

Plants defend against insects by inducing 'leaky gut syndrome'

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Fall armyworms are pests of corn plants. Credit: Nick Sloff, Penn State

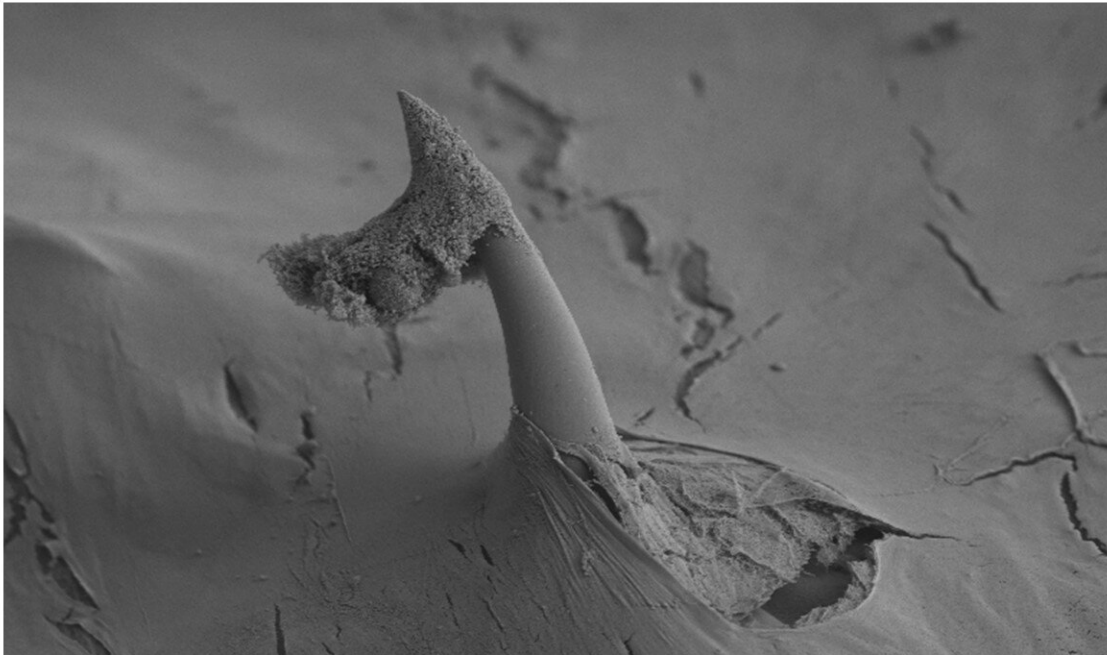
Plants may induce "leaky gut syndrome"—permeability of the gut lining—in insects as part of a multipronged strategy for protecting themselves from being eaten, according to researchers at Penn State. By

improving our understanding of plant defenses, the findings could contribute to the development of new pest control methods.

"We found that a combination of physical and [chemical defenses](#) in corn [plants](#) can disrupt the protective gut barriers of fall armyworms, creating opportunities for [gut microbes](#) to invade their body cavities," said Charles Mason, postdoctoral scholar in entomology. "This can cause septicemia, which can kill the insect, or simply trigger an [immune response](#), which can weaken the insect."

The researchers reared fall armyworms in the laboratory and inoculated them with one of three types of naturally occurring gut bacteria. They fed the insects on one of three types of maize—one that is known to express enzymes that produce perforations in insect gut linings; one that is characterized by numerous elongated trichomes, or fine hairs that occur on the surface of the plant and help defend against herbivores; and one that has just a few short trichomes. The team used scanning [electron microscopy](#) to evaluate the impacts of the various bacteria and maize types on the integrity of the fall armyworms' gut linings.

The scientists found that the presence of all three types of gut bacteria decreased the ability of fall armyworm larvae to damage maize plants, especially when other defenses—such as elongated trichomes and enzymes, both of which can perforate gut linings—were present. However, the species of [gut bacteria](#) varied in the extent to which they weakened the insects. The results will appear in the July 22 issue of *Proceedings of the National Academy of Sciences*.



Trichomes, or fine hairs that occur on the surface of the plant, can tear through insects' gut linings. Credit: Charles Mason, Penn State

"Our results reveal a mechanism by which some plants use [insects' gut microbiota](#) against them in collaboration with their own defenses," said Mason.

Gary Felton, professor and head of the Department of Entomology, noted that the results should have broad significance towards understanding the ecological function of plant defenses.

"In the context of our study, disparate plant defenses, such as leaf trichomes and plant enzymes, all require certain gut microbes for their optimal defense against herbivores," he said. "Our results predict that the variation in the effectiveness of plant defenses in nature may be, in significant part, due to the variability observed in the microbial

communities of insect guts."



A perforation in the gut lining of a fall armyworm. Credit: Charles Mason, Penn State

The team said the results could help to inform the development of insect-resistant crops.

"It may be advantageous to 'stack' plant defenses that target the insect gut in order to create a 'leaky gut' that exposes the insect to microbial assaults on their immune system," said Mason.

More information: Charles J. Mason et al., "Plant defenses interact with insect enteric bacteria by initiating a leaky gut syndrome," *PNAS* (2019). www.pnas.org/cgi/doi/10.1073/pnas.1908748116

Provided by Pennsylvania State University

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