

The betrayal of the aphids

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This photo shows aphids feeding on leaves. Credit: Scott Edwards, UC Riverside

Aphids are devastating insect pests and cause great losses to agriculture worldwide. These sap-feeding plant pests harbor in their body cavity bacteria, which are essential for the aphids' fecundity and survival. *Buchnera*, the bacterium, benefits also because it cannot grow outside

the aphid. This mutually beneficial relationship is sabotaged, however, by the bacterium which proceeds to betray the aphid, a research team led by scientists at the University of California, Riverside has found.

"Although this betrayal is unintentional, it nevertheless alerts the plant about the [aphid](#)'s presence and the aphids are unable to reproduce in large numbers," said Isgouhi Kaloshian, a professor of nematology, who led the research project. "A protein from the bacterium, found in the aphid saliva and likely delivered inside the plant host by the aphid, triggers plant immune responses against the aphid. It seems that the plant immune system targets the bacterium and exploits the strict mutual dependency between the plant and aphid to recognize the aphid as the intruder."

Study results appear online this week in the *Proceedings of the National Academy of Sciences*.

While feeding, aphids secrete saliva in the plant. To identify the protein composition of the aphid saliva, the researchers collected saliva from more than 100,000 aphids. Using mass spectrometry, they detected 105 proteins. They discovered these proteins were of both aphid and *Buchnera* origins. One of these *Buchnera* proteins, GroEL, was found to induce immune responses in plants.



This photo shows aphids feeding on a stem. Credit: Scott Edwards, UC Riverside.

"GroEL was known previously to trigger immunity in animals," said Kaloshian, a member of UC Riverside's Institute for Integrative Genome Biology. "However, our finding that it induces immunity in plants is new. Since most aphids harbor *Buchnera*, and likely have GroEL in their saliva, this bacterial protein may generally alert plants of the presence of aphids. How it is recognized by plants is still unknown. GroEL can now be exploited to engineer durable resistance of crops against aphids."

According to the researchers, since *Buchnera*-related bacteria are present in a number of insects (other than aphids), their findings are likely to be broadly applicable to other arthropods. GroEL and additional proteins from insect bacteria probably are delivered to plants through insect saliva and contribute to shaping plant-insect interactions.

"Strikingly, the majority of the aphid salivary proteins predicted for secretion were of unknown function and different from those typically secreted by microbes into [plants](#)," Kaloshian said. "However, these aphid

salivary proteins, too, serve similar purposes in manipulating plant metabolism. Thus, aphids and microbes seem to have evolved different molecular solutions to achieve the same goals."

Currently, Kaloshian's lab is working on identifying the plant receptor for GroEL that initiates the plant immune response. Her team is also functionally characterizing the aphid salivary proteins with no known function to identify their roles.

"We would like to understand how these proteins are able to modulate host metabolism and identify their host targets," she said.

She was joined in the research by Ritu Chaudhary (first author of the research paper) and Hagop S. Atamian at UC Riverside; and Zhouxin Shen and Steven P. Briggs at UC San Diego. Shen and Briggs performed the [mass spectrometry](#). The researchers used the model plant *Arabidopsis* in their experiments with the aphids.

More information: GroEL from the endosymbiont *Buchnera aphidicola* betrays the aphid by triggering plant defense , *PNAS*, 2014.
www.pnas.org/cgi/doi/10.1073/pnas.1407687111

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