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Proactive IPM of the Big Avocado Seed Weevil, *Heilipus lauri* (Coleoptera: Curculionidae)

Aeration chambers in quarantine set up to capture H. lauri aggregation pheromones.

Avocados, an iconic specialty crop grown in California, are native to parts of México, and Central and South America, where associated native insect biodiversity is high. In contrast, the biodiversity of the arthropod fauna associated with avocados in California is low, consisting primarily of about four invasive pest species of insects (red banded whitefly, avocado thrips, and avocado lace bug) and mites (persea mite) that primarily feed on leaves (Hoddle 2006).

Currently, California-grown avocados are free from specialist fruit feeding pests such as seed feeding weevils (e.g., *Heilipus lauri*) and moths (e.g., *Stenoma catenifer*). Establishment of these fruit feeding pests in California would cause significant disruption and threaten the long term economic viability of this industry (Hoddle 2006). The avocado seed moth, *S. catenifer*, was the subject of a proactive Integrated Pest Management project sponsored by the California Avocado Commission. This multi-year project, run primarily in Guatemala and Peru, resulted in identification of this moth's sex pheromone, optimization of its field use (Hoddle et al. 2011), and development of natural enemy inventories and life table quantification of their impacts (Hoddle and Hoddle 2008; 2012). Similar work is needed for the big avocado seed weevil, *Heilipus lauri*. This weevil is an avocado specialist native to México and it is considered to be one of the most damaging pests associated with cultivated avocados (e.g., Hass and Fuerte) in Mexico and Colombia where it is an invasive pest (Caicedo et al. 2010; Castañeda-Vildózola, et al. 2017; Luna et al. 2017; Vallejo et al. 2014). Around 60% of Hass fruit have been reported as being damaged by *H. lauri* in unmanaged orchards in Morelos, México (Medina 2005), while in Colombia, damage levels in managed Hass orchards average 4-8% (Caicedo et al. 2010).

Adult *H. lauri* feed on leaves and young stems but don't reproduce on these structures. Female seed feeding weevils lay eggs inside holes they drill into fruit using their long beak-like snout or rostrum. Larvae that hatch from eggs bore through the fruit pulp to the seed. Upon reaching the seed, larvae burrow into the seed to feed causing significant internal damage. Mature weevil larvae pupate in the damaged seed then later emerge as adult weevils. Internal feeding by larvae damages fruit, making

Aeration chamber with adult male and female H. lauri and immature avocado fruit that are supplied as food.

it unmarketable, and in some instances heavy damage causes fruit to drop prematurely. Chemical control is difficult because larvae are protected from insecticides within the fruit (Caicedo et al. 2010).

Consequently, *H. lauri* is listed by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service as an avocado pest of high concern for countries that export avocado fruit (i.e., Hass) to the USA from areas where avocados and *H. lauri* is native (e.g., México) or invasive (e.g., Colombia).

Initiating a Proactive IPM Program Targeting Heilipus lauri

To get ahead of a potentially serious problem, a "Proactive IPM" project was initiated targeting *H. lauri* in advance of its possible accidental introduction into California. Funding for this project came from the California Department of Food and Agriculture's Office of Environmental Farming and Innovation and the California Avocado Commission. This project is a collaborative effort with Dr. Armado Equihua-Martínez and Dr. Edith Estrada-Venegas from Colegio de Posgraduados, Posgrado en Fitosanidad, Entomología y Acarología, in Montecillo, Texcoco, in México

