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An Introduction to the Square-Necked Grain Beetle as a Predator of Coffee Berry Borer in Hawai'i

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Common name

Square-necked grain beetle

Family name Silvanidae (silvanid flat bark beetle)

Scientific name

Cathartus quadricollis (Guérin-Méneville)

Introduction

Coffee berry borer (CBB), *Hypothenemus hampei* (Ferrari), a devastating pest of coffee, was discovered in Kona in 2010. In 2013, square-necked grain beetles were observed in the laboratory to prey on all life stages of CBB when provided CBB-infested coffee beans (R.T. Curtiss, personal communication August 10, 2016). As a result of this

observation, research was initiated on these predatory beetles. The purpose of this publication is to provide a better understanding of the host range, distribution, biology, behavior, feeding habits, and potential of square-necked grain beetles as a biocontrol agent of CBB.



Figure 1: Adult square-necked grain beetle (USDA ARS)

Hosts

Square-necked grain beetles and other flat bark beetles are typically found living under the bark of trees. They feed on a vast array of sources including detritus, fungi, pollen and flowers, grain and grain products, oilseeds, and nuts, and they occasionally prey on other insects. In warm and tropical areas, square-necked grain beetles can be a minor grain pest (Rees 2004) and have been known to infest a wide range of stored commodities. The larvae and adults prefer to feed on the grain germ but will also develop on endosperm alone. One benefit of this feeding habit is that square-necked grain beetles are easily reared on milled grains.

In Hawai'i, square-necked grain beetles are found in unharvested sticktight macadamia nuts (nuts that

have not abscised or fallen from the tree), where they likely feed on tropical nut borer (TNB), *H. obscurus* (F.) and help to suppress this pest. They have also been found in and prefer old, drying coffee berries and coffee raisins (dried coffee berries) remaining on the tree (Follett et al. 2016). Initially identified by Vega et al. (1999) as

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According to Follett (unpublished data), squarenecked grain beetles are not storage pests of green (unroasted) coffee beans or parchment.

Distribution

Square-necked grain beetles are likely native to South America, but today they are widely distributed throughout the world.

The predatory behavior of the square-necked grain beetle was first discovered in Hawai'i during a macadamia nut field study in the 1990s at a South Kona farm that examined ways to manage the TNB attacking macadamia nuts. Its interaction with TNB is described in the macadamia pest-management book by Jones (2002).

Square-necked grain beetles were found on Big Island farms in Kona and Ka'u, the major coffee-growing regions, and on farms in Hilo, Puna, and Kohala (Follett et al. 2016). They were collected at elevations ranging from 100 to 800m. Preliminary sampling also detected square-necked grain beetles in coffee raisins at Kunia, O'ahu.

Biology

According to Allotey and Morris (1993), eggs of the square-necked grain beetle hatch, producing larvae, which develop through five stages before pupating and then emerging as adult beetles. Their opaque-white oval eggs are difficult to see with the naked eye, measuring less than a millimeter in length. In tropical climates, eggs can hatch within 4 days of being laid, and the emerging larvae are active predators (Follett et al. 2016). The pupae are stationary and darken in color in a progression from opaque-white to tan to a brown or brown-red color. Larvae can be as long as adult beetles, although they have the appearance of minute, fast-moving grubs rather than beetles. Pupae are slightly smaller (2.5 mm) than the adults (2.5-3.5 mm) and develop in den-like pupal cases when reared on cracked corn and cornmeal. When food is scarce, there may be a reduction in the size of adults that emerge from the pupae.

The life span of square-necked grain beetles in tropical regions is currently unknown. However, some adult beetles in the same colony can live on average 6–8 months, which can be extended to several years in cool, temperate climates.

Behavior

Square-necked grain beetles fly readily and are aided by wind for dispersal. In macadamia nut and coffee, these beetles locate entrance holes and actively feed on eggs, larvae, and pupae of TNB and CBB in the galleries and tunnels created by their prey.

