Pesticides: Research provides new insights into their effects on shrimps and snails

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Ground breaking research by an international team of scientists has resulted in greater understanding of the effects of pesticides on aquatic invertebrates such as shrimps and snails.

Research published in the journal *Environmental Science & Technology* by a team of scientists from the UK, Switzerland and Finland provides an important new approach for systematically measuring and modelling the sensitivity of aquatic invertebrates to various pesticides.

Aquatic invertebrate species are abundant in European freshwaters and play an important role in the decomposition of organic material, as well as serving as a food source for other higher level species.

However, the almost 7,000 species living in European waters are currently facing a major challenge due to exposure to a variety of pesticides entering surface waters after application due to spray drift, leaching or run-off from fields. At the same time, farmers need better pesticides to grow food, while pesticide manufacturers aim to design effective pesticides without unacceptable side effects based on our understanding of pesticide effects in nature.

Previous research has shown that aquatic invertebrate species do not respond to pollution similarly, with a large variation in sensitivity among organisms. Not only do species vary substantially in their sensitivities to a given toxicant, but a given species can vary greatly in its sensitivity across toxicants.

The new research was carried out at Eawag - the Swiss Federal Institute of Aquatic Science and Technology, and the Swiss Federal Institute of Technology Zürich (ETHZ) in collaboration with Harlan Laboratories in Switzerland. It involved researchers now working at the University of York, the Helmholtz Centre for Environmental Research, the University of Eastern Finland, and the Swiss Federal Institute of Technology Lausanne, Switzerland.

As part of the new approach, the researchers stress the importance of toxicokinetics – biotransformation and distribution of the toxicants – as a means of explaining the variation in sensitivity to chemicals.

Principal Investigator Dr Roman Ashauer, an Anniversary Lecturer with the University of York's Environment Department, who formerly worked at Eawag, said: "We produced images of the pesticide distribution within the shrimps and snails to better understand which organs are at risk. It turns out that for some pesticides the distribution in the body matters a lot, whereas for other pesticides it is the organism's ability to detoxify.

"Our study introduces a systematic way of understanding the differences between species' reactions to pesticides. As there are so many species in our waters we need a systematic understanding. In the end it is all about developing effective, modern pesticides. We need to better understand species' differences, because we want to kill the pests, but not all the other species in our environment."

The research team looked at the effects of three pesticides - diazinon, imidacloprid and propiconazole - on the aquatic invertebrates *Gammarus pulex* (freshwater shrimp), *Gammarus fossarum* (freshwater shrimp) and *Lymnaea stagnalis* (pond snail).

Corresponding author Dr Anna-Maija Nyman, now working at the

University of Eastern Finland, said: "When we think about pesticides and how to kill the pests without harming other organisms, we have to start with mechanisms of toxic action. Diazinon and imidacloprid, for example, are neurotoxic insecticides, which are designed to kill pest insects. Toxicity of these neurotoxicants does vary a lot among species – in our study, the shrimps turned out to be much more sensitive than the pond snail.

"But what makes some species more at risk than others? Is it the differences in the nervous system and the target receptors? We cannot answer these questions before linking the effects first to chemical concentrations in the tissues where the target receptors are present. Earlier studies have investigated interspecies variation mainly based on exposure concentrations. We were surprised how much the difference in accumulation in the target tissues could explain the interspecies variation in sensitivity and how little the variation is therefore due to the differences in the target receptors themselves."

Professor Kristin Schirmer, from Eawag and the Swiss Technical Universities in Lausanne and Zürich, said: "I am fascinated about the possibility of using imaging methods developed for mice and rats to see what is going on inside a shrimp or a snail. I am convinced that imaging the chemical distribution inside aquatic species in general holds great promise to better understand their sensitivity to pesticides and other chemicals."

More information: The article 'Importance of toxicokinetics for interspecies variation in sensitivity to chemicals' is published online in the journal *Environmental Science & Technology* at pubs.acs.org/doi/abs/10.1021/es5005126

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