UC SANTA BARBARA

THE Current

February 7, 2022
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The Frogs of Baja California

There's a pandemic sweeping across the globe. No, not COVID, a different one. For decades, a brutal fungal infection has been decimating amphibians worldwide.

"We call it a panzootic," said Andrea Adams, an assistant researcher in the Earth Research Institute at UC Santa Barbara. "It's like a pandemic, only with animals."

Scientists are hard at work investigating the disease's origin, trajectory, genetics and impact in an effort to safeguard vulnerable and valuable biodiversity. Biologists from Southern and Baja California have published the first major account — and most comprehensive study — of the amphibian disease chytridiomycosis in the Mediterranean region of Baja California. Their results, which appear in Global Ecology and Conservation, indicate that the disease is more prevalent on the peninsula than in similar areas of Southern California.

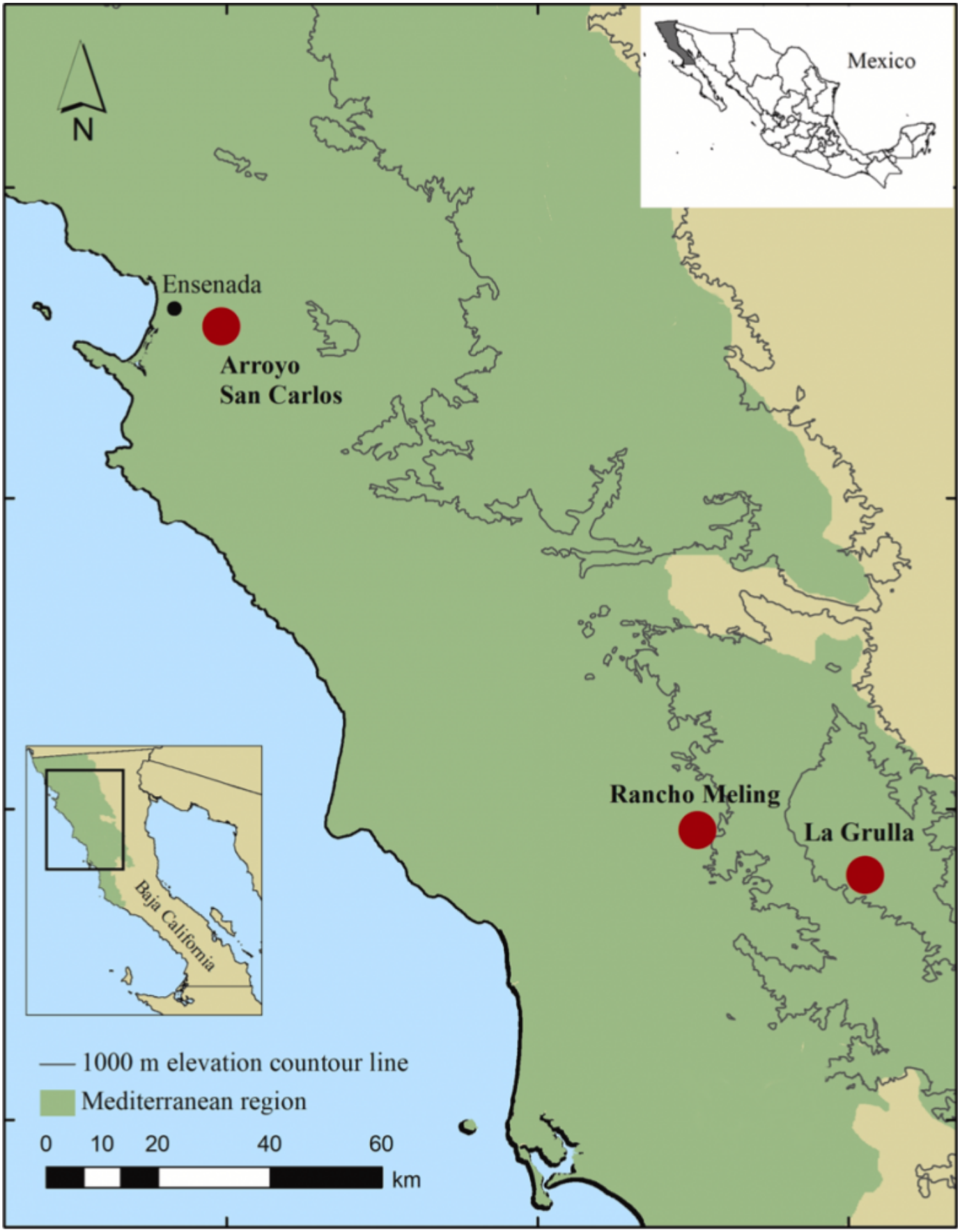
"Contrary to what we had expected," said Adams, the lead author, "what's going on in Baja California is very different than what's going on with chytrid fungus in Southern California, where the species are pretty much the same, and the environment is very similar."

