Development of the Orchid Weevil, *Orchidophilus aterrimus* (Waterhouse)[1]

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ABSTRACT

Orchidophilus aterrimus (Waterhouse) is a weevil pest of *Vanda, Dendrobium, Phalaenopsis,* and other orchids in Hawaii. Development of all immature stages usually occurred within orchid pseudobulbs. Eggs were deposited into cavities made by adult feeding and hatched in an average of 11.3 days. Larval development was completed in approximately 117 days. Larvae pupated in cells within the gallery. The pupal stadium averaged 15.9 days. The entire life cycle required an average of 144 days. A 47 day preoviposition period was observed. Females laid an average of 2.4 eggs per week during their lifespan. Feeding and oviposition occurred primarily during daylight hours.

The orchid weevil, *Orchidophilus aterrimus* (Waterhouse) has become a serious pest in Hawaii cultivated orchids since the banning of persistent chlorinated hydrocarbon insecticides. The weevil occurs on the islands of Kauai, Oahu, Maui, and Hawaii. *O. aterrimus* is commonly found on *Dendrobium, Vanda,* and *Phalaenopsis,* and its larvae have also been collected from *Renanthera, Angraecum, Saccolobium, Cymbidium,* and *Spathoglottis* (Swezey 1945).

Orchidophilus aterrimus has also been found in Singapore (Waterhouse 1874) and England (Champion 1913), and it probably occurs in the Philippines, Thailand, Indonesia, and Japan (Swezey 1945). Buchanan (1935) believed that this insect was indigenous to the upper Malayan area of the Oriental Region.

The orchid weevil was described by Waterhouse (1874) as *Baridius aterrimus* but was later assigned to the genus *Orchidophilus* by Buchanan (1935). It was frequently intercepted here in orchid shipments from the Philippines during the early 1900's and became established in Hawaii by 1944 (Fullaway 1938; Swezey 1945).

MATERIALS AND METHODS

Rearing — Adults collected from *Dendrobium* and *Vanda* 'Miss Joaquim' plants were reared in the laboratory at 24 ± 4°C in 235 cc paper cups covered with plastic lids. No more than 80 individuals were placed in each cup. Fresh *Dendrobium* leaves were provided 3 times a week, and the adults were transferred to clean containers monthly.

Sexing — Males were identified by the presence of a subapial tooth-like process on the ventral surface of the rostrum (Buchanan 1935).

Life Cycle — Five adults of each sex were placed in a nylon organdy bag (18 × 26 cm) which was then placed over a succulent *Dendrobium* pseudobulb, and the bag opening tied around the pseudobulb with a drawstring. A total of 109 plants were caged with the weevils. After 3-4 days, oviposition was assumed, and the bag and weevils were removed. The pseudobulb was labelled with the starting date, and the plants were checked weekly for adult emergence.

Upon finding the first emergence hole, each pseudobulb was dissected to determine the insect's stage of development. Adults in pupal chambers were sexed,

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placed into 10 dr plastic vials with nylon-organdy covers, and fed. Pupae were placed individually into vials. Non-prepupal larvae were placed back into the original gallery and the piece of pseudobulb was placed into a vial. The larvae and pupae were checked daily for metamorphosis. Larval duration was calculated by subtracting the length of the incubation period from the egg to adult period.

To estimate the number of larval instars, head capsule width measurements were made of larvae (n = 114) dissected from *Dendrobium* pseudobulbs collected in Hilo and Kohala, and of newly hatched larvae (n = 25).

Oviposition and Incubation — Fresh *Dendrobium* leaves were placed with caged weevils at ca. 6 a.m. and 6 p.m. The leaves were then soaked for 2-3 min to soften the epidermis over the oviposition cells. The eggs were removed, counted, and incubated on wet filter paper in covered petri dishes. The eggs (n = 165) were then observed at 12 hr. intervals to determine the incubation period.

Egg Fertility — In one study, 6 egg collections were made over 2- to 3-day periods on field collected adults of 5 age groups (3, 7, 11, 13, and 16 weeks). The ages of the weevils were based on the date of collection, equalling day 1 and were therefore minimal ages. Percentage of egg hatch was determined 16 days after collection.

In another study, eggs from field-collected weevils of 11 and 13 months ages, as determined from the date of capture, were collected at weekly intervals 6 times in the former and 7 times in the latter group.

Fecundity and Longevity — Eggs were collected at 2-3 day intervals from 4 groups of adults averaging 34 males and 35 females. Mortality data was taken weekly for 52 weeks. Weekly fecundity was calculated by the number of females alive at the start of the week.

