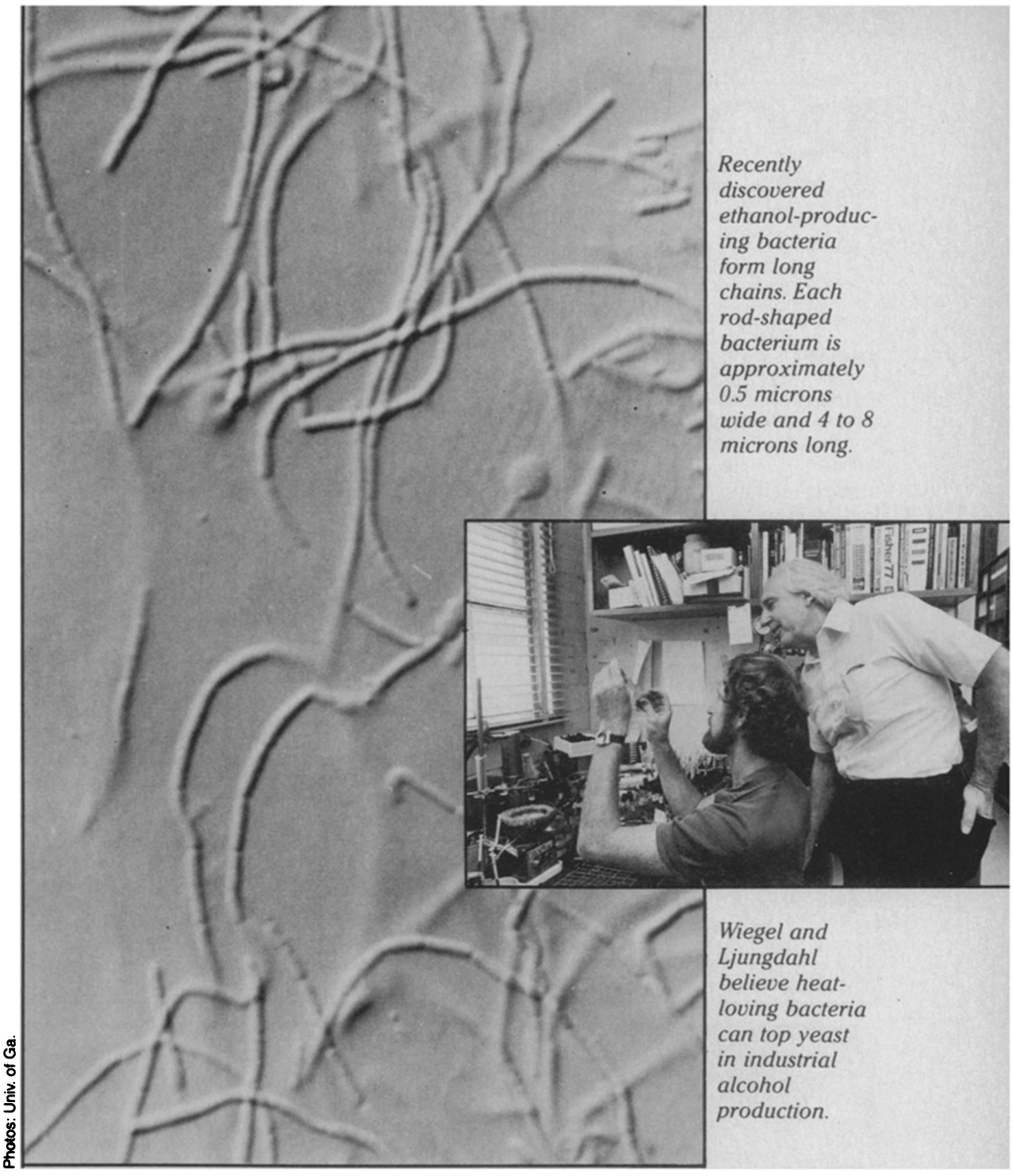
HOT BUG FOR ENERGY

Bacteria from hot springs are promising for alcohol production

BY JULIE ANN MILLER



Recently discovered ethanol-producing bacteria form long chains. Each rod-shaped bacterium is approximately 0.5 microns wide and 4 to 8 microns long.

