

DEVELOPMENT OF *METAMASIVS CALLIZONA*
(COLEOPTERA: CURCULIONIDAE) ON PINEAPPLE STEMSJORGE SALAS¹ AND J. H. FRANK²¹FONAIAP, Centro de Investigaciones Agropecuarias del Estado Lara
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ABSTRACT

In the laboratory at 26°C and 14:10 L:D, female *Metamasius callizona* (Chevrolat) oviposited in pocket-shaped slits that they cut in pineapple leaves. Eggs were 1.98 × 0.97 mm and incubation averaged 8.3 d at 82% RH. On a diet of pineapple stem, 5 larval instars averaged 37.4 d to develop to the pupa. The pupal stage averaged 11.8 d, and the pupal weight averaged 0.12 g. Development from oviposition to adult emergence took about 8 wk.

Key Words: Florida, bromeliads, pest weevil, larval instars

RESUMEN

En el laboratorio a 26° y bajo regímenes de luz de 14 y 10 h respectivamente, hembras de *Metamasius callizona* (Chevrolat) ovipositaron en escisiones con forma de bolsillos que ellas hicieron en hojas de piña. El tamaño de los huevos fue de 1,98 × 0,97 mm y la incubación tomo 8,3 días (promedio) a una HR de 82%. Con una dieta de tallos de piña, los 5 instares larvales tomaron 37,4 días para convertirse en pupa. El estado pupal duro 11,8 días y la pupa peso 0,12g. El desarrollo desde la oviposición hasta el adulto tomó 8 semanas.

Metamasius callizona (Chevrolat), a bromeliad-eating weevil native to southern Mexico and some countries of Central America, was first detected in Florida (USA) in 1989. It was reported attacking several native bromeliad species of the genus *Tillandsia*, being most abundant on *T. utriculata* (L.) in southern Florida (Frank & Thomas 1994). It also attacks 12 other genera of bromeliads (including *Ananas*) grown in Florida as ornamental or food plants (Frank & Thomas 1994). Native epiphytic bromeliads are considered highly desirable elements of the flora, and most of them are protected by law (Florida Administrative Code 1998).

A University of Florida project to control *M. callizona* by biological methods (importation of a specialist parasitoid—a tachinid fly of the genus *Admontia*) is in progress. Because of this, a comprehensive knowledge of the life cycle, behavior, and climatic requirements of this weevil is necessary.

MATERIALS AND METHODS

Research was conducted in a rearing room of the Biological Control Laboratory of the Entomology & Nematology Department, University of Florida, Gainesville, with a photoperiod of 14:10 L:D. A microenvironment for rearing eggs, larvae, and pupae was provided in several 140 mm diam and 25 mm high, large plastic Petri dishes, each having a circular hole cut through its lid to allow introduction of a battery-powered thermo-hy-

grometer probe (RH82, Omega, Stamford, CT). The hole was stoppered when the thermo-hygrometer was not in use. Within the Petri dish, humidity was maintained at 82 ± 6.7% RH (by moistening absorbent paper in the dish), and temperature at 26 ± 0.5°C.

Adult weevils were taken from a greenhouse colony in which numbers are reared for experimental purposes on pineapple (*Ananas comosus* (L.)) crowns rooted in potting soil in plant pots. Pineapple crowns were used as oviposition sites. Two to 3 crowns were planted in soil in pots, or placed vertically in 19 × 14 × 11 cm plastic boxes with a 1-cm sheet of water, and then placed inside a 30 × 30 × 30 cm metal rearing cage. Four to 6 previously sexed couples were placed on the leaves of each crown to obtain eggs. Plants were removed on the second day after adults were introduced. All leaves were separated from the plant and checked under a dissecting microscope for eggs. Eggs were laid individually in slits cut into leaves by adult females. Each egg found was removed and placed in a 55 mm diam × 15 mm high plastic Petri dish with a circular piece of moist paper towel on the bottom. These small Petri dishes were placed within the above-mentioned large ones. Four groups of eggs (n = 14, 14, 13 and 10) were followed through hatching to determine their incubation period. Eggs collected may have been anywhere from 0 to 48 h old; we considered them 24 h old, and adjusted the incubation time accordingly.