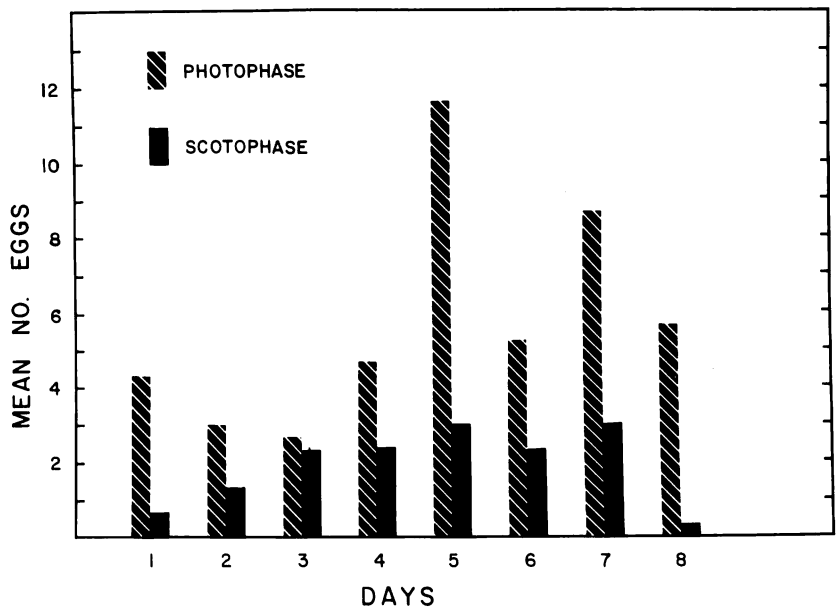

FIGURE 1. Oviposition during the photophase and scotophase under 12-hour photophase.

RESULTS AND DISCUSSION

In the field, most eggs were laid in the pseudobulbs and at the base of developing leaves of *Dendrobium,* and in the leaf axils and pseudobulbs of *Vanda* 'Miss Joaquim'. Females readily oviposited in *Dendrobium* leaves in the laboratory. The eggs were deposited singly in cavities made by feeding, and these did not differ in appearance or location from cavities without eggs.

Eggs were oval, with a grainy chorion surface, and measured 0.74 ± 0.046 by 0.51 ± 0.029 mm (n = 25). Eggs remained white during the first 9 days and then the mandibles of the developing grub became visible as brown triangular spots. The head capsule became visible within a day after this, and the eggs hatched a day later. Incubation period varied from 10.5-13 days with a mean of 11.3 ± 0.54 days at 24 ± 4°C. (n = 165). Most eggs (n = 84) hatched during the 11th day. Egg totals for females 3, 7, 11, 13, 16 weeks old, and 11 and 13 months old, were 283, 151, 169, 185, 196, 24, and 29; % hatched were 97, 97, 98, 97, 88, and 90, respectively. Hatch from all age groups averaged 97.0%, and there was no significant difference ($P < 0.01$) among age groups.

Larvae — The legless larvae began feeding soon after hatching. Although grubs can sometimes be found feeding at the base of unopened *Dendrobium* leaves and in pencil-shaped leaves of terete types of *Vanda,* larval development mainly ocurred within the pseudobulbs. While feeding, the larva produced a gallery that was oriented longitudinally (usually downward) and filled with frass up to a short distance behind the grub. In *Vanda* 'Miss Joaquim' the larval galleries were produced longitudinally in either direction from the site of oviposition.

The light brown head capsule of early instars turned dark brown later. The body was white to yellow white throughout the developmental period. Mature larvae were ca. 8-9 mm long and 3 mm wide. Head capsule widths plotted against frequency (Dyar 1890) indicated a minimum of 5 but possibly 6 larval instars.

The calculated duration of the larval stage was 117 days with a range of ca. 3->5 months. The developmental period of the larvae appeared shorter in younger, succulent *Dendrobium* pseudobulbs than in old, harder ones. The rate of development of larvae within the same pseudobulb sometimes varied greatly.

Larval feeding usually did not kill the pseudobulbs; however, there were definite side effects due to larval infestation. Damaged *Dendrobium* pseudobulbs frequently stopped growing and many of them did not produce flowers. *Vanda* 'Miss Joaquim' continued to grow despite larval infestation, but larval presence has been associated with color break of flowers characterized by numerous white longitudinal streaks on the labella.

Pupae — The fully grown larva made a cell of fibers and frass at the end of the gallery and pupated within it. The pupae were creamy white during the early stages of development. The eyes and wingpad tips darken to light brown 8-10 days after pupation and became black 4 days later. Two days after this the rostrum, antennae, femoratibial joints, and pretarsus became brown. A brown area was observed on the pronotum, and brown lines on the dorsum of the meso- and metathorax. Adult emergence occurred less than 24 hr later. Pupal development was completed in 13-18 days with a mean of 15.9 ± 1.2 days (n = 26).