Wiegel and Ljungdahl believe heat-loving bacteria can top yeast in industrial alcohol production.

Photos: Univ. of Ga.

Bacteria, as well as higher organisms, are being enlisted in the campaign to stretch fossil fuels. Microorganisms collected last year from hot springs at Yellowstone National Park may boost the ranks of the "gasohol" camp. The newly discovered bacteria may someday supply the alcohol that, mixed with unleaded gasoline, can serve as an alternative automotive fuel (SN: 9/8/79, p. 173).

Yeast currently produce alcohol for industrial use, as well as for alcoholic drinks. Bacteria, however, have several advantages over yeast, says Lars Ljungdahl of the University of Georgia. With Jurgen Wiegel, a visiting microbiologist from Germany who collected the new strains while vacationing in Yellowstone Park, Ljungdahl is examining the bacteria. Hot living is their outstanding feature; they can grow at temperatures as high as 78° C (172° F). In contrast, yeast fermentations usually occur at a much cooler 37° C (98° F). The bacteria's ability to function at high temperatures indicates that, in an industrial setting, alcohol could be distilled continuously as the bacteria ferment sugars. As a further bonus, the risk of so hot a vat becoming contaminated with undesirable microorganisms would be quite low.

To produce alcohol from sugar, the newly discovered bacteria use no oxygen in a process more efficient than one using some oxygen, Ljungdahl says. Few other bacteria have been identified that can grow without oxygen at high temperatures, he adds. Ljungdahl and Wiegel believe their specimens represent a new genus, in part because those bacteria do not form spores. The scientists propose to name the genus *Thermoanaerobacter ethanolicus* after the organisms' three distinctive characteristics — survival at high temperature, without air, while producing the alcohol ethanol.

The wide range of sugars that these bacteria can convert to alcohol gives them another practical advantage over the more selective yeast. Ljungdahl even proposes that to convert cellulose to ethanol the bacteria be teamed with others that degrade cellulose to sugars. He outlines his scheme: "If this were an industrial operation, you would see big fermenters taking in wood, or waste paper, or grain or straw and mixing it up. Then the two bacteria would be put into the mixture. One bacterium breaks down the cellulose to cellobiose and glucose, and our alcohol bacterium continues the process and makes alcohol."

The bacterial teamwork would pay off in efficiency as well as in convenience, the research indicates. The presence of an alcohol-producing bacterium accelerates the rate of cellulose breakdown by another bacterium, *Clostridium thermocellum*. Ljungdahl speculates that in that bacterium the enzyme that degrades cellulose may be inhibited by the products of the breakdown reaction. The alcohol-producing bacterium could stimulate the reaction by efficiently removing those sugars.

At first Ljungdahl and Wiegel thought they had discovered two different strains of high-temperature, anaerobic, ethanol-producing bacteria. Wiegel had scooped one from a slightly alkaline spring and the other from a more acid source. But no differences in their characteristics have been uncovered so far in the laboratory investigations. "Now we don't think the strains differ," Ljungdahl says. "They just seem to grow over quite a wide pH spectrum." He points out that such versatility would be another advantage in industrial applications.

Ljungdahl is eager to interest industry in bacterial ethanol production and has been deluged with inquiries about the unusual bacteria, but he has postponed responding in order to continue evaluating the organism. "I would like to nail down whether it is a new genus before we let it loose," he admits.

Although the researchers are interested chiefly in finding out more about the physiology and metabolism of anaerobic bacteria, they are part of a Department of Energy project on converting biomass to energy. Ljungdahl says, "Gasohol with alcohol produced from cellulose should be given serious consideration because it would use surplus cellulose materials like grain and straw. It would also put to good use paper products that wind up in the city garbage and have to be disposed of at taxpayers' expense." □