TENNESSEE BIODIVERSITY PROJECT: Snake Fungal Disease and other wildlife pathogens: what is the cure?

by Gregg Elliott and Don Walker

In Tennessee and other states across the Eastern U.S., Snake Fungal Disease (SFD) is part of a larger pattern of virulent infectious diseases in natural wildlife populations that have been increasing in recent years, leading to significant animal die-offs and even extinctions.

A rattlesnake with Snake Fungal Disease- Dr. Danny Bryan

"SFD is eerily similar to White-nose Syndrome in bats," says Josh Campbell, Wildlife Diversity Coordinator for TWRA, "in the way it has popped up with sudden major effects, beginning in the Northeast. Up north, both Timber and Massasauga Rattlesnakes have been impacted."

Research on wildlife disease treatment begins with basic questions

To better understand, and even eventually treat SFD, a Tennessee Technological University team of researchers under the direction of microbiologist Dr. Walker have been investigating the interaction between snakes' resident skin microflora and the pathogen. The working hypothesis is that specific microflora on snakes' skin produces antifungal and antibacterial compounds, a kind of built-in medicine chest. These friendly microbes may also be protective by outcompeting invading pathogens.

> Not only are "good bacteria" now a well-recognized part of a healthy human gut, they are also a part of the innate immune system of many snake species.

A key question is where does the microbiome come from, mom or the environment? (Some species of snakes are born live, and some receive a degree of parental care after birth or hatching). One of the most recent TTU studies documents how the microbiome on a snake's skin differs significantly from that in the immediate soil or water environment where it was found. Microbiologists found differences in both species composition and patterns of abundance. Ultimately, researchers hope that this research could lead to a form of probiotic designed to treat or prevent SFD infections.

"I would like to believe," says Dr. Walker, "that some probiotics we discover and isolate may be used for treatment, probably as an individual-based program or a captive breeding program. We could possibly treat hibernacula for some of these snakes, but logistically it would be very difficult. Those hiding places are hard to find and even harder to access."

It's more feasible to use this kind of blanket approach to treating White-nose Syndrome in the wild, since people can access caves and treat hibernating bats in large numbers. In fact, scientists may well begin testing this kind of approach using the recently discovered "achilles heel" of the White-nose Syndrome fungus: ultraviolet light.

Why are infections emerging now?

"We have documented that the microbiome changes as a whole when the pathogen is present," says Walker, "but we don't understand why or how. Myriad stresses, such as habitat fragmentation, pollution, and climate change, may all be contributing to snake populations with less resilience or creating a landscape that is allowing the fungal pathogen to become more virulent."

As with White-Nose Syndrome and SFD, honey bee colony collapse disorder (CCD) rose to the attention of beekeepers in America rather suddenly beginning in 2006-07. CCD and the more general global decline of both wild and domestic pollinators (as well as the plants that rely on them) are thought to arise from many problems. The factors that combine and interact to overwhelm these important insects include:

- habitat loss and fragmentation
- agrochemicals
- pathogens
- alien species
- climate change

Top: Little Brown Bat with WNS-US Fish & Wildlife Service. Bottom: Spring peepers, which have declined across the Eastern U.S. due to wetland loss more than Bd-Todd Pierson, Flickr

Probably the most famous of these worldwide wildlife pandemics is the loss of frogs and other amphibians. *Batrachochytrium dendrobatidis*, known as Bd in frogs causes the disease chytridiomycosis. It appears most of the world's 6,000 amphibian species can be infected by Bd, which has been a major cause of devastating amphibian declines and even extinctions around the globe for the past two decades.

In 2015, scientists reported a major breakthrough by successfully eradicating a chytridiomycosis infection from a wild population of toads in Spain. The protocol required treating both infected tadpole larvae and their aquatic environments.

Why did Bd—a lineage of chitrid fungus that is likely thousands of years old—emerge as a worldwide threat to frogs in the 1990s? It's thought that this case cannot be ascribed to a new, virulent strain of the fungus, but rather to something far more familiar: globalization. The vastly expanded mobility of people has in all likelihood allowed the fungus to spread, via trade or accident, to new areas where frogs that have not experienced the disease before.

Similarly, White-nose Syndrome is an introduced pathogen in North America. "The origin of *O. ophiodiicola*, the cause of SFD, is less clear," says Walker. "It is great that TWRA is investing in research to help understand this phenomenon and get a handle on the problem before it becomes huge."

Whether snakes, bats, frogs, or bees—they are all "canaries." Like the proverbial "canary in the coal mine," these beleaguered wildlife populations remind us that we inhabit one world. Humans and wildlife alike are susceptible to the changes that we are causing in our shared environment.