Biology

From a meeting in Atlanta of the American Society for Microbiology

Glowing bacteria may guard sea floor

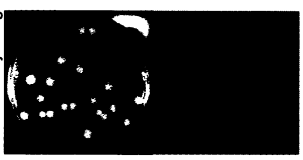
Coal miners once depended on canaries for good health. The little birds would succumb to gases such as carbon monoxide long before the miners suffered any harm. Now, scientists suggest that much smaller creatures, glowing bacteria, can serve as "deep-sea canaries" by dimming when toxic compounds leak from waste containers on the ocean floor.

The investigators are pursuing the issue because of the controversy over proposals to store potentially toxic dredged material on the deep ocean floor. A major concern about such plans has been whether disposal containers could be monitored, at a reasonable cost, for leaks. "You would have to monitor [the waste] forever," notes William Jones of the University of Maryland Biotechnology Institute in Baltimore.

Enter bioluminescent bacteria, microbes that glow. In the 1940s, scientists noticed that exposure to toxic compounds darkens the bacteria. "If the bacteria are unhappy or unhealthy, they produce less light," explains Jones. Indeed, investigators have used glowing bacteria in the past to test the toxicity of soil and river water.

Not all microbes are cut out for life on the ocean floor, however. Jones and his colleagues have identified two bioluminescent bacterial strains that can grow at the immense pressure and near-freezing temperature of such a habitat. Furthermore, they've demonstrated that the bacteria dampen their light show by more than half when exposed to heavy metals such as copper and zinc, pesticides, PCBs, and other toxic compounds. The scientists have even created a prototype biosensor device that can operate at high pressures.

While the bacteria don't respond differently to each potential pollutant, the investigators envision continually monitoring the microbial glow as an indicator that additional tests need to be conducted. "We want a broad general response so that if there is any problem, this would be the first signal," says Jones. —*J.T.*



Sunny Jiang

Glowing bacteria in daylight (left) and in the dark (right).

Mutant microbes could work for EPA

Arlene Wise of Los Alamos (N.M.) National Laboratory has also turned to bacteria as a potential way to keep track of pollution. She and her colleagues have mutated a bacterial gene so that it will transform any microbes that use it into living sensors capable of detecting important pollutants.

The scientists work with bacteria that metabolize simple phenols. Related phenol molecules, used in dyes, pesticides, photographic chemicals, and elsewhere, can make their way into the water supply and pollute it. The Environmental Protection Agency lists 11 phenols among its priority pollutants, notes Wise.

Normally, phenol-eating bacteria ingest the molecules, which then attach to a receptor called DmpR. That complex then binds to DNA and activates metabolic genes. Wise and her colleagues manipulated this pathway by mutating the gene for DmpR and adding to the bacteria a reporter gene that any DmpR-phenol complex could activate. The mutations allow the bacteria to metabolize more complex phenols, including many of the ones listed by EPA. When the bacteria encounter phenols, they turn on the reporter gene, which produces an easily detected protein, says Wise.

The phenol biosensors aren't perfect yet, however. While some strains are extremely sensitive to phenols, they can't distinguish toxic and nontoxic varieties. Other strains are more finicky but less sensitive. "I have a lot of mutant strains in the freezer that I haven't tested yet," says Wise. —*J.T.*

Geology

From a meeting in Boston of the American Geophysical Union

Life at its lowest

In search of exotic species, Japanese scientists sent an unmanned submersible into the deepest cranny of the ocean, the Mariana Trench in the western Pacific. When they examined mud from the bottom of the sea, however, they found a fairly ordinary mixture of microbes and fungi, including many that seemed completely out of place.

In 1996, the 3-meter-long *Kaiko* submersible settled onto the floor of the Challenger Deep, the lowest part of the Mariana Trench. At a depth of 10,897 meters below the ocean surface, the sub retrieved a sample of the bottom mud, the first ever collected from such a depth, says Hideto Takami of the Japan Marine Science and Technology Center in Yokosuka.

After growing organisms from the samples in the laboratory, the researchers identified hundreds of species of bacteria, archaea, and fungi. They compared these with the residents of garden dirt and deep-sea sediments. "We were expecting that the Mariana soil was a sort of special soil, but from the analysis of it, I think the composition was basically the same as the sediment of other deep-sea sites or land soil. We couldn't find any big difference," says Takami.

In addition to the mundane species, the Japanese team found some heat-loving bacteria in the sediment, where the temperature registers a chilly 4° Celsius. These apparently survive as resistant spores and are not active, says Takami.

Although the pressure at the bottom of the Mariana Trench reaches 1,000 times that at sea level, some species can handle the conditions, according to tests of bacterial growth in a pressurized chamber. The researchers are seeking the genes that help these microbes survive the intense squeeze. —*R.M.*

A quest for Earth's core

Several groups of physicists around the world are racing to create laboratory models of Earth's core. Their goal is to generate a self-perpetuating magnetic field in a manner resembling the production of Earth's geomagnetic field by currents of molten iron, says Cary B. Forest of the University of Wisconsin-Madison.

Forest and his coworkers are trying to mimic Earth's liquid outer core with a 1-meter-wide sphere containing molten sodium, which is a good conductor of electricity. Two sets of propellers in the sphere swirl the sodium into a complex flow pattern. Forest calls it a "spherical blender."

The experiment relies on the principle that electric fields can spawn magnetic fields and vice versa. As the sodium whips around the sphere, its interaction with Earth's small magnetic field induces electric currents within the liquid. If all goes as planned, these currents will, in turn, power their own, much stronger magnetic field, says Forest. This kind of self-generating dynamo developed early in Earth's history, with help from some preexisting field in the solar system.

The group chose sodium for their model in part because it has the same consistency as water, enabling them to carry out initial experiments with water. Researchers in Germany and Latvia are also experimenting with liquid sodium, and a French team is building a core model out of liquid gallium.

If they can succeed in generating a magnetic field, Forest says, the next question is, does it mean anything? The researchers will seek to understand how the induced magnetic field affects the turbulent fluid that spawned it.

Geophysicists have recently made strides modeling the geodynamo with large computers (SN: 10/19/96, p. 250). Jeremy Bloxham of Harvard University says the new experiments hold promise because they can explore small-scale turbulence that computer models cannot. "I used to feel that [laboratory models] had a limited role to play, but now I feel that they have a central role," he says. —*R.M.*