Amphibians living close to farm fields are more resistant to common insecticides

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Amphibian populations living close to agricultural fields have become more resistant to a common insecticide and are actually resistant to multiple common insecticides, according to two recent studies conducted at the University of Pittsburgh.

In a study published today in *Evolutionary Applications*, the Pitt researchers demonstrate, for the first time, that tadpoles from populations close to farm fields are more resistant to chlorpyrifos—one of the most commonly applied insecticides in the world, often sold as "Dursban" or "Lorsban." In addition, a related study published in February shows that tadpoles resistant to chlorpyrifos are also resistant to other insecticides.

"While we've made a lot of progress in understanding the ecological consequences to animals that are unintentionally exposed to insecticides, the evolutionary consequences are poorly understood," said study principal investigator Rick Relyea, Pitt professor of biological sciences and director of the University's Pymatuning Laboratory of Ecology. "Our study is the first to explore how amphibian populations might evolve to be resistant to insecticides when they live in places that have been sprayed for many years."

The Pitt researchers used newly hatched tadpoles collected from nine populations of wood frogs living at different distances from agricultural fields. They tested the frogs' resistance when exposed to chlorpyrifos, which is used against insects, and Roundup Original MAX®, which is a common herbicide used against weeds.

Relyea and his Pitt collaborators exposed the tadpoles from each of the nine populations to environments containing either no pesticides, chlorpyrifos, or Roundup®. After 48 hours, they measured how well the populations survived.

"Wood frogs living close to agricultural land were more likely to have been exposed to pesticides for many generations compared to those living far from agriculture; the latter frog populations likely experienced little or no exposure to pesticides," said Rickey Cothran, the lead author of the study and a postdoctoral researcher in Relyea's lab. "Although populations differed in their resistance to Roundup®, populations closer to fields were not more resistant to the herbicide."

"Because chlorpyrifos kills in a way that is similar to many other insecticides, higher resistance may have been favored each time any insecticide was sprayed," said Pitt alumnus Jenise Brown (A&S '09), a coauthor of the study and a former undergraduate researcher in Relyea's lab. "In contrast, herbicides have a variety of ways that they kill organisms, which may make it harder for animals to be resistant when exposed to different herbicides over many years."

In a related study, published online Feb. 21 in *Environmental Toxicology and Chemistry*, Relyea's Pitt research team examined whether wood frog populations that were resistant to chlorpyrifos might also be resistant to other insecticides. This phenomenon, said Relyea, happens commonly in pest species when farmers switch pesticides from year to year, but little is known about how this switching of pesticides affects amphibians.

Using three commonly applied pesticides that have similar chemical properties— chlorpyrifos, carbaryl, and malathion—the Pitt researchers exposed 15 populations of wood frog tadpoles to high concentrations of each insecticide. They found that wood frog populations with resistance to one insecticide also had resistance to the other insecticides.

"This has a beneficial outcome," said Jessica Hua, the lead author of the second study and a graduate student in Relyea's lab. "While it doesn't mean that pesticides are beneficial to amphibians, our work does suggest that amphibians can evolve to resist a variety of pesticides and therefore improve their survival."

As they hypothesized in the study published today, the researchers suspect that the reason for this cross-resistance is that chlorpyrifos kills in a way that is similar to many other insecticides. Thus, evolving higher resistance to one insecticide may provide higher resistance to others.

"This finding may buffer an amphibian population from suffering the consequences of exposures to new, but similar-acting chemicals," said Aaron Stoler, a coauthor of the second paper and a graduate student in Relyea's lab.

In the future, Relyea and his team plan to study the genetic mechanisms that underlie increased resistance in amphibians and determine whether increased resistance occurs in additional animal species that are not the targets of pesticides.

The article published today in *Evolutionary Applications* is titled "Proximity to agriculture is correlated with pesticide tolerance: Evidence for the evolution of amphibian resistance to modern pesticides." The article published Feb. 21 in *Environmental Toxicology and Chemistry* is titled "Cross-tolerance in amphibians: Wood frog mortality when exposed to three insecticides with a common mode of action."

Provided by University of Pittsburgh