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The Hunt for Alien Life Starts in Earth's Most Extreme Places

By studying Antarctica's icy ecosystems, scientists hope they'll discover what makes life tick in hostile environments—and how to find it in the solar system

By Daniela Hernandez
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Microbiologist Jill Mikucki went to Antarctica last year on a special mission: She was looking for signs of what life on other planets and moons might look like. Her work is part of an effort to understand the origins of life—not just in our world, but in the solar system—by examining the organisms that thrive in Earth's most extreme environments.

In a salty, ferrous glacial waterfall known as Blood Falls, her team previously discovered a new strain of bacteria adapted to survive in brutally cold temperatures. The landscape looks almost Martian.

By studying the chemistry, physical properties and biology of Antarctica's icy ecosystems, scientists are hoping they'll not only discover what makes life at extremes tick, but also determine where to look—and what to look for—when they send satellites and robots to explore other potentially habitable planets and moons. Antarctica's ice-covered coastal regions and frozen lakes, for instance, mimic the geology that planetary scientists expect to encounter in the moons of Jupiter and Saturn, which have ice-shelled salty oceans.

"The universe is very cold," says Dr. Mikucki of the University of Tennessee in Knoxville.

Until relatively recently, the idea that earthly life could thrive in extremely cold ecosystems, like deep within glaciers or in subglacial lakes, was controversial. When Dr. Mikucki first learned about Blood Falls as a graduate student in the early 2000s, she asked her professor what organisms lived there. Her question was met with skepticism and some laughter, she recalls.

Scientists now know that so-called extremophiles—microorganisms that live in acidic or hot environments—are common, and that they also thrive in ultra-frigid places. They can survive high radiation too and feed off or breathe metals, like uranium or iron, which are present at

Jill Mikucki and T.J. Rogers collect samples at Blood Falls in Antarctica. **PHOTO:** RICARDO GARZA-GIRON

Blood Falls.

A deeper understanding of these creatures' metabolism could help guide scientists searching for alien life, researchers say. On Earth, the work could also help bioengineers develop new antibiotics or crops better suited for extreme climates. That now-booming field, known as bioprospecting, is also interested in cold-loving microbes, and research in this area has accelerated with recent advances in molecular biology and genetic sequencing, she said.

When she began her doctoral work, she joined the lab of Montana State University's John Priscu, a firm believer that life could exist even in seemingly uninhabitable places like deep within Antarctica's ice sheets.

"It never settled well with me that that much real estate—the fifth-largest continent—was dead," he said. Except for the "Dry Valleys," home to Blood Falls, most of Antarctica is covered in ice that can be miles thick.

Charles Darwin, the father of evolution, once wrote that life grew out of a warm pond. Dr. Priscu didn't fully agree. Hot temperatures can degrade amino acids and DNA, the building blocks of life, while the cold is a natural preservative that gives life time to evolve, he says.

Dr. Priscu said he spent years trying to get funding for projects to look for microbial life in Antarctica's ice. In 2009, he finally got money from the U.S. National Science Foundation to drill through the ice sheet. The technologies his team has used—including a remotely operated vehicle and an ice drill that can bust through nearly 1,100-meter-thick ice using high-pressure, ultraclean hot water—are helping scientists prototype the tools that could be useful for exploring Europa, one of Jupiter's icy moons, he says. The drill, he said, was designed, in part,

A member of Britney Schmidt's team near Barne Glacier. Dr. Schmidt, a roboticist and planetary scientist, is using a robotic vehicle called Icefin to gather data that shed light on the underwater ecosystem, as well as the interactions between Antarctica's ice and ocean. **PHOTO:** ALEXANDER HOTZ/THE WALL STREET JOURNAL

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with extraterrestrial exploration in mind. When robots finally make it to the Jovian satellite, they'll need to drill through more than 10 miles of ice, while ensuring they don't contaminate the environment. But they'll also have to be much, much lighter, Dr. Priscu said. The drill, for instance, weighed 500,000 pounds, "a mass that would never make it to space," he said.

