SCIENCE AND ENVIRONMENT

Abelson Seminar: It's "Time for Microbes to Have Their Due"

A visitor to Earth during most of the planet's history would have been greeted only by microbes, and those ubiquitous organisms continue to help shape both the planet's destiny and ours, according to researchers who spoke at the Philip Hauge Abelson Advancing Science Seminar at AAAS.

"It's definitely time for microbes to have their due," said David Stahl, a professor of environmental engineering and science at the University of Washington. "We live on the planet of the microbes," he said, with very large numbers of those organisms controlling the key cycles of planetary chemistry that produce such essentials to life as oxygen and organic forms of carbon and nitrogen.

But in many cases, he said, scientists still don't know which populations of bugs are in control of specific cycles. There have been surprising discoveries just within the past few years. An anaerobic organism that digests ammonia, first described in 1999, represents a major part of the nitrogen cycle that had been missed during a century of investigation, according to Stahl. Another bug, discovered in 1992, accounts for about 20% of the bacterial component of the plankton that drifts in ocean waters.

Speakers at the symposium told how genomics, microbiology, mineralogy, geochemistry, and materials science have provided new insights on the history of microbes and their potential for such practical applications as cleaning up polluted sites, mitigating the effects of climate change, or producing electricity.

The 26 October seminar "Microbes, Minerals and the Environment" honored the late Philip Abelson, editor of *Science* for 22 years and then senior adviser to AAAS. He founded and sponsored the seminar series to encourage participants to think about where science is going, not where it has been.

"We're so lucky to work on a diverse group of organisms that we know so little about," said Anna-Louise Reysenbach, a professor of microbial biology at Portland State University who has been studying the heat-loving microbes found around hydrothermal vents, seafloor geysers that spew superhot, mineral rich water. She showed an image of one organism, which she calls the "devilheterotrophventblob," whose cell wall had formed two horn-like structures. It turns out to be the first truly acid-loving microbe in the neighborhood of such hydrothermal vents.

Microbiologist Derek R. Lovley; human microbiota *Lactobacillus,* which produces lactic acid (right).

The durability and variety of microbes continue to astonish researchers. Keynote speaker Derek R. Lovley, a microbiologist at the University of Massachusetts, Amherst, mentioned Strain 121, a deep-sea organism discovered in 2003 that survives at 121°C (250°F). That is the highest temperature at which life is known to exist—equivalent to the heat in autoclaves used to sterilize surgical instruments.

Species of bacteria called *Geobacter* are of interest because of their novel abilities to transfer electrons. They can harvest electricity from aquatic environments and may prove useful as power sources for underwater monitoring instruments, Lovley said. It is likely that fuel cells can be made from pure cultures of *Geobacter* organisms, he added, perhaps initially to power electronic gadgets like cell phones.

There are other practical applications on the horizon, speakers said, including use of *Geobacter* species and other microbes to bind uranium, plutonium, and other metals in polluted groundwater or soils. Bruce Hungate, an ecologist at Northern Arizona University, offered a cautionary note, however, on one proposed "biological fix" for rising carbon dioxide levels in the atmosphere. While plants may grow more in response to elevated carbon dioxide levels, Hungate said, microbes in the soil apparently have a reverse effect, limiting the amount of carbon that the soils can sequester.

Paul Falkowski, a professor in the Institute of Marine & Coastal Sciences and the Department of Geological Sciences at Rutgers University, was wary of human tinkering with natural cycles. "We are messing with something we don't really know much about," he said. "We have, in the last 150 to 200 years, so critically altered the carbon, phosphorus, sulfur, nitrogen, water cycles," Falkowski said, that society is on a path toward unsustainable development.

Falkowski urged reductions in carbon dioxide and sulfur emissions and in the use of nitrogen-containing fertilizers so that we can return to a world "where microbes basically are taking care of the cycles for us, because we cannot take care of the cycles for ourselves."

—*Earl Lane*

EDUCATION

Digital Architects Ponder the Library of the Future

The emergence of the Internet over the last decade as an everyday data and communication tool has created enormous possibilities in science education, but also inefficiencies and distractions. If you doubt it, go to your favorite Internet search engine and type in v-e-n-u-s.

What do you get? Not just the second planet from the Sun, but a line of women's clothing, the Roman goddess of love and beauty, and an e-zine about women in the arts.

For the past 11 years, the U.S. National Science Foundation (NSF) and a corps of visionaries funded by NSF have been building a library that sharpens the focus of the Internet and makes it an effective, efficient tool of 21st-century education for science, technology, engineering, and mathematics (STEM). It's called the National Science Digital Library (go to your search engine and type in n-s-d-l). Nearly 200 of the library's architects—including representatives from industry, major universities, and government—gathered at AAAS 18 to 20 October to consider its future.

"You know all the reports that are out now about the conditions of the STEM disciplines in the United States and how few kids are going into them, the whole pipeline issue," said Kaye Howe, executive director of NSDL Core Integration. "We would really like to be part of the solution on this, both by creating a community

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