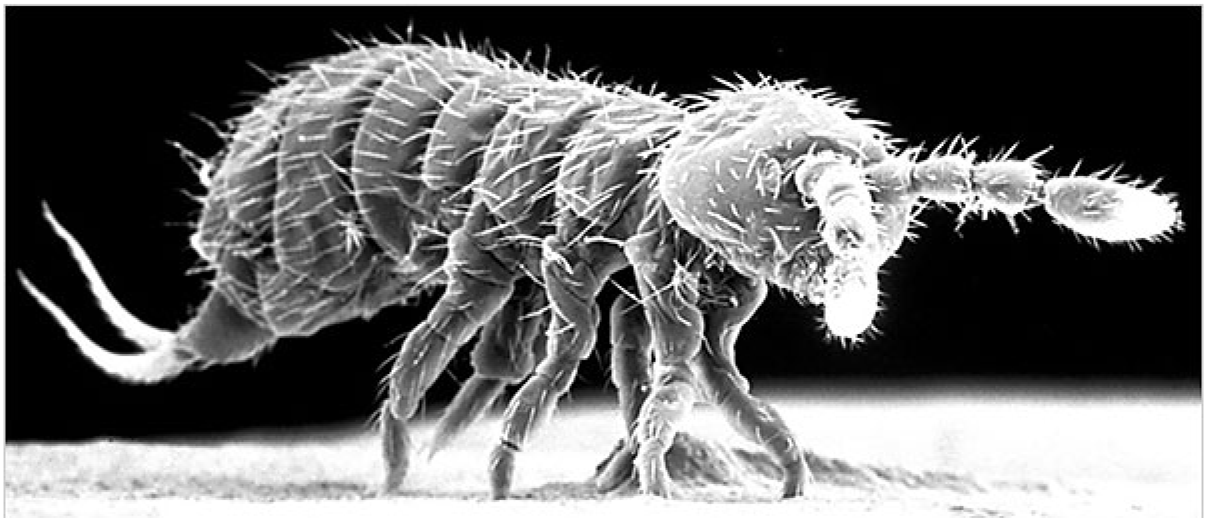
SCIENTIST AT WORK | DIANA H. WALL

An Antarctic Ecosystem Shows Signs of Trouble as a Tiny Worm Turns



Val Behan-Pelletier/Canadian National Collection of Insects

Creatures like microarthropods, above, play a role in the cycling of carbon through a soil ecosystem.

By AMANDA LEIGH HAAG
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In the freeze-dried landscape of the Antarctic Dry Valleys, ridges and rocks chiseled by the scouring winds seem frozen in time, with little evidence of change from one season to the next. But to the researchers who return there year after year, much is changing, and the change is alarming.

Evelyn Hockstein for The New York Times

Diana H. Wall, right, of Colorado State University, taking soil samples at Kapiti Plains in Kenya.

The New York Times

Antarctic Dry Valleys, home of three kinds of nematodes. (Click for more detailed map.)

Diana H. Wall, director of the Natural Resource Ecology Laboratory at Colorado State University in Fort Collins, is to make her 16th trip to the continent next month. Each austral summer, Dr. Wall and 9 or 10 colleagues return to study the tiny roundworms called nematodes, which occupy the top rung of the food chain in this pared-down ecosystem.

The polar desert of the Dry Valleys was once thought to be sterile and lifeless. But now the valleys are known to be home to three species of nematodes, spongy mats of moss and algae in the nearby streams and frozen lakes, and an abundance of bacteria.

Dr. Wall and her team of “worm herders” — as they are called by the helicopter pilots who ferry them to their remote field camps — study the process of carbon turnover, how carbon travels through the ecosystem.

In soil, turnover works this way: molecules containing carbon provide fuel for organisms; as the organisms die and decay, the carbon is released back into the soil in the form of nutrients. Eventually, it is exhaled out of the soil by the respiration of microbes and soil invertebrates.

“The cycling of carbon is the basis of life,” said Ed Ayres, a postdoctoral researcher working with Dr. Wall.

