Microbes in Unexpected Places or with Unexpected Activities

Here are several recent examples of microbes being found in unexpected niches or undertaking unexpected activities:

- Rocks within the gabbroic layer of the Earth, which lies above the mantle but is more than 1 km below sea level, provide a niche for a poorly diverse microbial community, much of it devoted to degrading hydrocarbons, according to Stephen Giovannoni of Oregon State University, Corvallis, and collaborators there and at several other institutions. Details appear in the November 5, 2010, PLoS ONE.

- When fed to mice, nonpathogenic strains of Clostridium bacteria can stimulate regulatory T cells in the gut, in turn suppressing allergies and autoimmune diseases of the host, according to Kenya Honda of the University of Tokyo and collaborators. Details appear online 23 December 2010 and in print on 21 January 2011 in Science (331: 337–341).

- A strain of bacteria from the mud of Mono Lake, California, appears to thrive on arsenic, perhaps substituting it for phosphate, according to Felisa Wolfe-Simon at the U.S. Geological Survey in Menlo Park, Calif., and her collaborators. Details appear online in the 3 December 2010 Science. (These findings are stirring considerable controversy in the scientific blogosphere.)

year, according to Caroline Smith DeWaal, who is Food Safety Director for the Center for Science in the Public Interest, a consumer advocacy organization in Washington, D.C. Recent high-profile outbreaks of foodborne illnesses helped to build broad and bipartisan support for the new law, she says. Its provisions are directed mainly at FDA, in part because public concerns about food safety focus there during outbreaks. The U.S. Department of Agriculture (USDA) shares federal responsibility for food safety, particularly through its inspections of meat and poultry.

The new law, which “marks an overall improvement,” contains several important provisions, says Michael Doyle, Director of the Center for Food Safety at the University of Georgia in Griffin. For example, giving FDA authority to issue “mandatory food recalls is new,” as is extending agency authority over food imports. Another provision that is “new and important is that all companies will need to have food safety plans in place, except for those that are waived,” he adds, referring to smaller companies that operate only locally or with low volumes of products.

Some changes that were incorporated into the new law reflect a “shift to risk analysis and what’s the biological basis of adverse effects” that took shape during the past decade, says Robert L. Buchanan, who directs the Center for Food Safety and Security Systems at the University of Maryland, College Park. An important component of this approach is “risk ranking,” which entails figuring out “what foods present the most risk.” Complicating any effort to bring better scientific understanding to these analytic challenges, however, is the way the public seems to treat food risks, he says. “It’s fascinating; we seem to feel differently about food than anything else. It’s almost sacred—either safe or unsafe—whereas with drugs, we recognize [gradations of risk].”

Even before President Obama signed FMSA, some members of Congress were vowing to block its provisions by curbing FDA funds. “One of the big hurdles is that it will cost $1.4 billion to implement FMSA,” Doyle says. Earlier versions of the legislation included user fees, but they were discarded along the way to enactment. “If FDA wants to hire 2,000 inspectors, it will require a considerable appropriation,” he says. “Time will tell.”

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Sequencing Technologies Yield Novel Microbial Noncoding RNA Molecules

DNA sequencing is continuing to reveal noncoding (nc) bacterial and archaeal RNAs, many of unknown function. These efforts now include a new batch of 104 highly structured ncRNAs uncovered by Ronald R. Breaker and his colleagues at Yale University in New Haven, Conn. “These ncRNAs not only greatly expand the variety of known RNAs, they provide a starting point for the biochemical and genetic studies needed to explain their biological functions,” he says. Breaker spoke this February at a Presidential Research Seminar, a weekly series sponsored by Memorial Sloan-Kettering Cancer Center (MSKCC) in New York, N.Y. “An additional challenge will be to determine the three-dimensional structures of the large ncRNAs and attempt to correlate them with function,” says Dinshaw Patel of MSKCC, who hosted the seminar.

Bacterial genomes contain 10 to 15% noncoding DNA sequences that, when transcribed into RNAs, endow
the cell with critical fitness advantages. Both large and small ncRNAs are structurally diverse, with some of the larger ncRNAs nearly as complex as ribosomes. Their conserved complexity and diversity along with their varied genomic locations suggest that these RNA molecules are involved in a wide range of biologic roles and activities. See Genome Biology (http://genomeweb.org/2010/11/3/R31) for details.

One of the most surprising recent findings is a cyclic di-guanosyl-5’-monophosphate (c-di-GMP)-binding riboswitch, which is linked to a self-splicing intron. Its host bacterium, Clostridium difficile, appears to harness this apparatus to promote protein production from a downstream pathogenicity gene, according to Breaker. Thus it seems that not all group I self-splicing ribozymes are associated with selfish genetic elements, he says. “Furthermore, because this regulatory region can read both GTP and c-di-GMP concentrations and trigger splicing accordingly, it appears to constitute a two-input gene control system.” Details appear in the 13 August 2010 Science (329:845–848).

Breaker and his collaborators also are investigating a set of ornate large extremophile (OLE) RNAs produced by Bacillus halodurans. These RNA molecules bind to an OLE-associated protein (OAP), which has several transmembrane domains. “We know that OAP recruits OLE RNA to the cell membrane, suggesting that’s where most of the transcript’s complex structure performs its biochemical function,” Breaker says. Noting that OLEs are not only membrane-bound but also abundant in B. halodurans, he speculates that they enable this extremophile to adapt to its environment. “The newer and faster technologies will most likely reveal a vast number of additional ncRNAs,” he adds, referring to recent improvements in DNA sequencing analysis.

See the January 2011 Molecular Microbiology for details.

“This study shows how inexpensive next-generation sequencing is revolutionizing the field of molecular microbiology,” say Wes Sanders and Alain Laederach at the University of North Carolina in Chapel Hill. “Now it is possible to characterize an entire bacterial transcriptome in a single experiment,” they add. Moreover, says Eric Westhof of the Université de Strasbourg in France, “Until Breaker’s group exploited the power of comparative sequence analysis—combining sophisticated automatic technology with manual intervention—the complex structures of ncRNAs remained hidden in the genome’s ‘dark matter’ long considered nothing more than junk.”


Marcia Stone

Three Crenarchaeotes, All Hyperthermophiles, Form Biofilms

In the absence of other microbial species, three closely related hyperthermophilic crenarchaeotes—Sulfolobus acidocaldarius, S. solfataricus, and S. tokodaii—form biofilms, according to Sonja-Verena Albers and her collaborators at the Max Planck Institute for Terrestrial Microbiology in Marburg, Germany. Although other investigators report finding archaea within bacterial biofilms, these experiments appear to be the first in which archaeal species propagate biofilms on their own, she says. Details appear in the