Current Topics

RESEARCH ADVANCES

Climate Change Affecting Microbes in North America Soils

Barry E. DiGregorio

Changes within microbial communities in arid topsoils in the western region of the United States can be correlated for the first time with global warming trends, according to microbiologist Ferran Garcia-Pichel of Arizona State University in Tempe and his collaborators there and at the Universidad Autónoma de Madrid in Madrid, Spain. Topsoil layers, which are rich in microbial content and activities, not only are crucial for controlling soil erosion but may also serve as indicators of climate change. Details appear in the June 28, 2013 Science (340: 1574–1577).

“The findings . . . were not the result of a targeted effort to understand global warming effects on microbial distributions,” says Garcia-Pichel. “Rather, it was an effort to see if biogeographic patterns of distribution were present in soil crust organisms.” Based on DNA sequencing, two key topsoil cyanobacteria, Microcoleus vaginatus, which is psychrotolerant, and M. steenstrupii, which is thermotolerant, are critical for maintaining the health of thousands of other microbes that occupy topsoil. However, the recent data suggest that M. steenstrupii is outcompeting and might replace M. vaginatus as global temperatures continue to rise. Although the focus of the study was on microbial communities from Arizona, Oregon, New Mexico, Utah, and California, the findings could apply to similar communities in other arid environments.

This replacement of cyanobacterial species is serious and constitutes a revealing example of how rising temperatures are affecting microbial distributions, according to Garcia-Pichel. “We can no longer neglect microbes and their distributions in impact evaluations of global climate change,” he says. “One might now have to contend with effects that are not based simply on thermodynamics of metabolism, but much more on stochastic linkages between function and presence/absence of particular microbes. We would also like to explore the competition between these two microbial crust pioneers through time to see if there is a seasonal separation of growth periods.”

“I agree with the authors that higher temperatures may result in a shift of the microbial community structure, and that this phenomenon may cause the replacement of M. vaginatus by M. steenstrupii,” says soil microbiologist Thomas Fischer from the Brandenburg University of Technology in Cottbus, Germany. “Temperature is the driving climatic factor for this possible replacement process in arid environments.”

“This is a significant study because it is the first I know which shows that microbial distributions may be affected by global climate change,” says soil microbiologist Jeffrey Johansen at the John Carroll University in University Heights, Ohio. “We have really not begun to think much of what the impact might be on microbial communities. This article is also interesting because it shows how a cyanobacterium that was thought to be almost universally distributed in desert soils is actually restricted by temperature.”

The populations of microbes that inhabit topsoil may be changing as a result of climate changes. Researchers have found that warmer temperatures in the American Southwest are correlated with a replacement of cold-tolerant soil bacteria by more heat-tolerant species. (Photo © kelvinjay/iStockphoto.)
However, Jack Gilbert of Argonne National Laboratory in Argonne, Ill., who is lead microbiologist of the Earth Microbiome Project, suggests the replacement of one cyanobacterial species by another may mark a neutral shift. “Replacement . . . would be moot anyway as [Garcia-Pichel and his collaborators] do not attempt to show any effect,” he says.

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ASM MEETINGS: 2013 ICAAC
DNA Inhibitors again among Top New Antibacterial Prospects

Jeffrey L. Fox
Several new antimicrobial candidate drugs that share enzyme targets with fluoroquinolones but act through distinct binding sites dominated the poster summary session “Early New Antimicrobial Agents” at the 2013 Interscience Conference on Antimicrobial Agents and Chemotherapy (ICAAC) in Denver, Colo., last September. Other hopefuls include a narrow-spectrum DNA synthesis inhibitor that is active against Clostridium difficile, improved drug candidates that target the type III secretion apparatus of gram-negative bacterial pathogens, and a series of broad-spectrum β-lactamase inhibitors that help overcome resistance in pathogens to β-lactam antibiotics.

GSK944 is active against a range of conventional gram-positive bacterial pathogens as well as several bio-threat pathogens, including Yersinia pestis and Bacillus anthracis. One pathogen against which it is not active is Chlamydia pneumoniae—“one of the surprises you get when working with a novel class,” he says.

The benzisoxazoles are another group of antibacterial compounds that target DNA gyrase and topoisomerase, but with a mechanism that is distinct from FQ antibiotics (and presumably from GSK944, too), according to John Mueller of AstraZeneca in Waltham, Mass. These agents appear to have a dual target, at least when evaluated for activity against Staphylococcus aureus in vitro, he says. Among the benzisoxazoles, AZD0914 is “highly active” against clinical isolates of Neisseria gonorrhoeae, including those that are resistant to ciprofloxacin, he says. Whether it or other gyrase inhibitors in this class are similarly active against C. trachomatis, another sexually transmitted bacterial pathogen, remains to be tested.

Like FQ antibiotics, fused 2-pyridone compounds belonging to a newly disclosed PTC series are dual inhibitors of DNA gyrase and topoisomerase bacterial enzymes, according to Gary Karp of PTC Therapeutics in South Plainfield, N.J. Some compounds in this series show potent activity against a broad array of drug-resistant—including to fluoroquinolones—gram-negative and gram-positive bacterial pathogens, he says. Structural adjustments lead to some compounds within this series with “quite good activity against N. gonorrhoea,” including multiple-drug-resistant isolates of this pathogen.

Although the structurally unrelated compound SMT19969 also inhibits DNA synthesis, its precise molecular target is not known but under study, according to Richard Vickers of Summit PLC in Abingdon, United Kingdom. This novel antimicrobial agent is “highly active and bactericidal” against C. difficile, he says. In part because of its narrow activity and apparent superiority to vancomycin, SMT19969 is already entered into clinical trials. It has another advantage in having little activity against other bacterial species of the gastrointestinal tract, including other clostridial species, based in part on analysis of fecal samples from the phase 1 clinical trial, he adds. A phase 2 clinical trial is planned for 2014.