Scientific Note

Macadamia Felted Coccid, *Eriococcus ironsidei*: Biology and Life Cycle in Hawaii

Dominique R. Zarders* and **Mark G. Wright**
Department of Plant and Environmental Protection Sciences, University of Hawaii at Manoa, 3050 Maile Way, Honolulu, HI 96822. *email: dreg@hawaii.edu

Abstract. The life cycle and general biology of *Eriococcus ironsidei* were observed in the field and under laboratory conditions. We provide data on duration of developmental stages, fecundity, and longevity of the insects. The female can be found in high numbers on branches of macadamia nut tress while the males mostly colonize the leaves. The average duration of time to complete metamorphosis varied between the sexes. Females took 32 days and males 16 days after hatching from eggs to reach the adult stage. Females produced up to 97 eggs (mean of 36.7) and were capable of producing eggs for over 50 days under laboratory conditions.

Introduction

Macadamia felted coccid, *Eriococcus ironsidei* (Williams) (Hemiptera: Eriococcidae), was originally reported from macadamia nut trees (*Macadamia integrifolia*, Proteaceae), in Australia, by Ironside (1970). *E. ironsidei* infest *Macadamia* species and feed by inserting their thread-like stylet into the plant tissues (Figure 1). Damage caused by the scale includes distorted leaves, new shoots, flowers, possible abortion of immature nuts and discolored yellow spots on leaves. Heavy infestations result in dieback of branches and reduced yields. In Australia, *E. ironsidei* was, and still is, typically considered to be a minor pest of cultivated macadamia nuts, and occasional outbreaks are controlled with insecticides as necessary.

The first detection of *E. ironsidei* in Hawaii was from the South Kona district on the island of Hawaii in 2005 (Conant et al. 2005, Wright and Conant 2009). That initial infestation was treated intensively with insecticidal oils and insect growth regulators (Wright and Vorsino 2005). The residual populations were subject to relatively high levels of mortality attributable to various predators and parasitoids, which appeared to control the populations (Conant and Hirayama 2005, Wright and Conant 2009). The infestation initially appeared to be restricted to South-Kona, but *E. ironsidei* spread to the east and northern parts of Hawaii Island by 2009, resulting in severe infestations in many locations (Wright and Conant 2009). *E. ironsidei* is currently a severe pest of macadamia nut in Hawaii, and efforts are underway to develop integrated pest management procedures for population suppression.

While the general biology of Eriococcidae is understood from published work on other felted coccids, no quantitative data on the biology and life cycle are available for *E. ironsidei*. This paper reports the basic biology of *E. ironsidei* from Hawaii macadamia nut trees, with a description of the life cycle and morphometric data for the various life stages.

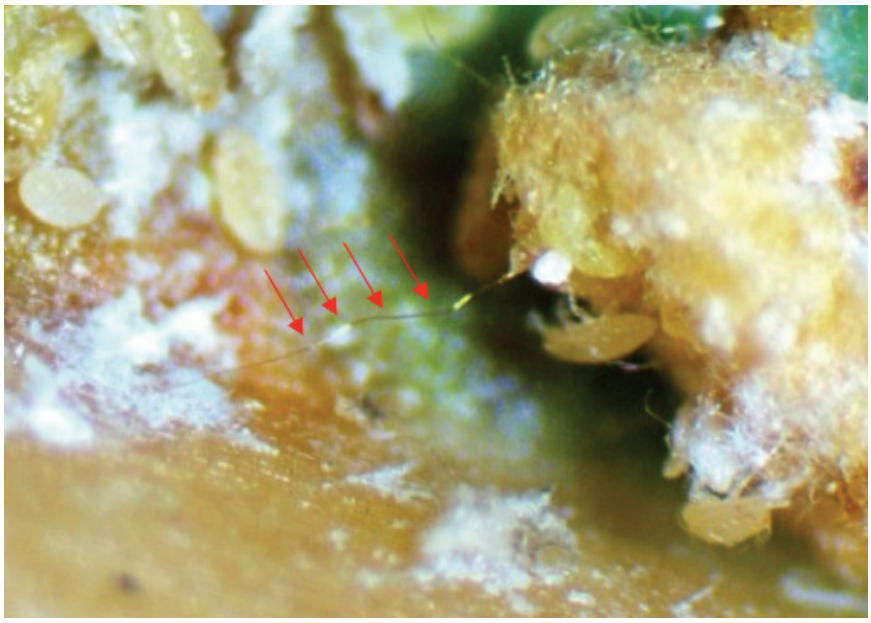

Figure 1. Adult female rostrum, indicated by red arrows.