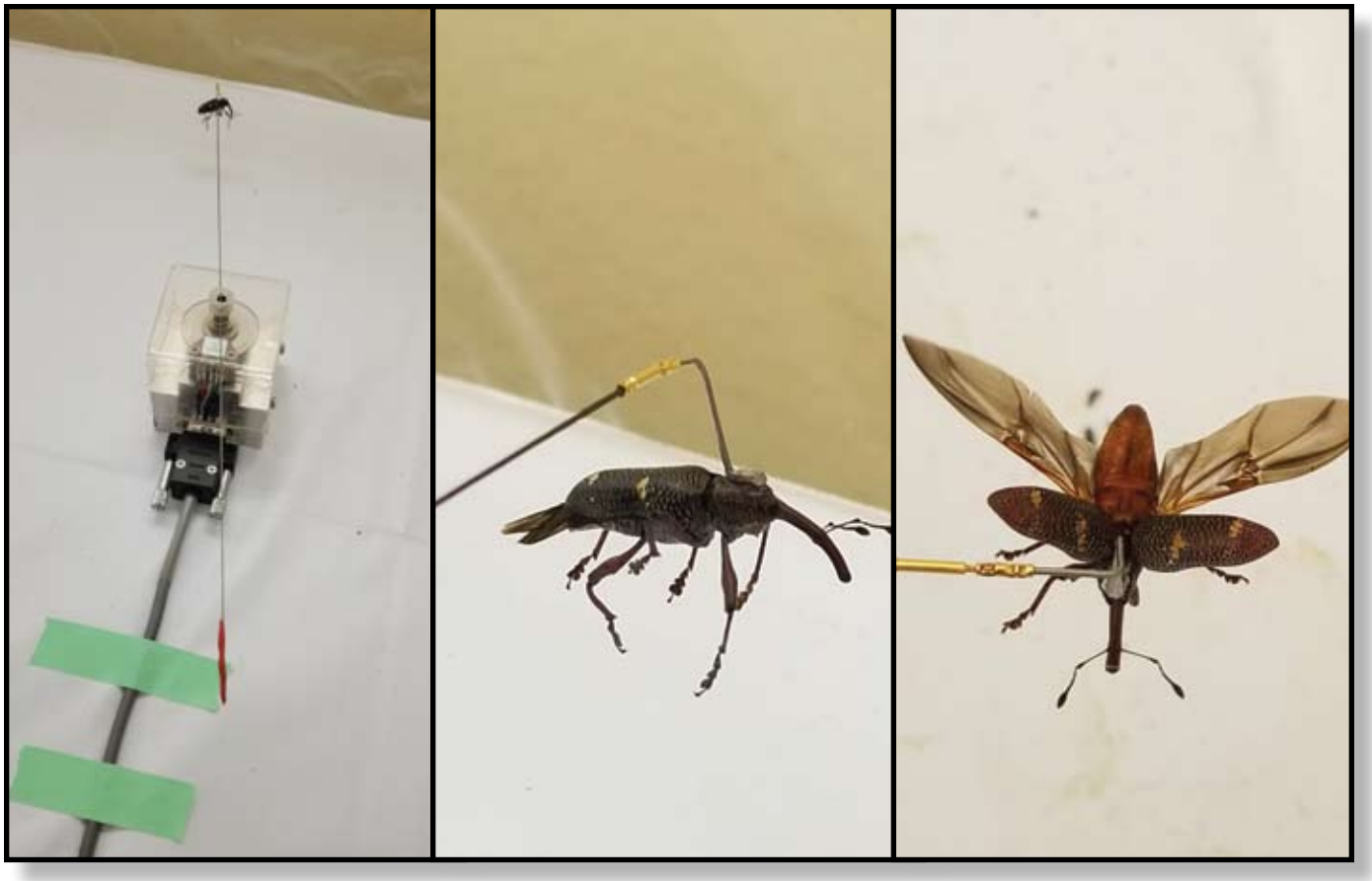
The Proactive IPM project has the following objectives:

1) Identify the putative aggregation pheromone of *H. lauri* so it can be used in monitoring and control programs.

2) Survey *H. lauri* eggs, larvae, and pupae in México for natural enemies that could potentially be used in a future biocontrol program should this pest establish in California.

3) Quantify the distances adult male and female weevils can fly using flight mills. These data could be very useful for establishing monitoring or quarantine boundaries should *H. lauri* be detected in California.

In February 2020, field collections of *H. lauri* were made in México with Dr. Equihua-Martínez and Dr. Estrada-Venegas, and their Ph.D. student, Valentina Diaz-Grisales. Adult weevils were returned to the Insectary and Quarantine Facility at UC Riverside under USDA-APHIS permit and used for experiments to address the objectives above. This work is ongoing and further updates will be provided as research is completed.



(A) Adult female Heilipus lauri attached to flight mill. (B) Close up of female weevil attached to the flight mill harness which tethers the weevil to the rotor arm of the flight mill. (C) Adult male weevil attached to the flight mill harness with elytra and wings spread in preparation for flight. When weevils commence flight they fly in circles around the pivot point. A lap top computer records distances flown, flight velocity, and periodicity of flight. These flight data can be compared between male and female weevils, young vs. old weevils, virgin vs. mated weevils.

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