

Three-Way Symbiosis Supplies Insect Pest With Well-Rounded Diet

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The glassy-winged sharpshooter obtains a well-rounded diet by playing nice with two bacteria species that live inside the insect's cells.

Researchers figured out the sharpshooter's nutritional secrets by analyzing the genes of the insect's symbiotic bacteria, internal hitchhikers the insect cannot live without.

The research is the first genomic analysis of an obligatory symbiotic relationship that has multiple partners.

The glassy-winged sharpshooter transmits Pierce's disease, a bacterial pathogen which is threatening California's vineyards. A few of the insects were found in the Sierra Vista, Ariz. area in 2005.

Plant-sucking insects such as sharpshooters can transmit disease as they suck the sap from plants. Knowing the genetic background of the insect's symbionts could lead to new ways to thwart the transmission of such plant diseases.

"The glassy-winged sharpshooter is one of the most important invasive insect pests in the world," said co-author Nancy A. Moran, a Regents' Professor of ecology and evolutionary biology at The University of Arizona in Tucson and a member of UA's BIO5 Institute. "This insect is really large and flies a long way, so it's a very good disease vector."

Moran and her colleagues' research article, "Metabolic complementarity and genomics of the dual bacteria symbiosis of sharpshooters," is in the June 2006 issue of the *Public Library of Science Biology*. A complete list of authors is at the end of this release. The research was funded by a National Science Foundation grant to Moran.

Many insects, such as aphids and cicadas, feed on the sap from pipes that transport water and food within a plant. These sap-feeders are often known

to rely on resident bacteria for a balanced diet – especially the synthesis of the essential amino acids that all animals, including humans, cannot make for themselves.

Some of the sap-feeders tap into a sugar-rich type of sap known as phloem. In contrast, the glassy-winged sharpshooter, *Homalodisca coagulata*, taps into xylem, a sap only slightly more nutritious than flavored water.

"My initial interest in sharpshooter symbiosis was in the hope that we could find out exactly how xylem can be used as food," said Moran, an expert in the co-evolution of insects and their resident bacteria known as endosymbionts. "It's terribly poor in nutrients."

The researchers decided to figure out what nutritional goodies the sharpshooter's endosymbionts produced to supplement the water and minerals and other nutrients supplied by the xylem. To do so, researchers in Moran's lab isolated bacterial DNA from sharpshooters.

Moran recruited Jonathan Eisen of The Institute for Genomic Research (TIGR), now at the University of California, Davis, to conduct the painstaking forensic type of DNA analysis known as "metagenomics." Such analyses sequence the DNA for an organism's entire set of genes, known as the genome, and reveals what kinds of materials those genes can produce.

The team assumed that sharpshooters carried *Baumannia cicadellinicola*, a known endosymbiont of sharpshooters. But the analysis of genes for that bacterium revealed vitamins-making capabilities, but no genes to direct the manufacture of essential amino acids.

The researchers, wondering if some other bacteria were also present, looked back at their DNA analyses. Some of the DNA matched neither the

insect nor the endosymbiont *Baumannia cicadellinicola*. Reviewing those bits of DNA turned up genes from another bacterium, *Sulcia mulleri*.

The genes from the second bacterium coded for essential amino acids.

Eisen said, "When doing this type of forensic metagenomics, some scientists suggest you can just analyze the whole system as one unit—a so-called 'black-box' approach--without knowing which piece of DNA came from which organism."

He added, "But this black-box ecology just does not work well. To really understand the system, you've got to assign the different bits of DNA to organisms. This study shows why."

The sharpshooter and the two bacteria depend on a three-way interaction. The sharpshooter channels some of the xylem's nutrients to the bacteria, which in turn feed the insect vitamins, cofactors and essential amino acids. In addition, the two bacterial species probably supply each other with needed nutrients.

The bacteria species, which live within the insect in a specialized structure called a bacteriome, are passed down from mother to daughter in the egg.

Moran said, "It's a three-way partnership. Each of the three organisms is essential to the whole."

The information in this release was prepared by Mari N. Jensen, with additional information from The Institute for Genomics Research.

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