Materials and Methods

E. ironsidei were collected from various orchards in Pahala, Hawaii Island, from large mature macadamia nut trees with severe infestations. They were collected from infested leaves, husks of nuts and from infested branches. The insects were transferred onto seedling plants in a greenhouse to establish a controlled population. Populations of *E. ironsidei* were maintained under greenhouse conditions with temperature highs of 49°C, 98% relative humidity (RH) and occasional lows of 16°C, 77% RH, averaging 33°C and 87% RH. Observations were made on the biology of the insects by collecting newly emerged juveniles (crawlers), and placing them onto excised clean leaf material. The leaf material was then placed on top of a moistened cotton square inside of a Falcon 50 mm x 9 mm Petri dish. The Petri dishes were kept inside the laboratory (28°C, 64% RH). Observations on development were made daily, recording insect size, development of the felted sac and sex ratio. Measurements of total length of the insects were made using an Olympus SZ61 paired with LWScientific USB 2.0, 5.1MP Mini-VID and LWScientific Toupview measuring tools, measuring to the closest 0.10 mm. Density counts of insects were taken from randomly selected infested areas on leaves and branches of 645 mm^2. A total of 352 scales were observed on branches; and 287 on leaf material. Data were also collected showing how the sexes occupied space on the leaf material by counting number of groups and noting the location on the leaf (midrib or margin of leaf).

Results and Discussion

Behavior. The adult females (enclosed by sacs) can be observed anywhere above ground on the macadamia tree, but the densest female populations occur on branches, typically towards the lower parts of the tree. On leaves, males comprised 71% of patches of *E. ironsidei*. They

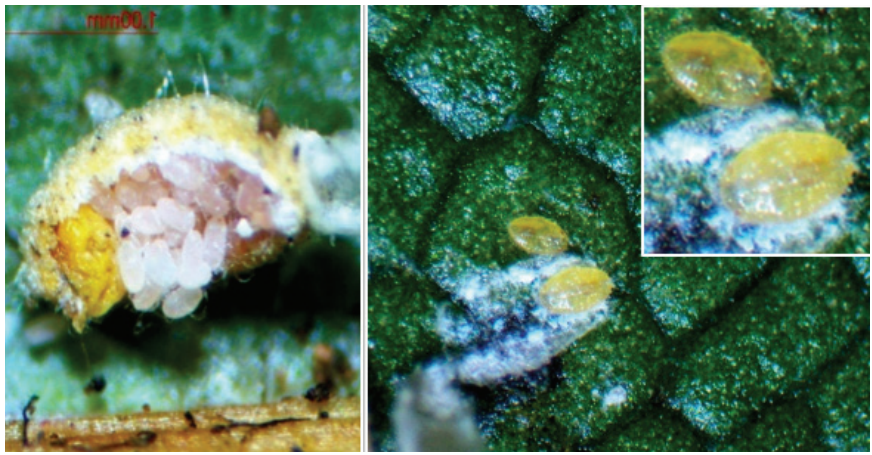

Figure 2. Female sac turned over to expose constricted female body and eggs (left), and first instar crawlers (right, magnified in inset).

tended to aggregate near leaf veins. On branches, 80% of the scales were found to be female.

Life cycle. ***Egg to crawlers.*** Eggs are elongate, 0.1 mm in length, laid under the female felted sac where they develop, and hatched in 2–4 days (mean = 3 days) after being laid (Figure 2). Crawlers have red eyes and elongate translucent bodies that gradually become orange. Red-pigmented spots can be observed on the abdomen as they develop. The legs are visible and functional as crawlers leave the ovisac. Crawlers become settled on the host plant, using their thread-like stylet to penetrate plant epidermis to feed on plant fluids. The body is very fragile and measures 0.2–0.8 mm in length, 0.1–0.4 mm width, with four male juvenile stages and three female instars. When crawlers reached the length of 0.4 mm, almost 90% had developed a felted sac covering the body cover. The duration of the juvenile stage varied depending on environmental conditions and sex.

Female. The female *E. ironsidei* nymphal stage was completed 29–36 (mean = 32 days) days after hatching. The final instar settles, and the adult females become sedentary, and then create a felted sac covering the body (Figure 3), within which eggs are laid and hatch, until the female dies. Female lifespan can be more than 50 days. The female eriococcids have five morphological stages (egg, three instars, and adult). The adult female body is orange, rounded, without wings, unchitinized, very fragile, and concealed by a white or yellowish felted sac. The eyes are dark red and minute. The short legs are visible on the body from a ventral viewpoint but the mature adult is sessile. A circular opening outlined in white is visible at the posterior end of the yellowish felted cover where hatched crawlers emerge. Females produced from 18 to over 97 eggs (mean = 36.68, SEM = 3.6, n = 25) each. As the female lays eggs, the body constricts, causing the length and width of the body to vary, but not of the felted sac, which remains approximately 1 mm long throughout the life of the female.

