Montana State grad student to study unique soil around Yellowstone hot springs

May 11 2010

A Montana State University graduate student has received a fellowship to study soil crusts unlike any he has ever seen.

Located around some of the hot springs in Yellowstone National Park, the soil is very fine, soft and has a unique rippled texture that reminds him of a brain, said James Meadow, recipient of the Boyd Evison Graduate Fellowship. It houses microorganisms, but mostly consists of the glassy dead bodies of diatoms. Diatoms are microscopic algae that turn light into energy. Their cell walls are made of silica.

"The diatoms are what makes this soil crust so unique," Meadow said. "Diatom deposits are generally only found in lake and marine sediments. ... It is very unique to find these deposits growing on the soil surface."

He noticed the unusual crust while sampling plants near alkaline hot pools in the Imperial Meadow of the Lower Geyser Basin, Meadow said. Working on his Ph.D. in ecology and environmental sciences, Meadow said his primary research deals with fungi that live symbiotically with plant roots. Symbiosis occurs in all soil systems, but his Ph.D. research focuses on fungi that thrive in harsh thermal environments.

Cathy Zabinski, his adviser in MSU's Department of Land Resources and Environmental Sciences, said ,"If we can understand how plant/microbe interactions enable plants to grow in this extreme environment, we can also apply those same principles to other extreme environments, such as remediation sites after mining activities. We are

also using this work to understand how plants might respond to warming soil temperatures in the future."

Grand Teton National Park and the Grand Teton Association selected Meadow out of 19 applicants for the 2010 fellowship that honors the late Boyd Evison. Evison worked 42 years with the National Park Service and then became executive director for the Grand Teton Association, which is dedicated to aiding interpretive, educational and research programs for Grand Teton National Park. The fellowship program -- which will give Meadow approximately $10,000 over two years -- encourages scientific and conservation-related research in Grand Teton and throughout the Greater Yellowstone. It supports research leading to a master's or doctoral degree in the biosciences, geosciences or social sciences.

The fellowship allows recipients to develop their own ideas, independent of the projects their advisers have funded, Zabinski said.

"From a graduate training perspective, there is no better way to prepare students for the academic job market," Zabinski said.

Meadow said he will use his fellowship to study the composition, diversity and ecological environmental of the soil he observed in Yellowstone. The soil changes color and texture with the season. A product of thermal vents, it is loaded with chemicals, especially silica.

A major benefit of the fellowship is that it will allow him to conduct molecular analysis, Meadow added. Instead of identifying organisms under a microscope, which could take years, he can crush small samples of the soil, pull as much DNA as possible and run tests to identify the organisms that live in the soil and, to some extent, tell what they are doing.

"It's pretty common to find new organisms in these environments," Meadow said. "What I have seen so far is, it seems to be a combination of common crust organisms, along with those only found in thermal environments.

Soil crusts -- generally called biological soil crusts -- are composed mostly of bacteria (primarily cyanobacteria), fungi, lichens and mosses, Meadow said. They also incorporate the top few millimeters of soil. They dominate in arid soils where plants are limited and open patches of soil are exposed to full sunlight.

Scientists have conducted extensive studies of the crust environments in Canyonlands National Park and Arches National Park, both in Utah, Meadow said. But he found nothing to indicate that anyone had researched thermal crusts like he noticed in Yellowstone.

His findings -- besides contributing to general scientific knowledge -- will be shared with the Grand Teton Association, park visitors and others, Meadow said. He will work with park staff to create interpretative materials that will explain the diversity of life forms that live only in thermal ecosystems, specifically the soil.

His research might also contribute to environmental restoration, Meadow said. Meadow worked on ecological restoration projects at mines and other industrial sites throughout the West before coming to MSU.

"Doing that, it became obvious to me that a lot of the time restoration kind of fails because we don't really understand how organisms live in really harsh environments in natural systems," Meadow said. "Thermal soil biology gives me a chance to see how organisms cope with really, really tough environments."

Zabinski said the area is "absolutely fascinating."

"You find really poorly developed soils, low nutrient levels for plant growth, soil temperatures that are at the extreme of what plant tissues can tolerate, and a set of plants, some of which only grow on hot soils and others which are widely distributed and can also tolerate the heat," she said.

Provided by Montana State University