Freeze-dried mats of microbes awaken in Antarctic streambed

August 9 2005

An experiment in a dry Antarctic stream channel has shown that a carpet of freeze-dried microbes that lay dormant for two decades sprang to life one day after water was diverted into it, said a University of Colorado at Boulder researcher.

Image: CU-Boulder Professor Diane McKnight (blue jacket) and her research colleagues use sandbags to divert water into a streambed in Antarctica that had been dry for 20 years. Dormant bacterial mats popped up the next day. Photo courtesy CU-Boulder

The results showed the resilience of life in the harsh polar environment, where temperatures are below freezing for most of the year and glacial melt water flows for only five to 12 weeks annually, said Professor Diane McKnight of CU-Boulder's Institute of Arctic and Alpine Research. Such research on life in extreme environments is of high interest to astrobiologists, who consider Antarctica's McMurdo Dry Valleys an analogue for Mars because of its inhospitable climate and intermittent water flow.

"This was something we did not anticipate," said McKnight, whose research group is working at Antarctica's McMurdo Dry Valleys Long Term Ecological Research, or LTER, site funded by the National Science Foundation. "These mats not only persisted for years when there was no water in the streambed, but blossomed into an entire ecosystem in about a week. All we did was add water."

McKnight gave a presentation on the experiment at the Ecological Society of America's 90th Annual Meeting held Aug. 7 to Aug. 12 in Montreal.

The river channels under study feature intermittent streams that link glaciers to frozen lakes on the valley floor, she said. The streambeds contain photosynthetic microbes known as cyanobacteria, which collectively occur as thin, rubbery mat-like structures that can spread several meters across the streambed surface.

The experiment began in the 1994 research season, when the team used sandbags to divert water from an active streambed in the McMurdo Dry Valleys into the dry streambed, she said. A time series of aerial photographs, coupled with carbon isotope analyses of the cyanobacteria that measured variation in atmospheric carbon over decades, indicated the streambed had been dry for about 20 years.

"After we diverted the water into the channel, photosynthesis began the same day and the mats became abundant within a week," she said. "This showed us that they had been preserved in a cryptobiotic state."

Over the next several years, the microbial mats in the experimental channel had higher growth rates than mats in adjacent streambeds receiving annual summer water flow, she said. The study showed the new microbial mats were taking up atmospheric nitrogen at a higher rate than mats in adjacent streambeds, increasing biomass productivity, she said. As photosynthetic bacteria, cyanobacteria are believed by biologists to be among the first living organisms to colonize Earth. The mats generally are orange or black and consist of 10 to 15 different species of cyanobacteria, she said.

Because of a cooling trend in the McMurdo Dry Valleys, some streambeds that normally have annual summer flows have been dry in recent years, McKnight said. In contrast, the Antarctic Peninsula has warmed nearly 5 degrees Fahrenheit in the past 60 years and has seen the collapse of several major ice shelves and significant glacial thinning in recent years, according to several international studies.

The McMurdo Dry Valleys region consists of glaciers, open expanses of barren ground, stream channels and permanently ice-covered lakes. The life forms inhabiting the area include microorganisms, mosses, lichens and a few groups of invertebrates.

Study collaborators included Cathy Tate of the U.S. Geological Survey, Denver; Ned Andrews of the USGS, Boulder, Colo.; Dev Niyogi of the University of Missouri-Rolla; CU-Boulder graduate student Karen Cozetto; Cathy Welsh and Berry Lyons of Ohio State University; and Douglas Capone of the University of California, Irvine.

The McMurdo Dry Valleys site is one of 26 LTER sites in the world

designated by NSF. Approximately 25 scientists participate in research during each field season.

Source: University of Colorado at Boulder