Early exposure to insecticides gives amphibians higher tolerance later

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Amphibians exposed to insecticides early in life—even those not yet hatched—have a higher tolerance to those same insecticides later in life, according to a recent University of Pittsburgh study.

Published in *Evolutionary Applications*, the Pitt study found that wood frog populations residing farther from agricultural fields are not very tolerant to a particular type of insecticide, but they can become more tolerant with early exposure.

"This is the first study to show that tadpole tolerance to insecticides can be influenced by exposure to insecticides extremely early on in life—in this case, as early as the embryonic stage," said study principal investigator Rick Relyea, Pitt professor of biological sciences within the Kenneth P. Dietrich School of Arts and Sciences and director of the University's Pymatuning Laboratory of Ecology.

"Amphibian populations are declining worldwide, and pesticides and insecticides are one hypothesized cause," said Jessica Hua, lead author of the paper and a PhD candidate studying biological sciences in Relyea's laboratory. "So this discovery has promising implications for the persistence of amphibian populations."

The Pitt team—which also included Nathan Morehouse, Pitt assistant professor of biological sciences—examined three potential factors that might allow larval wood frogs to have a high tolerance to the insecticide: the concentration of the initial insecticide exposure, the timing of the

exposure, and the population's history of exposure. They chose to work with carbaryl, a popular household insecticide that also is used for malaria prevention.

The researchers conducted experiments with both embryos and hatchlings that were collected as newly laid eggs from four Pennsylvania ponds—two near agricultural fields and two farther away. Both embryos and hatchlings from all four environs were first exposed to a low, nonlethal concentration of the insecticide. Later, they exposed the same individuals to a lethal concentration of the insecticide at the tadpole stage and measured the tadpoles' mortality rates over the course of several weeks.

Next, the team wanted to observe whether insecticide tolerance played a role in the frogs' acetylcholinesterase (AChE), a key enzyme in the nervous system of animals. Carbaryl is known to bind itself to this AChE enzyme in frogs, causing their nervous systems to slow. The Pitt team measured the concentration of total tadpole AChE in a sample of tadpole bodies, finding that low exposure levels of carbaryl stimulated the tadpoles to produce greater amounts of the enzyme—making them more tolerant to the insecticide later in life.

The team is now examining whether exposure to an insecticide early in life can make amphibians more tolerant to other insecticides.

"In other words, we are asking if a tolerance to one insecticide can convey cross tolerance to other insecticides that affect the nervous system similarly," said Hua.

More information: The paper, "Pesticide Tolerance in Amphibians: Induced Tolerance in Susceptible Populations, Constitutive Tolerance in Tolerant Populations," first appeared online in *Evolutionary Applications*.

Provided by University of Pittsburgh