New research shows how different strains of bed bugs resist insecticides

April 21 2016

Bed bug, *Cimex lectularius*. Credit: Stephen Doggett.

There are many reasons why bed bugs have made a comeback in recent decades, and their resistance to commonly used insecticides is one of the most widely accepted explanations.

In a new paper published in the *Journal of Economic Entomology*, scientists from the University of Sydney and NSW Health Pathology describe how bed bugs are able to resist pyrethroid insecticides via metabolic detoxification, the process by which bed bugs break down insecticides.

The researchers focused on two types of detoxification enzymes, which are broadly known as esterases and oxidases. These two types of enzymes change the chemical composition of insecticides so that they're less harmful to the insect.

To understand which enzyme type might be responsible for resistance to commonly used insecticides, chemicals called synergists can be used. Synergists can inhibit or lower the levels of detoxifying enzymes, thereby increasing the toxicity of the insecticide. By using different types of synergists, it is possible to determine which enzymes may be present.

One of the most widely used synergists is a chemical called piperonyl butoxide (or PBO), which can inhibit both esterases and oxidases, but that ability in turn makes it hard to determine which enzyme type is contributing to the resistance.

However, a new synergist known as EN16/5-1 only inhibits oxidases, and not esterases, so it provides an opportunity to investigate the role of metabolic resistance and to determine which enzyme type may be responsible for resistance.

"What we set out to do was to determine the biological processes by which bed bugs were becoming resistant to insecticides," said David Lilly, a PhD candidate at the University of Sydney and lead author on the study. "We knew our bed bugs were highly resistant and that metabolic detoxification was almost certainly involved, but in using PBO

we didn't know which type of enzymes might be involved. The development of EN16/5-1 was the solution we were looking for."

The researchers exposed bed bugs to six different treatment categories. These categories included a combination of insecticide and synergist, as well as controls without insecticides. The mortality of more than 200 individual bed bugs that were exposed to these treatment categories was observed and recorded.

Analysis demonstrated that the presence of both PBO and EN16/5-1 greatly improved the effectiveness of the insecticide for many bed bug strains. However, for some strains, the addition of EN16/5-1 resulted in little improved mortality compared with the PBO, demonstrating for the first time that different strains have different metabolic enzymes—some have oxidases, some esterases, and some both.

The results of this study may have important implications for bed bug control in the future, according to co-author Stephen Doggett.

"The findings of this research are particularly important, as metabolic resistance is often known to confer 'cross resistance,' whereby resistance to one chemical group can result in resistance to a whole range of different insecticides, which limits what we can use now and even in the future for controlling bed bugs," he said. "This emphasizes the need for an integrated approach to bed bug control using all of the available tools, both chemical and non-chemical."

More information: David G. Lilly et al, Evidence for Metabolic Pyrethroid Resistance in the Common Bed Bug (Hemiptera: Cimicidae), *Journal of Economic Entomology* (2016). DOI: 10.1093/jee/tow041

Provided by Entomological Society of America