Male. The males have six morphological stages (egg, four juvenile and adult). Male juvenile stages develop over 13–19 days (mean = 16 days) before a mature male emerges from an elongate pale white

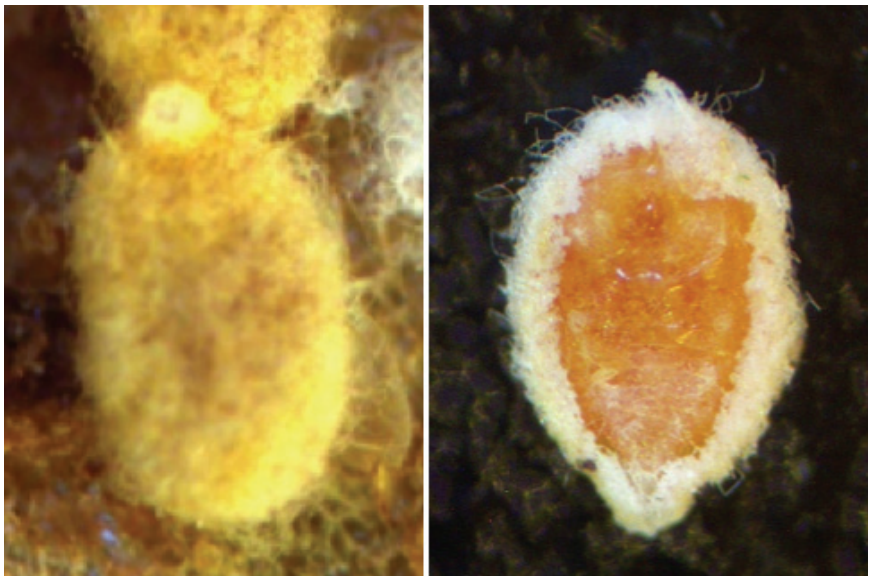

Figure 3. Adult female sac dorsal view (left) and ventral view (right).

Figure 4. Juvenile male with cover removed (left), male felted sac and crawlers (middle) and winged adult male (right).

felted sac (mean = 0.7 mm) where the last two stages (prepupa/pupa) develop (Figure 4). The males fly to seek sexually mature females and die soon after mating.

A composite representation of the life cycles of females and males is presented in Figure 5.

Acknowledgments

This work was supported by the USDA National Institute of Food and Agriculture, Hatch project HAW919-H, managed by the College of Tropical Agriculture and Human Resources, funding from Olson Trust and Royal Hawaiian Orchards, and the Hawaii Department of Agriculture.

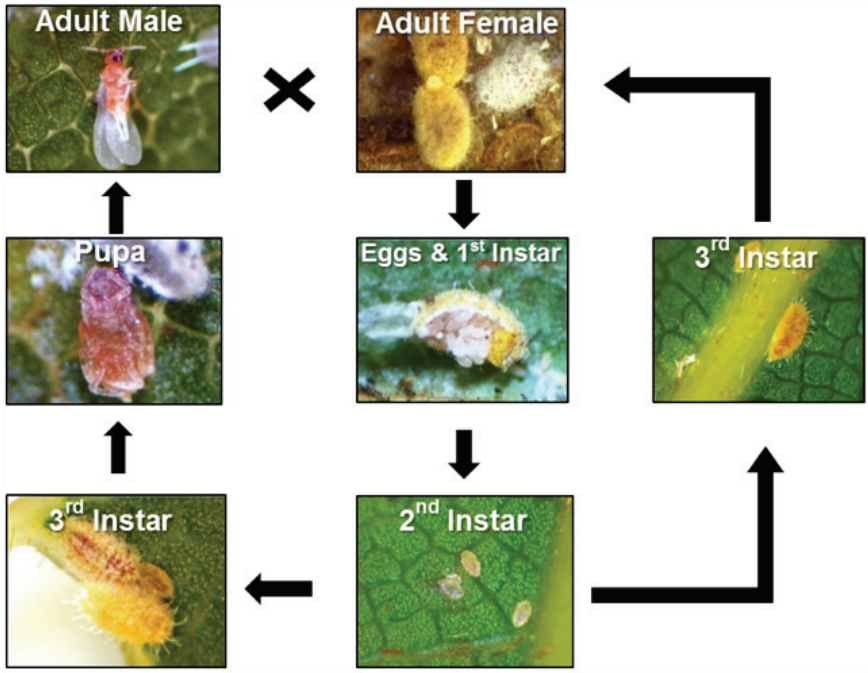

Figure 5. Complete life cycles of female and male *E. ironsidei*.

Literature Cited

Conant, P., and **C. Hirayama.** 2005. Natural enemies of macadamia felted coccid (*Eriococcus ironsidei*) Williams, (Homoptera: Eriococcidae) in Hawaii. 45th Annual Conference Proceedings, Hawaii Macadamia Nut Association. p. 30–34.

Conant, P., D.M. Tsuda, R.A. Heu, and **K.K. Teramoto.** 2005. Macadamia felted coccid. New Pest Advisory, April 2005, No. 05-01. Hawaii Department of Agriculture. http://hdoa.hawaii.gov/pi/files/2013/01/npa05-01-MFC.pdf.

Ironeside, D.A. 1970. The macadamia felted coccid. Queensland Agricultural Journal 96: 613–616.

Wright, M.G., and **A.E. Vorsino.** 2005. Macadamia felted coccid – preliminary data on insecticidal control and distribution in trees. 45th Annual Conference Proceedings, Hawaii Macadamia Nut Association. p. 26–29.

Wright, M.G., and **P. Conant.** 2009. Pest status and management of macadamia felted coccid (Hemiptera: Eriococcidae) in Hawaii. South African Macadamia Growers Association Handbook 17: 69–72.