

Bacteria in frog skin may help fight fungal infections in humans

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The bacterium *Pseudomonas cichorii* was isolated from the skin of frog species *Craugastor crassidigitus*. Credit: Christian Martin

In the past few decades, a lethal disease has decimated populations of frogs and other amphibians worldwide, even driving some species to

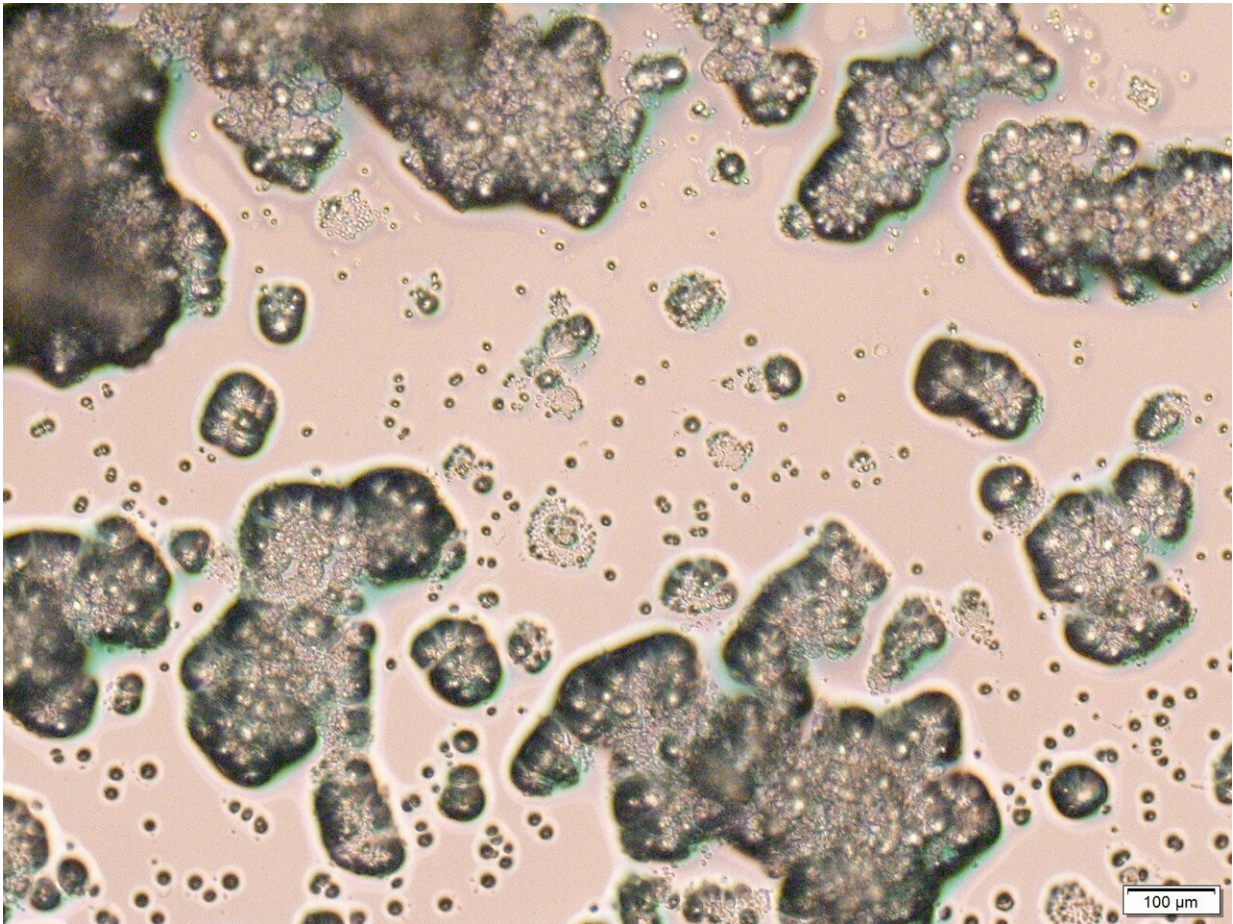
extinction. Yet other amphibians resisted the epidemic. Based on previous research, scientists at the INDICASAT AIP, Smithsonian and collaborating institutions knew that skin bacteria could be protecting the animals by producing fungi-fighting compounds. However, this time they decided to explore these as potential novel antifungal sources for the benefit of humans and amphibians.

