New research could lead to no scent, no sex for the Japanese beetle

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Walter Leal with Japanese beetles. Credit: Kathy Keatley Garvey

No scent. No sex. If a male Japanese beetle is unable to detect the sex pheromone released by a female, he won't be able to locate her and reproduce.

That's the gist behind chemical ecology research at the University of California, Davis published this week in the *Proceedings of the National Academy of Sciences.*

UC Davis chemical ecologists, led by Walter Leal, have isolated,

identified, cloned and expressed a pheromone-degrading enzyme in the Japanese beetle that could lead to important applications in controlling the invasive pest that has threatened U.S. agriculture since 1916. Damages in the larval and adult stages cost more than $450 million annually in the United States, according to the USDA.

The research, aimed at exploring new frontiers in pest control and funded by the USDA's National Research Initiative and the National Science Foundation, probes the male Japanese beetle's sophisticated sense of smell and how it distinguishes between two sex pheromones. An insect detect smells on sensilla in its antennae.

In the Japanese beetle, two olfactory receptor neurons (ORNs) housed in the same structure of the antenna, the sensilla placodea, are highly sensitive, said Leal, a professor of entomology at UC Davis. One detects the pheromone, R-japonilure, emitted by a female of the same species. The other, S-japonilure, tunes into a female of the closely related Osaka beetle. Both beetles are native to Japan and share the same habitat.

The S-japonilure serves as a behavioral antagonist or a stop signal. "If the Japanese beetle smells the other species, it shuts down," Leal said. "It's like a stop sign, the pheromone being green and the behavioral antagonist, red."

Previous studies by the Leal group showed that the Japanese beetle uses an enzyme or protein in its antenna to inactivate pheromone by degrading the compound. Leal and his postdoctoral researcher Yuko Ishida isolated that enzyme, PjapPDE, from more than 100,000 antennae.

The UC Davis study shows how the enzyme, PjapPDE, interacts with the pheromones. "We've found that it degrades the pheromones more rapidly," Leal said. "Kinetic studies indicate that PjapPDE is involved in

the fast inactivation of the pheromone, R-japonilure, and slower degradation of the behavioral antagonist."

Leal's goal is to find ways and means to slow down pheromone degradation by inactivating the enzyme, and "cause males to be unable to detect the pheromone and find females."

What's unusual about Japanese beetle's pheromone: The chemical molecules are "mirror images" that can take either a left-handed or right-handed form, Leal said. "If you look in the mirror, they mirror each other. The one on the right looks like the one on the left, the pheromone being a green signal, and the behavioral antagonist, a red signal."

Their findings could lead to better pest control methods, scientists agree. First detected in the United States in 1916, the Japanese beetle was initially found in a nursery near Riverton, N.J. It has now infested some 29 states east of the Mississippi River and is spreading west. Isolated infestations have popped up in California, Wisconsin and Oregon.

In its larval stages, the beetle is considered the most widespread turfgrass pest in the United States. The adult, about one-fourth-inch long with a shiny metallic green body and bronze-colored wings, feeds on foliage and fruits of several hundred species of fruit trees, ornamental trees, shrubs, vines, and field and vegetable crops, including apples, plums, apricots, cherries, peaches, grapes, roses, soybeans, Japanese maples and crape myrtles. Adult damage commonly appears as skeletonized leaves and larval damage as dry spots on lawns, golf courses and in pastures.

Leal worries that if the pest gains a foothold in California, it could be the next Mediterranean fruit fly or light brown apple moth. State agricultural officials have found hundreds of hitchhiking Japanese beetles at airports. "Unfortunately, California would provide a favorable climate and abundant food supply for the Japanese beetle," Leal said.

Source: University of California - Davis