Adults — Newly emerged adults remained in the pupal cell for an undetermined period. Newly emerged adults did not feed for at least 10 days. Evidently, adults remained within the orchid pseudobulb for ca. 2-3 weeks before emerging. The adult emerged from the cell by chewing a circular or oblong hole ca. 2-3 mm across. In

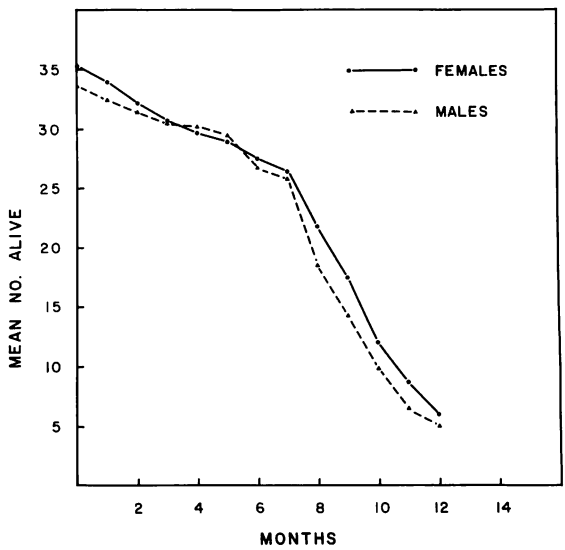

FIGURE 2. Longevity of field-collected *O. aterrimus* adults.

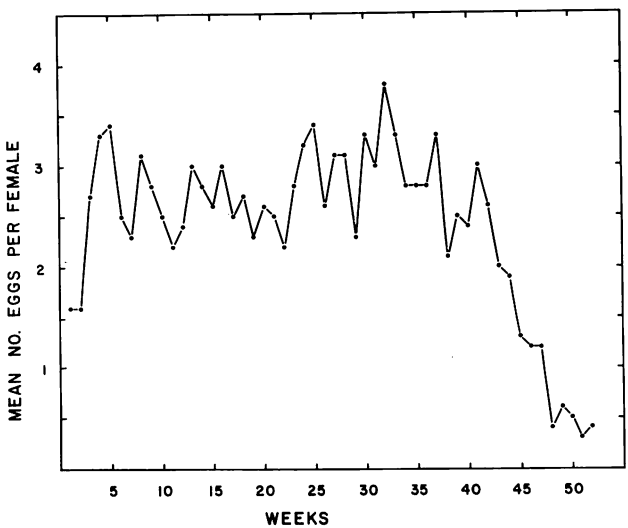

FIGURE 3. Fecundity of field collected *O. aterrimus* females.

many cases, this hole was the first visible evidence that the pseudobulb had been infested by weevil grubs.

The teneral adult was light to dark brown and became totally black in 3-4 days. The mature adult was dull black with distinct elytral striae. Field collected males and females (n = 50 of each sex) averaged 4.8 (range = 3.5-5.7) and 4.4 (range = 3.1-5.0) mm long, and 2.0 (range = 1.3-2.5) and 1.7 (range = 1.2-2.0) mm in pronotal width, respectively.

Adults fed on flowers, leaves, pseudobulbs, and exposed roots. On *Dendrobium,* they were usually found among the leaves at the apical end of the succulent pseudobulbs. Although younger growth was preferred, adults readily fed upon older pseudobulbs if succulent ones were not present. Because of the preference for young tissue, feeding damage most often occurred and was most obvious on apical growth. On terete types of vanda (e.g., *Vanda* 'Miss Joaquim'), the adults were usually found on the pencil-shaped leaves, pseudobulbs, and flowers. They preferred to feed and oviposit in leaf axils of the apical growth.

There was an unexplainable difference in the male to female sex ratio of field-collected and laboratory-reared adults. The former was 1:1.2 (n = 1291) and the latter was 1:0.4 (n = 68).

Field collected adults were extremely long lived (Fig. 2). Half of the males and females lived for 34 and 37 weeks, respectively. When the study was terminated after 52 weeks, 8% of the males and 15% of the females were living. There was no significant differences ($P < 0.01$) in the longevity of each sex.

Females were not parthenogenic. The pre-oviposition period averaged 47 days (range = 40-59) from ecdysis. This suggests that females are probably not capable of laying eggs upon emerging from the pseudobulb.

When reared at 12 hr photophase, females oviposited during both the photo- and scotophase; however, significantly ($P < 0.01$) more eggs were deposited during the photophase (Fig. 1). A total of 138 eggs was deposited during the light period and 47 during the dark. In addition, more feeding damage was observed during the photophase. These results suggested that adults are mostly diurnal.

Females continued to deposit eggs throughout the study period (Fig. 3). Each female laid an average of 2.4 ± 0.8 eggs/week. Fecundity decreased greatly from the 48th week to the end of the study. From these results, it is estimated that at least half of the females would lay ca. 89 eggs each in their lifespan.

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