Scientists still know little about how these soil organisms function. But by digging around in what some might consider just plain dirt, the researchers are finding that one very small worm is playing a critical role in the Dry Valleys ecosystem — and that its survival may be in jeopardy.

The creature is an Antarctic nematode, Scottnema lindsayae, just one millimeter long. In a temperate forest or even a hot desert, nutrients that cycle through an ecosystem form a vastly complicated web, far too interconnected to tease out the contributions of individual species. But in the parched landscape of the Dry Valleys, the researchers can decipher what role each species plays and how important each one is to the overall health of the ecosystem.

By measuring the "metabolism" of the soil, Dr. Wall and two fellow researchers, Jeb Barrett and Ross Virginia, both of Dartmouth College, found that Scottnema is a veritable carbon factory.

While the nematodes themselves make up just 0.025 percent of the total carbon in the ecosystem budget, they play a disproportionate role in recycling it from one useful form to another. Scottnema is responsible for about 10 percent of the carbon processed in the Dry Valleys soil ecosystem. This workload would employ a whole orchestra of soil organisms in more complex ecosystems.

Dr. Virginia compares the role of Scottnema to that of buffalo on the grassland. "Buffalo go around and graze on grasses, controlling productivity of grasses and returning waste to the soil, which then alters soil fertility," he said. "The nematodes are grazing on the yeast, bacteria, fungi and the microscopic life in the soil, and they're providing some of those same services."

But in the past 10 years, Dr. Wall and her colleagues have documented some striking changes in the natural laboratory of the Dry Valleys. While the temperature across much of Antarctica is rising, the Dry Valleys experienced a regional cooling period, which in turn led to cooler and drier soils. As a result, the Scottnema population has shrunk by 65 percent since 1993. This drop translates to a loss of a third of the total carbon cycling in the ecosystem. “People have said, ‘Oh well, it’s a desert, who cares?’ ” Dr. Wall said. “What we’re seeing is that the beast that has the most to do, or a disproportionate amount to do, is one species that is crashing and burning.”

Because so little research has been done, scientists have no way of knowing whether similar disturbances are taking place worldwide.

“The complexity in most other soils has prevented one from teasing apart these variables in a way that we’ve done down there,” Dr. Virginia said. But he noted that the effects on biodiversity in the cold-desert ecosystem of the Dry Valleys make an apt comparison to regions like the hot, arid desert of the Sahara, which is increasingly under threat from desertification and climate change. And such areas make up about one-third of the earth’s land surface.

Scientists know that on a global scale, the amount of carbon dioxide released by soil invertebrates and microbes is greater than 10 times the annual carbon emissions from fossil fuels. The oceans and forests perform crucial roles as carbon “sinks,” drawing in carbon that would otherwise linger in the atmosphere.

Yet soils hold more carbon than trees and the atmosphere combined. Along with James Heath, a plant physiologist at Lancaster University in Britain, Dr. Wall’s colleague Dr. Ayres reported last year in the journal Science that heightened levels of carbon dioxide in the atmosphere hindered the soil’s ability to store carbon and led to increased levels of soil respiration by microbes.

In another global study being led by Dr. Wall, scientists from 20 countries are scouring 30 sites worldwide to study decomposition and to fill in the missing blanks from current carbon models. Volkmar Walters, a soil ecologist at Justus-Liebig University in Giessen, Germany, likens the study — called Glide, for Global Litter Invertebrate Decomposition Experiment — to the human genome project. It is, he said, like “asking for the whole genome instead of some chromosomal bands.”

Soil research is gaining organized advocates in both Europe and the United States. The House of Representatives now has a Soils Caucus to promote research and education on subjects like erosion and soil biodiversity. Karl M. Glasener, director of science policy for the American Society of Agronomy and the coordinator of the caucus, said that when he first told people about it, they thought it was a joke.

“That’s kind of what we’re used to,” he said. “People say: ‘What, soils? Who cares?’ But then we explain to them that engineers were counseled many times by soil scientists at L.S.U. about the unusual chemical characteristics of the soils in New Orleans and that they needed to be taken into account when they built the levees. And they didn’t.”