Unlikely life thriving at Antarctica's Blood Falls

by Bend_Weekly_News_Sources

An unmapped reservoir of briny liquid chemically similar to sea water, but hidden under an inland Antarctic glacier, appears to support microbial life in a cold, dark, oxygen-poor environment â€“ a most unexpected setting to be teeming with life.

This blood-red stain at the snout of Taylor Glacier in Antarctica is the by-product of unique microbes thriving in a salty ocean-like reservoir beneath the glacier. Photo credit: Peter West, NSF

The McMurdo Dry Valleys of Antarctica are devoid of animals and complex plants and scientists consider them to be one of the Earth's most extreme deserts. The Valleys receive, on average, only 10 cm (3.93 inches) of snow each year. Despite the lack of precipitation, during the Antarctic summer, temperatures rise just enough for glaciers protruding into the valleys to begin melting. The meltwater forms streams that enter lakes covered by ice that is two-to-three-stories thick.

Even less forgiving are the conditions found below the Taylor Glacier, an outlet glacier of the East Antarctic Ice Sheet in the otherwise ice-free Dry Valleys. The lack of light beneath the glacier makes the process of photosynthesis improbable, causing researchers to wonder how organisms found below the glacier could survive.

The research, which appears in the April 17 issue of Science, suggests that over the past 1.5 million years the microbes adapted to manipulate sulfur and iron compounds to survive. In place of photosynthesis, the microbes converted Fe(III) to Fe(II) to create food and energy.

The study was led by Jill Mikucki, a National Science Foundation-funded researcher at Dartmouth College. Mikucki and a team of researchers based their analysis on samples taken at the ominously, but aptly named Blood Falls, a water-fall-like feature at the edge of the glacier that flows irregularly, but often has a strikingly bright red appearance in stark contrast to the icy background.

The key piece of data supporting the hypothesis that the microbes were in fact surviving by turning Fe(III) to Fe(II) came from samples analyzed by Ariel Anbar, one of the authors of the study and an associate professor at Arizona State University, and researchers in his group, using instruments in the W. M. Keck Laboratory for

Environmental Biogeochemistry at ASU.

"We found that the isotopes of Fe(II) in the brines are shifted in a way that is consistent with this microbial process," said Anbar, who holds joint appointments in the School of Earth and Space Exploration and the Department of Chemistry and Biochemistry in the College of Liberal Arts and Sciences.

Even the earliest explorers noted the massive red stain at the snout of the glacier and speculated as to what may have caused it. Some guessed that red alga was responsible for the bright color. "In fact, the red color is a result of all that Fe(II) produced by bacteria," said Anbar. "When the Fe(II)-rich water reaches the surface, the Fe(II) reacts with oxygen in the air to make Fe(III) compounds that are sort of like rust. That's the source of the red color."

The microbes are remarkably similar in nature to species found in marine environments, leading to the conclusion that the populations under the glacier are the remnants of a larger population of microbes that once occupied a fjord or sea that received sunlight. Many of these marine lineages likely declined, while others adapted to the changing conditions when the Taylor Glacier advanced, sealing off the system under a thick ice cap.

In the paper, however, Mikucki and her colleagues argue that the creatures that survive under the Taylor Glacier are both far more exotic and far more adaptable than the early explorers thought.

Because the outflow from the glacier follows no clear pattern, it took a number of years to obtain the samples needed to conduct an analysis. Finally Mikucki obtained a sample of an extremely salty and clear liquid for analysis.

"When I started running the chemical analysis on it, there was no oxygen," she said. "That was when this got really interesting; it was a real 'eureka' moment."

Further genetic analysis suggests that of the relatively small numbers of microorganisms found in the brine, "the majority of these organisms are from marine lineages," she said.

In other words, microorganisms more similar to those found in an ocean than on land, but capable of surviving without the food and light sources available in the open ocean.

"The salts associated with these features are marine salts, and given the history of marine water in the dry valleys, it made sense that subglacial microbial communities might retain some of their marine heritage," she added.

This led to the conclusion that the ancestors of the microbes beneath the Taylor Glacier probably lived in the ocean many millions of years ago. When the floor of the Valleys arose more than 1.5 million years ago, a pool of seawater from the fjord that penetrated the area was trapped. The pool was eventually capped by the flow of the glacier.

The briny pond, whatever its size "is a unique sort of time capsule from a period in Earth's history," Mikucki said. "I don't know of another environment quite like this on Earth."

Life below the Taylor Glacier may help scientist address questions about life on "Snowball Earth", the period of geological time when large ice sheets covered the Earth's surface. But it's also a rich laboratory for studying life in other hostile environments, including the subglacial lakes of Antarctica and perhaps even on other icy planets in the solar system such as below the Martian ice caps or in the ice-covered oceans of Jupiter's moon Europa.

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