Dr. Schmidt lowers the Icefin robot under sea ice. **PHOTO:** ALEXANDER HOTZ/THE WALL STREET JOURNAL

In 2013, Dr. Priscu's team, which included Dr. Mikucki, found a high density of cells in samples they collected from a subglacial lake. This year, his team found preliminary evidence of microbes underneath another lake under the West Antarctic Ice Sheet, further suggesting the continent is teeming with hidden life-forms, he said.

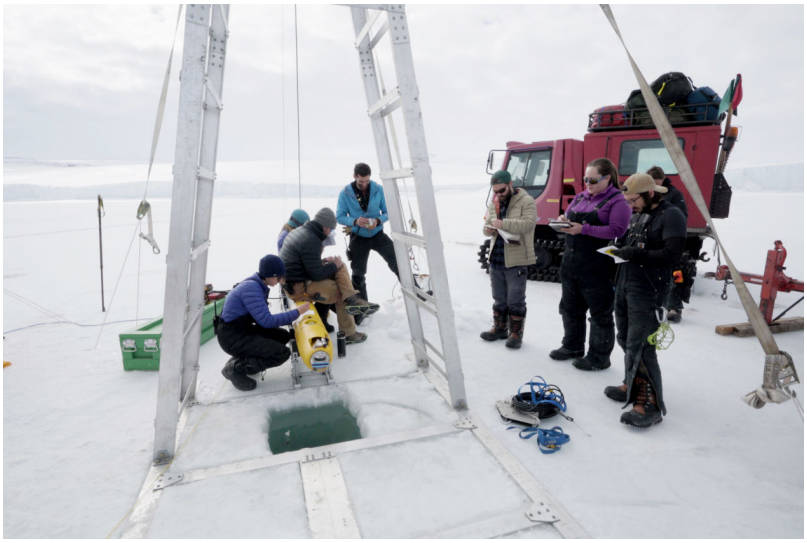
The origin of these microbes is unclear. But now that some of the new samples arrived in the U.S. earlier this month, his group will spend months sequencing and analyzing their genomes, he said.

Still, one thing is certain: The lakes' organisms haven't "seen the sun in hundreds of thousands of years," which means, to live, they must "get their energy from the earth," Dr. Priscu said. It also means they thrive in extreme cold. All this makes him think Europa, like Antarctica, hosts life.

"It's not 'if we have life there,' it's when we go and find it," he said. "The microbial world has no limits."

To know where to drill and how to navigate once under the ice cover, scientists need practice.

On November 30, a few days after Dr. Mikucki flew to Blood Falls, Britney Schmidt, a roboticist and planetary scientist from the Georgia Institute of Technology, led a team of scientists and engineers to Barne Glacier, near McMurdo Station, the largest U.S. base on the continent. They had with them a generator, tents, computers and a yellow torpedo-shaped robot called Icefin. Atop the sea ice, they set up a temporary camp and control room from which they monitored Icefin as it coursed underneath the ice.



The Icefin robot has cameras and sensors that measure salt content, pressure, oxygen levels and temperature, among other factors. **PHOTO:** ALEXANDER HOTZ/THE WALL STREET JOURNAL

The 12-foot machine, which Dr. Schmidt describes as a robotic oceanographer, resembles vehicles scientists might one day send into space, she said. It has cameras and sensors that measure salt content, pressure, oxygen levels and temperature, among other factors. That data, which the team is still analyzing, will help them understand the underwater ecosystem, as well as the dynamic interactions between Antarctica's ice and ocean, which affect the kind of life that can thrive there, she said.

Such Antarctic expeditions give researchers a chance to figure out what types of measurements they might need to sleuth out signs of life in previously uncharted terrain. During such missions, there is very little room for error because any miscalculation could damage the machines tasked with exploring places humans can't go, Dr. Schmidt says. In outer space, the stakes are even higher because any misstep could be fatal for a robot.

"If you haven't been to a place, it's hard to imagine how you explore it," she said. "The only hope for doing it there is to do it well here."

—Alexander Hotz contributed to this article.

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