NEWSROOM

Excess levels of nitrogen, phosphorus causing deformed frogs

Finding the 'warm gun'

By Tony Fitzpatrick | September 7, 2004

It's like a scene out of a Stephen King novel, begun in the nineties and continued at a more rapid pace in the oughts: scores of deformed frogs flopping around as best they can, found often near cattle ponds and other wetlands throughout North America.

Deformed frogs such as this one have been found in wetlands in much of North America.

Researchers looked for chemical pollutants or hormonal changes in the frogs as culprits. But recent evidence linked the deformities – missing, extra, or deformed limbs – to the presence of *Ribeiroia ondatrae*, a frog parasite that has been noted in the scientific literature for a century and a half. But no one could explain why the incidence of deformities has increased to upwards of 20 to 30 percent of some frog populations in the 21st century compared with probably less than one percent historically.

Now a collaboration involving ecologists at Washington University in St. Louis and the University of Wisconsin strongly points to farming practices and development, two factors that create a condition called eutrophication in ponds and wetlands. Eutrophication is caused by higher phosphorus and nitrogen (prime components

of agricultural fertilizer) levels in wet ecosystems. Higher levels of these nutrients cause a profound impact on the food web that imperils the frogs' existence.

A warm gun

"What we have is a warm gun, not yet a smoking one," said Jonathan Chase, Ph.D., assistant professor of biology at Washington University in St. Louis. "We have evidence that eutrophication creates a favorable situation for a common snail that thrives on high phosphate and nitrogen levels.

A collaboration involving ecologists at WUSTL and the University of Wisconsin strongly points to farming practices and development, two factors that create a condition called eutrophication in ponds and wetlands, as the cause behind the deformities.

This particular kind of snail, the ramshorn snail, found in pet stores, is the snail needed by a different life stage of the same parasite that causes the deformed frogs. So the snail, frog, and parasite are entangled with each other in a complicated food web."

Chase had previously studied the ecology of food webs in small ponds and the important role of the ramshorn snail in that web. His co-author, Pieter Johnson, a doctoral student in biology at the University of Wisconsin, had studied the role of *Ribeiroria ondatrae* in frog deformities, confirming that deformed frogs were indeed caused by the parasite, and tracing the parasite in the scientific literature to the mid-1800s. Johnson heard Chase at a conference speak on the ramshorn

snail and realized the connection between eutrophication caused by increased nutrients, the snail, and the parasite. The authors published their work in the July 2004 issue of *Ecology Letters*.

Oh, that tangled web. Here's how the two species make a tag team to create deformed frogs. The adult parasite lives in birds, laying its eggs inside the bird; the eggs then get excreted as waste in a pond or wetland; the young parasite has evolved to seek out a ramshorn snail and invades the snail, staying inside for up to 20 days when it sheds out and embeds itself in a tadpole.

Eutrophication is caused by higher phosphorous and nitrogen that create a profound impact on the food web, threatening the frogs' existence.

Inside the tadpole, the parasite finds the developing limb bud where it forms a cyst and sits between the cells that will become the limbs of the frog that the tadpole will turn into. By interfering with the tadpole's limb development, the parasite causes the frog to become deformed, often by making extra or missing limbs. This deformed frog is then prime prey for wading birds, such as herons or egrets, which the parasite needs for sexual reproduction.

As for the snail, it wouldn't be so abundant in these ponds were it not for run off of nitrogen and phosphorus found in agricultural fertilizers and animal waste. The ramshorn snail is bigger than other snails in a pond because it takes advantage of the abundance of nutrients, growing faster than the others and becoming too large for its predators to eat it.

Getting there from here

"A frog flopping around in the mud is a perfect meal for a bird." Chase pointed out. "The parasite has evolved to find a snail for a temporary host and then a tadpole, which creates a deformed frog bearing the parasite, a sitting duck for a bird."

In their paper, Johnson and Chase show the links between phosphorus, snail biomass, the number of amphibians with the parasite, the number of parasites and how likely it is that the frogs will be deformed. They combined data from their studies of ponds in several Midwestern and Western States. In an ongoing experiment started in the spring of 2004, Chase thinks they'll nab the 'smoking gun.'

Jonathan Chase

He and Johnson poured phosphorus and nitrogen into experimental ponds in Wisconsin and will see if they get a higher incidence of ramshorn snails, the parasites, and deformed frogs, compared to experimental ponds without those nutrients.

Johnson and Chase's finding adds to the growing list of wrongs human activities have visited upon frogs. Studies have shown that certain pesticides cause frogs and toads to become hermaphrodites, impairing reproduction. Others have shown that the depletion of the ozone layer, caused by industrial pollutants, exposes frogs and frog eggs to excessive ultraviolet radiation, which can slow growth rates, damage the immune system and create other bodily malformations.

"We're showing that humans have probably created more deformed frogs through eutrophication by way of a series of complex interactions in the pond food web," Chase said. "Add habitat destruction to all of these other concerns and there's no question that humans are messing up frogs left and right."