

Insects hijack reproductive genes of grape vines to create their own living space on plant

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The researchers studying how insects control grape vines are, from left, Dr. Melanie Body, postdoctoral associate; Dr. Jack Schultz, senior executive director for research development; and Dr. Heidi Appel, dean of the Jesup Scott Honors College and professor in the Department of Environmental Sciences. Credit: Dan Miller, The University of Toledo

A team of scientists at The University of Toledo reports new details about the intimate relationship between insects and plants, opening the door to new possibilities in protecting grape crops worldwide from a major agricultural pest.

The biologists discovered that an insect that nearly wiped out [wine production](#) at the end of the 19th century in France, the grape phylloxera, hijacks a grape vine's reproductive programs to create a leaf gall, which it uses as a pseudo apartment for the parasite to siphon off the plant's nutrients. The research is published in the latest issue of *Scientific Reports*.

A gall is a plant organ a little smaller than a marble that can resemble a wart, flower or fruit, and provides insects with a protected place to feed and reproduce. "When galls form on a leaf, the flower genes are on. They shouldn't be activated, but the insect is manipulatively inserting its own signals into the pathway to get a flower-like result," said Dr. Heidi Appel, dean of the Jesup Scott Honors College at The University of Toledo and professor in the Department of Environmental Sciences.

The insect lays an egg and starts the process to exploit the plant's reproductive genetic machinery, directing the plant to create these structures. Appel and Dr. Jack Schultz, senior executive director for research development at the University of Toledo, said Charles Darwin guessed at the idea in 1867, when he observed that the interior of a gall bears a certain degree of resemblance to the inside of a peach.



Phylloxera galls on the leaf of a grape vine. Credit: Dr. Melanie Body, The University of Toledo

"We examined Darwin's hypothesis and found the insect forces the plant to use the same genes to make a gall that the plant uses to make a flower or fruit," Schultz said. "The plant produces the central part of a flower known as the carpel in a place the plant would never produce one on its own."

"In each case as we genetically held up a mirror to see the differences in the plant at each stage of galling, an insect injected some kind of signal into the plant," Appel said. "The signal took over the plant's development and told the plant to make a gall on a leaf instead of normal plant tissue."

Galls damage grape vines by draining resources and getting in the way of photosynthesis, resulting in lower yields. By identifying the genes in grape vines that have to be activated for an insect to produce a gall, scientists can next find a way to block the insect from attacking the plant.

"While North American [grape](#) vines have developed the ability to resist phylloxera, one option is to cross breed plants to be genetically resistant," Schultz said. "Another option is to create a biologically based pesticide to spray on [grape vines](#) to manipulate the hormones in [plants](#) to be active at different times."



Insects have set up house in phylloxera galls on this leaf. This cross-section of a gall taken with a stereomicroscope shows an insect mom -- the orange ball in the center -- surrounded by eggs she laid -- the surrounding yellow ovals. Credit: Dr. Melanie Body, The University of Toledo

More information: Jack C. Schultz et al, A galling insect activates plant reproductive programs during gall development, *Scientific Reports* (2019). [DOI: 10.1038/s41598-018-38475-6](https://doi.org/10.1038/s41598-018-38475-6)

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