Tint of life: Color catalog built to find frozen worlds
15 March 2022, by Blaine Friedlander

With a color catalog based on Earth’s microbes, astronomers can begin to decipher the tint of life on distant, frozen exoplanets, as depicted in this artistic rendering. Credit: Jack Madden

Aided by microbes found in the subarctic conditions of Canada’s Hudson Bay, an international team—including researchers from Portugal’s Instituto Superior de Agronomia and Técnico, Canada’s Université Laval in Quebec, and Cornell—has created the first color catalog of icy planet surface signatures to uncover the existence of life in the cosmos.

As ground-based and space telescopes get larger and can probe the atmosphere of rocky exoplanets, astronomers need a color-coded guide to compare them and their moons to vibrant, tinted biological microbes on Earth, which may dominate frozen worlds that circle different stars.

But researchers need to know what microbes that live in frigid places on Earth look like before they can spot them elsewhere.

The study published March 15 in the journal Astrobiology, provides this toolkit.

"On Earth, vibrant, biological colors in the Arctic represent signatures of life in small, frozen niches," said lead author Lígia F. Coelho, an astrobiologist and a doctoral student at the faculty laboratories of Zita Martins, João Canário and Rodrigo Costa at Técnico, who grew and measured this frigid, colorful biota at the Carl Sagan Institute at Cornell (CSI).

This summer, Coelho will become a postdoctoral researcher in the lab of Lisa Kaltenegger, professor in the Department of Astronomy and director of CSI in the College of Arts and Sciences.

"The colors from organisms could dominate the whole surface of icy worlds," Coelho said. "Frozen exoplanets are not lost causes. With upcoming telescopes you could find the telltale signs of microbes—if you know what to look for. That’s why we’ve created this catalog."

Coelho collected 80 microorganisms from ice and water at Kuujjuarapik, Quebec, working across the frozen Hudson Bay, obtaining ice cores and drilling holes in the ice to take water samples. She acquired samples at the mouth of the Great Whale River in February 2019, during an excursion lead by Warwick Vincent of the Université Laval, with the logistic support of the Centre d’étude Nordiques.

"When searching for life in the cosmos, microbes in these frozen plains of the Arctic give us crucial insight of what to look for on cold new worlds," Kaltenegger said, explaining that this icy microbial life is well-adapted to the harsh radiation bombardment of space—which can be the norm on distant exoplanets under a red sun.

"Having the right tools to detect life forms on icy worlds is fundamental," said Martins, director of the astrobiology laboratory and professor at Técnico, who came up with the idea for this research with Kaltenegger. "Our study shows that biosignatures are more intense in drier environments, suggesting that locations that are drier than Earth and contain..."
microbial life forms could represent good targets for future space missions."

After Coelho isolated the microorganisms in Rodrigo Costa's lab (Técnico), she grew them in upstate New York's relatively balmy climate in the laboratory of Stephen Zinder, professor emeritus of microbiology in the College of Agriculture and Life Sciences. The measurements to find out how these microbes would look to our telescopes were made in the laboratory of William Philpot, professor in the School of Civil and Environmental Engineering.

"Icy environments on Earth show a surprisingly wide diversity of life and might have even provided the environment for life to originate," Coelho said. "The color catalog of life on Earth's subarctic will serve as the guide to search for surface life on icy worlds throughout all the habitable zone, not just in the warm parts."

Kaltenegger says that they "are assembling the tools to search for life in the universe, so as not to miss it, taking all of Earth's vibrant biosphere into account—even those in the breathtaking chilled places of our Pale Blue Dot."


Provided by Cornell University

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