After hatching, each larva was fed with sections of pineapple stem sized in relation to the larval size. Each piece of pineapple stem was impregnated with 1 ml of methyl-p-hydrobenzoate (1g/l) to reduce fungal growth. Every day, each larva was observed for development and presence of exuviae after molting. When a larval molt was detected, the exuviae with head capsule were transferred to a labelled vial containing 70% isopropanol, permitting subsequent measurement of head capsule width. Larval food was replaced after each molt. All larvae under observation were followed through each molt to determine the duration of each instar. These observations lasted until pupation. The duration of the pupal stage was recorded. Sex of adults was determined by presence of a depression (concavity) of the 1st and 2nd ventral abdominal segments of males, in many specimens accompanied by brownish coloration. In contrast, these same segments in females are flat and black. The sex ratio was observed in 116 newly emerged adults.

RESULTS

Eggs were laid individually, in horizontal slits cut in pineapple leaves. Slits were pocket-shaped, and most were on the lower sides of the inner (younger) leaves. Eggs were white when newly oviposited, then yellow, then light brown as they matured. Mean length was 1.98 ± 0.02 mm, width 0.97 ± 0.01 mm ($n = 35$).

Five exuviae were collected from each larva reared from egg to pupa ($n = 41$), indicating that *M. callizona* has 5 instars at least under the test conditions. The mean head capsule width ($n = 30$ for each instar) for the first instar was 0.92 mm; second 1.21 mm; third 1.69 mm; fourth 2.10 mm; and fifth 2.73 mm (Table 1). Size classes for instars 1-3 were discrete, but the smallest instar 5 heads were narrower than the largest instar 4 heads (Table 1). Discrimination of field-collected specimens of these instars would be difficult.

The incubation period for *M. callizona* eggs ($n = 51$) averaged 8.3 days (Table 2). The larval stage lasted 37.4 days ($n = 41$). The first 4 instars were

TABLE 1. HEAD CAPSULE WIDTH (MM) FOR LARVAL INSTARS OF *M. CALLIZONA* REARED ON PINEAPPLE STEMS (N = 30 SPECIMENS).

Instar	Width (mm)		Growth Ratio
	Mean \pm SD	Range	
1	0.92 ± 0.07	0.80-1.00	—
2	1.21 ± 0.29	1.10-1.30	1.32
3	1.69 ± 0.08	1.50-1.90	1.40
4	2.10 ± 0.15	2.00-2.50	1.24
5	2.73 ± 0.21	2.40-3.00	1.30

TABLE 2. MEAN DURATION OF THE DEVELOPMENTAL STAGES OF *M. CALLIZONA* REARED IN THE LABORATORY (26°C, 82% RH, 14:10 L:D).

Stage	Number reared	Duration (Days)	
		Mean \pm SD	Range
Egg*	51	8.27 ± 1.04	7-10
Larva			
1st instar	50	5.00 ± 0.72	4-6
2nd instar	48	4.51 ± 0.73	3-6
3rd instar	47	4.43 ± 0.67	3-6
4th instar	43	5.67 ± 0.62	5-7
5th instar	41	17.80 ± 1.48	15-24
Pupa	40	11.82 ± 1.53	9-15
Egg To Adult	40	57.49	

*Assumes eggs were 1-day old at time of collection.

of similar duration: first 5.0 days, second 4.5 days, third 4.4 days, and fourth 5.7 days, whereas the last was much longer and more variable 17.8 days. The pupal stage ($n = 40$) lasted 11.8 days. The pupa weighed on average 0.12 ± 0.03 g ($n = 20$). The mean development time from egg to adult for *M. callizona* ($n = 40$) was 57.5 days (8 weeks). Among 116 newly-emerged adults (40 reared individually in this study, and 76 obtained from pupae taken from the greenhouse culture), 66 were females and 50 males, resulting in a ratio of 1:1.32 (male:female), but not significantly different from the expected 58:58 ($\chi^2 = 1.10, P = >0.2$).