Landscape Ecology

Current studies (Brill et al. 2016) show that the entire life cycle of square-necked grain beetles can be found in macadamia nut sticktights. Additionally, adults and larvae have been found in the seedpods of koa haole (*Leucaena leucocephala*), a tree commonly found in Hawai'i's coffee-growing landscape. Other plants within the Fabaceae family such as the scrambled egg plant (*Senna* sp.), ice cream bean (*Inga* sp.), monkeypod (*Samanea saman*), and koa (*Acacia koa*) are potential host plants of flat bark beetles.

Addition of these plants within the landscape may help to provide a refuge for *C. quadricollis* and other predatory flat bark beetles when coffee raisins are unavailable in the crop site.

Using Square-Necked Grain Beetles as Biological Control Agents

It is possible to improve biological control of some pest insects by mass-rearing and releasing natural enemies into the environment, an approach termed "augmentative biological control." Square-necked grain beetles can be reared for augmentative biological control to contribute to the management of pest populations. Rearing can be done in containers with fine screen mesh (e.g., nylon fabric with 160-300µm mesh aperture) that prevents beetles from escaping, using a crushed-grain medium as a source of nutrition for the beetles. Studies have shown that square-necked grain beetles develop fastest on cut corn (egg to adult in 18–20 days at 28±2°C) but produce a greater number of offspring on cut sorghum (Allotey and Morris 1993). A 4:1 ratio of cut/cracked corn to cornmeal is recommend for rearing square-necked grain beetles. Cut/cracked corn is easily obtained at feed stores in Hawai'i, and cornmeal can be found at local grocery stores. Instructions for rearing and releasing flat bark beetles can be found at http://hawaiicoffee.weebly.com/ predators-of-cbb.html.

Avoid the escape or release of square-necked grain beetles in the home or storage areas, as they will infest



Figure 2: A small rearing jar containing square-necked grain beetle adults, larvae, and pupae reared on a diet of cracked corn and cornmeal (UH CTAHR).



Figure 3: *C. quadricollis* preying on coffee berry borer larvae and pupae in a dissected coffee bean recovered from the field. The video from which this photo was taken can be viewed at http://dx.doi.org/10.6084/m9.figshare.3486674.v1 (USDA ARS).

stored foods.

An aggregation pheromone lure has been developed for square-necked grain beetles, and current research by Follett et al. (2016) is investigating the effects of this lure in drawing greater numbers of predatory beetles into the coffee field.

Incorporating Biological Control Agents Into a CBB Integrated Pest Management Program

An integrated pest management (IPM) approach is used to control CBB. CBB IPM recommendations include field sanitation (e.g., strip-picking—the removal of old coffee berries and raisins from the tree, avoidance of dropped berries on the ground); monitoring CBB activity; spraying pesticides to kill CBB; and frequent, efficient harvests (Kawabata et al. 2015). Adult square-necked grain beetles are not susceptible to infection by the biopesticide *Beauveria bassiana*, used for CBB control in coffee (Follett et al. 2016).

Using augmentative releases of *C. quadricollis* alone will not adequately control CBB. Release of this predator should not replace strip-picking, which is the most efficient method of preventing CBB reproduction in raisin coffee. However, releases of square-necked grain beetles will help reduce CBB populations in raisins inadvertently left on the tree.

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Disclaimer

The research currently available indicates that flat bark beetles may help to reduce coffee berry borer. However, there is too little information available at the present time to offer any guarantee that this will occur under every situation, or that it will contribute to an improvement in coffee production or quality, or that it will not have any negative impacts on coffee. These data may change as new research information becomes available. Mention of a trademark or proprietary name does not constitute an endorsement, guarantee, or warranty by USDA, HDOA, University of Hawai'i, or UH CTAHR Cooperative Extension Service or its employees, and does not imply recommendation to the exclusion of other suitable products.

Caution: Pesticide use is governed by state and federal regulations. Read all pesticide labels to ensure that the intended use is included, and follow all label directions.

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