

Issue 114 (April 2015)

ISSN: 1026-0269

eISSN: 1817-3934

FrogLog

www.amphibians.org

Volume 23, number 2

Promoting Conservation, Research and
Education for the World's Amphibians

REGIONAL EDITION: THE AMERICAS

In Memoriam: César
Ramón Molina Rodríguez

Half a Million Dollars
Directed Towards Saving
Amphibians Around the
World

Shape-Shifting “Punk
Rocker” Frog Discovered

Environmental DNA and
Amphibian Monitoring

Recent Publications

And Much More!

FrogLog

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Unexpected Results in Probiotics Study Leads to new Questions for Scientists Seeking to Protect Golden Frogs

By Lindsay Renick Mayer

In the Panamanian Golden Frog Lab at the Smithsonian Conservation Biology Institute, one fact has remained steadfast: there is as much to learn from life as death, from the expected as the unexpected.

SCBI biologist Matt Becker knows this well. For his PhD dissertation at Virginia Tech, Becker took four probiotics—or beneficial bacteria—from frog species in areas of Panama where fungal disease chytridiomycosis was endemic and gave 32 Golden Frogs a probiotics bath before infecting them with *Bd*. In the end, Becker was disappointed to find that the beneficial bacteria didn't successfully stay on the frogs' skin to protect them from *Bd*. And yet somehow, seemingly impossibly, 30 percent of the frogs survived exposure to the disease. Only one Golden Frog in past studies had survived, which left Becker wondering what had happened.

"At first I wasn't even certain that those frogs had actually been infected," Becker says. "You basically take a very concentrated *Bd* stock and put less than a milliliter in a large container of water. But it always works. We had all but two frogs become infected."

The search for what the frogs that cleared infection had in common led Becker to an interesting and unexpected finding. Those frogs, it turned out, did have one thing in common from the start that the frogs that died didn't share: a high abundance of six bacteria completely unrelated to the probiotics Becker had tried. This surprising result is the focus of Becker's current study as a post-doctoral fellow at the Smithsonian Conservation Biology Institute: Did the high abundance of these six bacteria actually protect the individual frogs from the deadly pathogen or was this merely a correlation, while something else was at play? And if these bacteria did save the frogs from otherwise certain death, can researchers figure out how to get these bacteria to stick to the skin of frogs that don't already have that defense?

The next phase of the study will also try to determine why some of the Panamanian Golden Frogs had high abundances of these six bacteria, while others did not, even though they all came from the Maryland Zoo in Baltimore. His most recent work was published in *Proceedings of the Royal Society* in March.

"The findings in this paper are very encouraging," says Reid Harris, director of international disease mitigation for the Amphibian Survival Alliance and co-author on the paper. "If these bacteria do lead to survival, then we have the exciting possibility of adding these bacteria to frogs that lack them, or that have them in low numbers. If these bacteria colonize and persist, then this probiotic solution will allow us to get protected frogs into the wild.

It is exciting to imagine getting a species that is probably extinct in the wild back into nature."

Cori Richards-Zawacki, an assistant professor at Tulane University, is grappling with similar questions, though with a different set of seemingly unlikely survivors. What Richards-Zawacki and fellow researcher Jamie Voyles found in the wild after *Bd* swept through is encouraging. At first they found just a variable harlequin frog (*Atelopus varius*)—the sister species to the Panamanian Golden Frog—here or there at a handful of sites where they were once abundant. Most recently, however, they discovered a population of about 40 frogs at one site and are working to understand how this species is making a small comeback.

"We're looking into whether the pathogen has become less pathogenic, or if the frogs have developed some sort of resistance," Richards-Zawacki says. "This ties really well into what Matt Becker has found, that there seems to be some natural variation in how susceptible individuals are to this disease."

Neither Richards-Zawacki nor Becker are certain that the beneficial bacteria is actually the direct cause of survival, but they're both determined to discover the difference between the survivors and those that succumb to *Bd*. They're looking at the possible role of genetics—both of the frogs and the fungus—in varied responses to the pathogen. They're talking to scientists who are investigating how the frogs' environment can affect individuals' ability to fight off disease. And they're meeting with scientists doing immunology work in search of a potential vaccine.

"I'm definitely hopeful," Richards-Zawacki says. "I'd love to someday see either a re-introduction take place or for us as a community to do everything we can to foster the recovery of the populations that we have."



Dr. Cori Richards-Zawacki searching for Panamanian Golden Frogs at a site in Central Panama where they were once abundant. Photo: Brian Gratwicke.