Chytrids form a large group of mostly soil-dwelling fungi. They're quite common, and generally pose no harm. However, two species have evolved to infect the skin of amphibians. In highly infected animals, the skin responds by thickening.

This has a downside. "You probably heard frogs drink through their skin," Adams said. It's true. They also exchange salts and minerals through their skin. So when

their skin thickens, it can be a death sentence for many individuals.

The team wanted to know what environmental and biological factors influence chytrid infection in Baja California, particularly at different elevations. Unfortunately, there has been little research on the topic in the Mediterranean region of Baja California. “We knew chytrid was here, but we didn’t know how it was affecting different species or which variables mattered most,” said co-author Anny Peralta-García, director of Conservación de Fauna del Noroeste, a nonprofit organization dedicated to research and conservation in Baja California, especially for less charismatic species.


N
Mexico
Ensenada
Arroyo
San Carlos
Rancho Meling
La Grulla
Baja California
1000 m elevation countour line
Mediterranean region
0 10 20 40 60
km

The Mexican team surveyed frogs at three elevations in Baja California.

Photo Credit: ADAMS ET AL.

Along with UC Santa Barbara professor Cherie Briggs, Adams teamed up with Peralta-García's group and Carlos A. Flores-López, a researcher at the Autonomous University of Baja California, to carry out a survey of the disease in local frogs. The scientists collected samples quarterly from November 2015 to October 2016. They visited three sites in Baja California, each at a different elevation. The lowest is a perennial stream about 12 miles south of Ensenada. The area's hot springs make it a popular recreational spot. The middlemost location is about 2,000 feet up in the foothills of the Sierra San Pedro Mártir, a mountain range in northern Baja California.

Lastly, the team surveyed a mountain meadow 6,700 feet high in Sierra de San Pedro Mártir National Park, where despite some impacts from livestock, native amphibians still appear to thrive.

The Mexican team spent 2-3 days per location catching animals at night. They swabbed the frogs' skin to collect samples of the fungus, then released them back into the wild. Altogether, they collected enough data to analyze the disease prevalence and load in four species, including the endangered California red-legged frog and the invasive American bullfrog.

"We found that when it comes to chytrid infection, the most important things are where you live and who you are," Adams said. In other words, elevation and species. Chytrid infections were more common and more intense at higher elevations, where the cooler, moister environment provides ideal conditions for the fungus.

Some species are also more susceptible to the infection than others. For instance, the California red-legged frog was among the most infected, with the highest observed infection intensity and prevalence compared to other species.

The team found that chytrid was much more prevalent in Baja California, where 68% of animals they surveyed had the fungus, compared to 15% in Southern California, as observed in a previous study.


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Peralta-García and her group are working to reintroduce California red-legged frogs to parts of Baja California.

Photo Credit: ANNY PERALTA-GARCÍA

The difference was particularly striking for California red-legged frogs. In another study in Southern California, only 30% of the species was infected. “In Baja California, we found that 99% of the California red-legged frogs at the highest-elevation site were infected,” Adams remarked.

Not only was the disease more prevalent, infected animals also carried a higher pathogen load in Baja California. The team was curious when the fungus first arrived in Baja California. If it appeared recently, that could help explain the high infection intensities compared with Southern California. “When the fungus first arrives to a place it can cause die-offs and declines in susceptible species,” Adams explained.

Fortunately, the San Diego Natural History Museum has a wealth of amphibian specimens from Baja California that the team used to investigate the history of chytrid’s arrival. The scientists found the fungus in specimens collected as early as 1932. Previous research found the earliest record of chytrid detection from Baja California is 1926.

For comparison, the first record of the fungus in Southern California was found in specimens from Los Angeles County in 1915. This makes some sense, as invasive species often arrive at ports of entry and then fan out into the landscape. The combined ports of Los Angeles and Long Beach are the largest on the West Coast.

So, if chytrid has been in both places — Baja California and Southern California — for about the same amount of time, what could explain the differences the team found?

Much like the SARS-CoV-2 virus, the chytrid fungus has evolved over time. As the fungus mutates and adapts, more virulent or infectious strains may emerge in different locations.

Understanding what’s going on will require long-term monitoring, tracking individuals over time and establishing baselines. “These data help us prioritize sites that need conservation actions,” Peralta-García said. “For example, La Grulla, our highest elevation site, needs to continue to be monitored for disease.” The group is continuing their sampling and rehabilitation work, though getting samples tested will

require more funding.

“Right now, our main focus is trying to increase populations of California red-legged frogs in Baja California and Southern California,” Peralta-García said. They’ve had success reintroducing eggs, which lack keratin, so are not susceptible to the fungus, to historical sites in California. This means eggs can’t transfer the fungus from one site to another.

Adams does similar work in the United States. “Anny and I are actually doing very similar things,” she said. “We are both working to find the best ways to bring these frogs back to places they’ve disappeared from, and we learn a lot from each other.”

Chytrid is always part of the discussion, she added. “We can still be moving forward on chytrid questions and chytrid monitoring, while also trying to remedy species declines.”

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.