"Amphibians inhabit humid places favoring the growth of [fungi](#), coexisting with these and other microorganisms in their environment, some of which can be pathogenic," said Smithsonian scientist Roberto Ibáñez, one of the authors of the study published in *Scientific Reports*. "As a result of evolution, amphibians are expected to possess [chemical compounds](#) that can inhibit the growth of pathogenic [bacteria](#) and fungi."

The team first travelled to the Chiriquí highlands in Panama, where the [chytrid fungus](#), responsible for the disease chytridiomycosis, has severely affected [amphibian](#) populations. They collected samples from seven [frog species](#) to find out what kind of skin bacteria they harbored.

"Amphibians have glands scattered on their skin that produce different compounds," Ibáñez said. "In addition, their skin is inhabited by a diverse community of bacteria that produce metabolites that inhibit the growth of fungi and other bacteria."

Back in the laboratory, 201 bacterial strains were retrieved from their samples and tested against *Aspergillus fumigatus*, a fungus that causes invasive aspergillosis in immunocompromised patients. Of these, 29 showed antifungal activity, but one in particular caught their attention: a bacterium called *Pseudomonas cichorii*. This one showed the greatest potential to inhibit the growth of *A. fumigatus*.

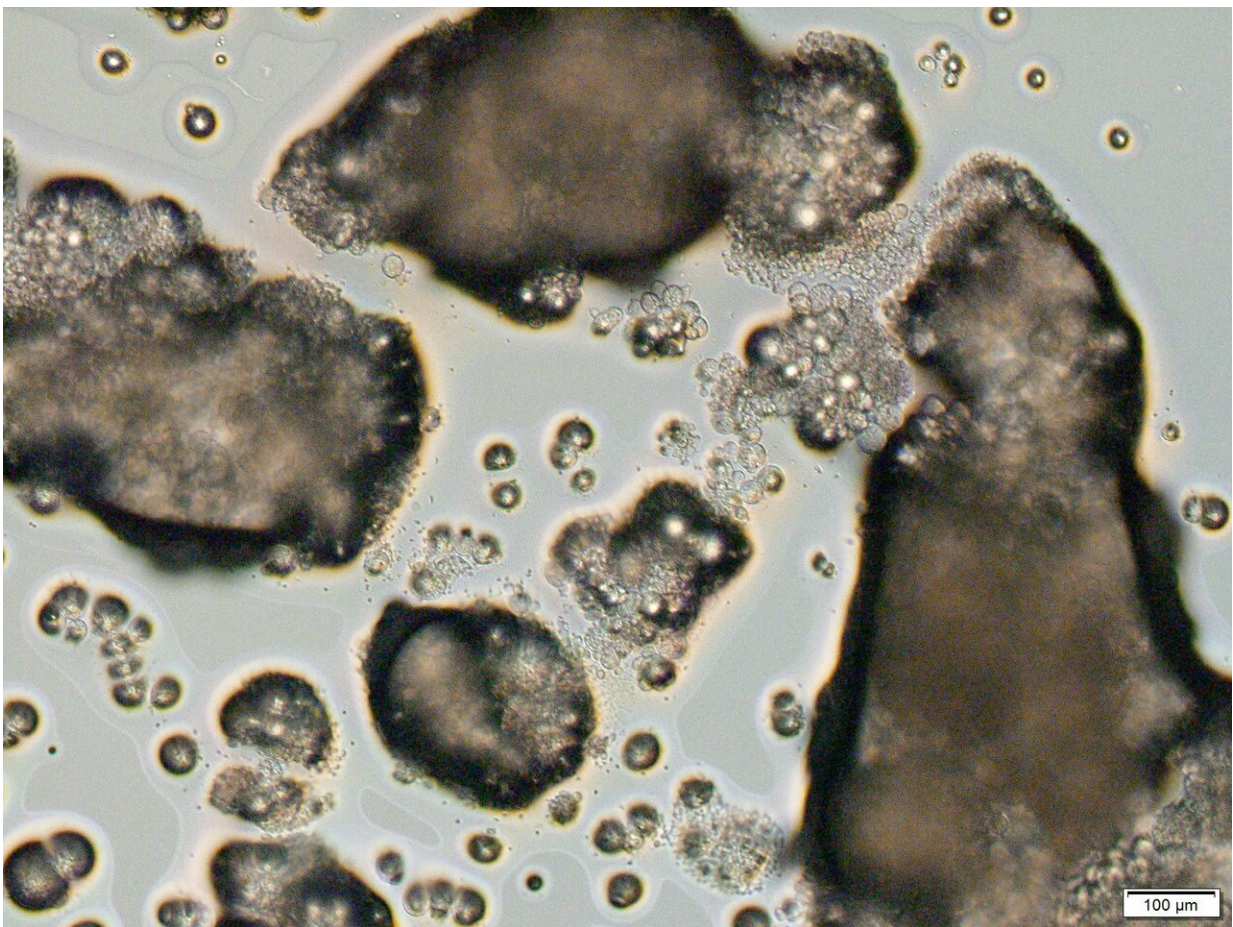


The compound viscosin, produced by bacterium *Pseudomonas cichorii*, displays significant activity against the chytrid fungus, which has severely affected amphibian populations worldwide. Credit: Christian Martin

After identifying the most promising bacteria, the scientists had a new question: among all the chemical compounds produced by *P. cichorii*, which one was keeping the fungi at bay? To find out, they used mass spectrometry and molecular networking techniques. They also observed the interactions between this bacteria and *A. fumigatus* to identify the bacterial compounds acting in areas where fungal activity was most inhibited. The main compounds were cyclic lipopeptides that included massetolides and viscosin.

