Blood samples show deadly frog fungus at work in the wild

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The fungal infection that has killed a record number of amphibians worldwide leads to deadly dehydration in frogs in the wild, according to a new study by University of California, Berkeley and San Francisco State University researchers.

High levels of an aquatic fungus called *Batrachochytrium dendrobatidis* (*Bd*) disrupt fluid and electrolyte balance in wild frogs, the scientists say, severely depleting the frogs' sodium and potassium levels and causing cardiac arrest and death.

Their findings confirm what researchers have seen in carefully controlled lab experiments with the fungus, but SF State biologist Vance Vredenburg said the data from wild frogs provide a much better idea of how the disease progresses.

"The mode of death discovered in the lab seems to be what's actually happening in the field," he said, "and it's that understanding that is key to doing something about it in the future."

The study is published online by peer-reviewed journal PLoS ONE and funded through the joint National Science Foundation and National Institutes of Health program, Ecology and Evolution of Infectious Diseases.

At the heart of the new study are blood samples drawn from mountain yellow-legged frogs by Vredenburg, who is an assistant professor of

biology at SF State, and colleagues in 2004, as the chytrid epidemic swept through the basins of the Sierra Nevada range.

"It's really rare to be able to study physiology in the wild like this, at the exact moment of a disease outbreak," said UC Berkeley ecologist Jamie Voyles, the lead author of the study.

Unfortunately, it is a study that can't be duplicated, at least not in the Sierra Nevada. Frog populations there have been devastated by chytrid, declining by 95 percent after the fungus was first detected in 2004.

"It's been really sad to walk around the basins and think, 'wow, they're really all gone,'" Vredenburg said.

The chytrid fungus attacks an amphibian's skin, causing it to become up to 40 times thicker in some instances. Since frogs depend on their skin to absorb water and essential electrolytes like sodium from their environment, Voyles and her colleagues knew that chytrid would disrupt fluid balance in the infected amphibians, but were surprised to find that electrolyte levels were much lower than anticipated for the Sierra Nevada sample.

"It's clear that this fungus has a profound effect in the wild," Voyles said.

"Wildlife diseases can be just as devastating to our health and economy as agricultural and human diseases," says Sam Scheiner, NSF program officer for EEID. "*Bd* has been decimating frog and salamander species worldwide, which may fundamentally disrupt natural systems. This study is an important advance in our understanding of the disease, a first step in finding a way to reduce its effects."

Scientists want to learn as much as they can about how chytrid affects

wild amphibians, with the hope that these findings will lead to better treatments for the infection.

For instance, Voyles said, the new study suggests that individual frogs being treated for the infection might benefit from having electrolyte supplementation in the advanced stages of the disease.

Researchers like Vredenburg already are experimenting with different ways of treating individual frogs, such as applying antifungal therapies or inoculating the frogs with "probiotic" bacteria that produce a compound that kills the fungus.

"The disease is not very hard to treat in the lab with antifungals. We know we can treat animals there," Vredenburg said. "But in nature, the disease is still a moving target."

It is still unclear exactly how chytrid spreads across a region, and which frogs might be susceptible to re-infection after treatment. Earlier this year, Vredenburg and colleagues published a paper showing that a common North American frog might be an important carrier of the infection.

Chytrid has killed off more than 200 amphibian species across the globe, but Voyles said the new studies offer "sort of a glimmer of hope that it might be possible to do something to mitigate the loss of frogs in the field."

More information: dx.plos.org/10.1371/journal.pone.0035374

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