

# Stopping the Coffee Berry Borer From Boring Into Profits

Water may be the essential liquid for Earth's life forms, but coffee really gets the body's motor going! Each day, millions stagger to the kitchen coffee pot or local coffee joint for the morning pick-me-up. But a tiny insect, the coffee berry borer (*Hypothenemus hampei*), is threatening the crop. Though it isn't the only pest of the coffee plant, it does the most damage—about \$500 million worth.

Agricultural Research Service entomologist Fernando E. Vega is investigating ways to stop the coffee berry borer from eating holes into coffee beans, reducing the income for coffee growers as well as lowering the quality of coffee crops around the world. Vega is not only a coffee researcher, but also a coffee fan who collects beans during vacations and roasts the precious commodity to perfection.

## The Life of the Coffee Berry Borer

The coffee berry borer, or CBB, has an interesting life cycle. The tiny (1.5-mm) bark beetle spends its entire larval life inside the coffee berry, which encases the seed, commonly known as the coffee bean. Males mate inside the berry with females, but never emerge. Only mated females emerge to fly to a new berry and bore into it to lay eggs and start the cycle anew. Only while outside the berry are the adult female borers vulnerable to predators or chemical controls.

"Living most of its life inside the berry makes this pest difficult to control with traditional chemical and biological controls, so other methods must be devised," says Vega, who is with the Insect Biocontrol Laboratory in Beltsville, Maryland. A commonly used insecticide, endosulfan, is largely being abandoned due to its high toxicity to humans and the insect's becoming resistant to it.

Every coffee drinker knows too much of the caffeine-laden beverage will lead to the jitters. But does caffeine do the same thing to the CBB? "Caffeine is toxic to many insects, but not so for the coffee berry borer," says Vega. "Why this insect

is immune to caffeine is one of the areas we are studying."

## How They Do Their Damage

CBBs cause damage by boring and depositing eggs into the berry. Larvae hatch and feed on the seed or bean, destroying it. Worldwide, the coffee berry borer causes an estimated \$500 million in losses. The coffee industry has an economic value exceeding \$70 billion annually, with over 20 million coffee-farming families producing coffee in more than 50 countries.

"The insect can cause coffee farmers to lose up to 20 percent of a crop and reduce the price by 30 to 40 percent," says Ted Lingle, executive director of the Specialty Coffee Association of America. "Damage from the borer hurts every coffee-producing country in the world."

Overall, the price of coffee beans is around 60 cents per pound, not enough to cover production costs in most countries. This low price is due to overproduction. But, if coffee is overproduced, why worry about the coffee berry borer?

"It's important to protect the economic viability to grow the crop; there are millions of people throughout the world who depend on coffee production for their subsistence," says Vega.

In the United States, however, coffee prices range from about \$2 per pound to more than \$30. Why the discrepancy? Hawaiian coffee, particularly Kona coffee, which sells for about \$35 a pound, is considered a specialty coffee, which commands a much higher price for growers. This makes it a commodity that must be protected from coffee berry borer damage. Specialty coffees, grown under stringent conditions for better quality, are gaining market share and becoming a more important U.S. commodity.

## Fighting Back With Fungi

A fungus, *Beauveria bassiana*, attacks a wide range of insects, including CBB. The challenge is to get the fungus in contact with the insect pest. Vega and

PEGGY GREB (K11523-1)



Technician Ann Sidor examines a liquid culture of fungal endophytes isolated from coffee plants. After harvesting and freeze-drying of the fungal mass, DNA will be extracted for molecular identification.

PEGGY GREB (K11516-1)



Postdoctoral scientist Francisco Posada injects the stem of a coffee seedling with a *Beauveria bassiana* spore suspension. The fungus attacks a wide range of insects, including the coffee berry borer.

Francisco Posada, a postdoctoral scientist in his laboratory, found the fungus can become endophytic—meaning, once introduced to the plant, it integrates with plant tissues. “We use four methods to place fungus: injecting it into the stem, spraying it on the leaves, soaking seeds in it, and drenching soil with it,” says Vega. “The idea is to make the fungus thrive in the plant so that the coffee berry borer can become exposed to it.” Vega and Posada have shown that each method integrates fungus into plant tissues.

Together with colleagues in Mexico, Vega is also investigating nematodes in the genus *Metaparasitylenchus* to control CBB. Nematodes are microscopic simple worms. During a 2002 collaborative study with Alfredo Castillo, Francisco Infante, and Juan B. Barrera of El Colegio de la Frontera Sur in Mexico and Lynn Carta in the ARS Nematology Laboratory in Beltsville, Maryland, Vega and his colleagues found that when female nematodes parasitized female coffee berry borers, the result was not death, but reduction in reproductive efficiency. “Nonparasitized insects laid an average of 10 eggs, but parasitized borers laid just under 2 eggs on average,” says Vega.

As for why the borer is able to withstand caffeine’s toxic effects, there are some yeasts that detoxify chemicals, creating an edible food source for insects. Vega, Michael Blackburn at the Insect Biocontrol Laboratory, and Cletus Kurtzman in the Microbial Genomics and Bioprocessing Research Unit and Patrick Dowd in the Crop Bioprotection Research Unit in Peoria, Illinois, conducted a study to determine whether yeasts found in CBB could detoxify caffeine. “We found that one of these yeasts, *Pichia burtonii*, does not appear to be associated with caffeine degradation and may produce enzymes involved in providing nutritional factors for the insect,” says Vega. “Further research is necessary to determine the role of yeasts in CBB biology.”

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To better understand fungal endophyte diversity in coffee, entomologist Fernando E. Vega examines a fungal and bacterial endophyte isolated from a coffee bean.

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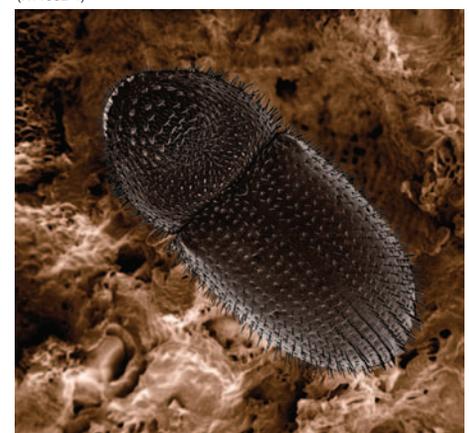
Adult female coffee berry borer (*Hypothenemus hampei*) on a green coffee bean. Adult females bore a hole in coffee berries and lay their eggs near the two coffee beans found inside the berry. Once the eggs hatch, the larvae feed on the beans, rendering them unsuitable for commerce or greatly lowering their quality.

Vega is looking at CBB not in isolation, but as part of the ecosystem. “There are innumerable interactions among the insect, the microorganisms it harbors, and the coffee plants. We need to understand those interactions to help alleviate the damage caused by this pest,” says Vega.—By **Sharon Durham**, ARS.

*This research is part of Crop Protection and Quarantine, an ARS National Program (#304) described on the World Wide Web at [www.nps.ars.usda.gov](http://www.nps.ars.usda.gov).*

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Scanning electron micrograph of coffee berry borer. Photo by Eric Erbe, colorized by Chris Pooley. Magnified about 28x.