The team then separated viscosin from the other components produced by *P. cichorii* and tested it invitro against *A. fumigatus* and the chytrid fungus. The results confirmed that viscosin displayed significant activity against both.

This research project holds promise for humans and frogs. Studying the skin bacteria of Panamanian frogs may lead to the development of alternative drugs to treat the fungi causing aspergillosis in humans, which are becoming more drug-resistant, and to defy the chytridiomycosis epidemic, the major source of disease-related death among amphibians worldwide.



The chytrid fungus before interacting with the compound viscosin. Credit: Christian Martin

"We are showing to the scientific community a set of possible alternative molecules to fight fungal drug resistance in humans," said Christian Martin, the first author of the study along with the principal investigator Marcelino Gutiérrez, both from INDICASAT. "Although more studies are needed, our collaboration could spark interest in the conservation of amphibians as a novel source of bioactive compounds in humans. For amphibians, this is a promising study because there are only four bacterial secondary metabolites chemically described that inhibit chytrid fungi. In this study, we are introducing a new family of chemical compounds found in Panamanian frogs that could help amphibians worldwide."

"I consider that bioprospecting [compounds](#) from [skin](#) secretions or bacteria living in frog's skins is just beginning," Ibáñez said. "This research has identified an antifungal compound produced by frog [skin bacteria](#), which may be used to control pathogenic fungi affecting humans and amphibians. More research will be required to determine its potential medicinal use."

More information: Christian Martin H. et al, Viscosin-like lipopeptides from frog skin bacteria inhibit *Aspergillus fumigatus* and *Batrachochytrium dendrobatidis* detected by imaging mass spectrometry and molecular networking, *Scientific Reports* (2019). [DOI: 10.1038/s41598-019-39583-7](https://doi.org/10.1038/s41598-019-39583-7)

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