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Fungi Find May Alter View of Global Warming

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Scientists probing the frozen soil beneath Colorado's Rocky Mountain snowpack have found a world of microbes no one knew existed -- a world dominated by microscopic fungi unlike any others previously found on Earth.

So numerous and diverse are these newly discovered organisms that scientists are having to rewrite the book on the ecological importance of fungi -- life forms that are neither animals nor plants but which, as nature's premier recyclers, do a big share of the work of keeping Earth in biological and chemical balance.

Indeed, scientists said, if other regions of the world have similar fungal communities thriving under their winter snows, as now seems likely, climatologists will have to revise their models of global warming to accommodate fungi's surprisingly massive role in the winter production of greenhouse gases, such as carbon dioxide.

Industrial chemists are eyeing the peculiar tundra fungi, too. They want to take advantage of the organisms' ability to perform biochemical reactions at temperatures that would put most microbes to sleep.

"The dogma was that not much biology goes on under the snow," said study leader Steven Schmidt, a microbiologist at the University of Colorado in Boulder. "But obviously, there's quite a bit going on."

Suspicions that something was cooking beneath the world's snowfields arose in recent years when scientists detected carbon dioxide and methane escaping into the winter air over Siberia and other arctic regions. The gases were exactly those that scientists would expect if bacteria and fungi in the soil were going about their usual summertime business of breaking down decaying plant matter -- a process that scientists thought came to a near-standstill under snow.

To see what was going on, Schmidt and his co-workers took a series of core soil samples at their 21/2-mile-high study site. Common methods of spotting microbes in soil, including using microscopes and trying to grow them in laboratory dishes, turned up little. But when the team used molecular tools to detect microbial DNA in the soil, they hit, well, pay dirt.

Analysis of those DNA samples indicated the presence of countless species of fungi, invisible to the eye and too finicky to grow in standard laboratory preparations. Some are genetically similar to known fungal species, indicating they are simply new species, the team reported Sept. 5 in the journal Science. Many others, however, have enough similarities to identify them as fungi but are otherwise completely novel, indicating they constitute entirely new groupings and probably perform unique biological functions.

Equally surprising, tests showed that the density of these organisms per gram of soil climbed dramatically in midwinter, when the researchers had predicted they would be at their minimum.

"At first I thought I wasn't reading the [researchers'] paper right," said Jo Handelsman, a plant pathologist and Howard Hughes Medical Institute microbiologist at the University of Wisconsin at Madison. "It shows a vast increase in fungal biomass in winter, with more than twice as much under the snow as in summer soil. That's really surprising."

If Handelsman is surprised, that's saying something, because she has made a habit of finding similarly unexpected troves of biology -- in her case, bacteria -- in environs that no one knew were so full of life.

Both she and Schmidt are part of a unique, decentralized effort known as the Microbial Observatory, funded by the National Science Foundation. The goal is to find new life forms on Earth, especially in extreme environments, in many

cases by trolling for traces of their DNA.

"What we know about the microbial world comes from the tiniest chip off the microbial iceberg, the little bit we've been able to see and grow," Handelsman said. "Most of what's out there is still unknown and will offer us a tremendous amount of information about how the world works."

Fungi are of particular interest to scientists studying biogeochemical cycles -- the big natural cycles through which organic (or carbon-containing) compounds are broken down and rebuilt, which keep the planet in biological and chemical equilibrium.

Although some fungi are visible -- bread mold, lichens and mushrooms among them -- most are microscopic. They sport delicate and tangled hairlike hyphae that exude digestive chemicals that allow them to penetrate and dissolve even the toughest components of plant cells, including cellulose and lignin.

Fungi can convert those compounds into stable molecules that effectively lock up carbon atoms in the soil for years, slowing their conversion into methane and carbon dioxide (CO2) -- major contributors to global warming. But fungi also release carbon dioxide themselves, just as people do when they exhale.

It remains to be seen whether these newly discovered communities of fungi -- not to mention all the other kinds of microbes yet to be found -- will dampen or strengthen predictions about rising temperatures on Earth. But global warming models can no longer ignore fungi in snowy regions and seasons as they have, scientists said -- especially because about 40 percent of Earth's landmass is covered with snow for at least part of the year.

"We're living in a world where global warming is a constant threat, but in fact we have relatively little knowledge of what the inputs and outputs are for CO2," said Steven Miller, a mycologist, or fungus specialist, at the University of Wyoming.

Although the ecological impact of these cold-hardy fungi remains uncertain, Miller said, their industrial potential is clear. Chemists are ever on the lookout for microbes that thrive in the cold, because these organisms are sure to harbor enzymes that have evolved to work best at low temperatures. Researchers want to put these enzymes to work driving chemical reactions that normally require big inputs of heat or caustic chemicals.

Some envision using the microbes or their enzymes to make paper pulp from wood in ways that are cooler and less polluting than current techniques. Others hope to use them to clean up toxic waste in places too cold for standard biological detoxification processes to work.

To take fullest advantage of these strange life forms, though, scientists will have to figure out how to grow them, so they can study them in the flesh. That will require a special kind of experimentalist -- part scientist, part chef -- to come up with the customized recipes that will appeal to each of these specialized species.

Schmidt's team has taken a few stabs. It has placed bits of Rocky Mountain soil in lab dishes filled with nutrients and tasty tundra plant extracts, then incubated them in refrigerators, in the hope of hitting on a recipe that the fungi find palatable.

So far, no luck, Schmidt said, sounding a bit like a parent with a fussy child.

So for now, at least, most of the world's microbial menagerie will continue to work in anonymity.