DISCUSSION

Development time (8 weeks through all immature stages) was shorter than the 11 weeks obtained when larvae were reared on small *Tillandsia utriculata* bromeliads in the laboratory (Frank & Thomas 1994). This probably is due to better physical and/or nutritional conditions. The same room temperature and light regimen were used for the earlier rearing, but small *T. utriculata* plants were placed into small cages for convenience. In nature in Florida, *M. callizona* typically develops in large *T. utriculata* plants (Frank & Thomas 1994). Plants of that species but under an undefined size (suggested here to be roughly the size that will fit easily within a cylinder measuring 13.7 cm in height and 8.5 cm in diameter) provide inadequate nutrition for larvae. Current rearings were made at high humidity, whereas earlier rearings were made in small plants in screen-covered cages in an air-conditioned room. Although those plants were misted occasionally with water to keep them alive, they and the insects may have been stressed by desiccation. The difference in nutritional value be-

tween pineapple stems and stems of small *T. utriculata* plants is unknown.

Calculation of minimum generation time simply adds x days (pre-ovipositional period of females) to the development time of the immature stages. However, calculation of mean generation time adds y days (the mean time from emergence of an adult female to the oviposition of her median egg) to the development time of the immature stages. We do not know either x or y .

All stages seem to be present throughout the year in southern Florida (Frank & Thomas 1994). Although cool winter temperatures must increase development time, they do not seem to induce diapause or synchronize generations. Minimal generation time in Florida might approach 10 weeks (5 generations per year), but mean generation time is more likely to be 13-17 weeks (3-4 generations per year) in part because of slower development in the cooler months. At all events, the generations are not discrete in nature in Florida.

The remaining discussion (below) concentrates on contrasts between *M. callizona* and other *Metamasius* species of the weevil subfamily Rhynchophorinae, which also includes *Cosmopolites*, *Rhynchophorus*, and *Sphenophorus*. The principal contrast is with the best-studied *Metamasius* species, *M. hemipterus* (L.), a widespread, polyphagous, Neotropical weevil, best known for its damage to sugarcane and bananas, which has been present in Florida since at least 1984 (Woodruff & Baranowski 1985). Its adults are of similar size to those of *M. callizona*. Another studied species is *M. ritchiei* Marshall, which is known from Jamaica and Cuba. Its natural hosts presumably are native bromeliads, but in Jamaica it has been reported to attack cultivated pineapple, which is not native (Gowdey 1923).

Oviposition

The style of oviposition, in which an egg is placed in a pocket cut into a leaf by the adult female, is known in other Curculionidae. It was seen in *Cionus* and *Cleopus* (Cioninae) and *Eugnamptus* (Rhynchitinae) by Howden (1995) who called it "Category 4" (among various oviposition behaviors of weevils) and noted that the pocket is cut by the female's mandibles.

Number of Larval Instars

Unlike many insect families such as Carabidae and Culicidae, the Curculionidae do not share a fixed number of larval instars. Not only is there interspecific variation, but even intraspecific variation. Restrepo et al. (1982) indicate variation within *M. hemipterus* as 7-9 larval instars. The indication by Risco (1967) of only 3 larval instars within the same species is devoid of data. For these reasons, we cannot guarantee that the 5

instars that we observed in *M. callizona* are immutable under all circumstances. *Rhynchophorus palmarum* (L.) has 11-13 instars (Restrepo et al. 1982).

Fecundity and Incubation Time

Risco (1967) specified that larvae of *M. hemipterus* in Peru hatched after an incubation period of 7-10 days. Without further discussion, Restrepo et al. (1982), using a sugarcane substrate in the laboratory in Colombia, stated that female *M. hemipterus* had a pre-mating period of 1 day, then laid 544 eggs during their ovipositional period of 34 days, 90% of eggs were viable, and egg incubation time was 2-3 days (remarkably shorter!). The incubation time that we obtained for *M. callizona* was 8.3 days. *Rhynchophorus palmarum* laid a maximum of 880 eggs, and its incubation time was 2-3 days (Restrepo et al. 1982), but *R. cruentatus* (F.) females laid 26 ± 15 eggs, which had an incubation time of 69 ± 17 hours (Giblin-Davis et al. 1989).

Pupal Duration

Frank & Thomas (1994) obtained a pupal duration of 8-24 days for *M. callizona*, with mean \pm SD of 15.6 ± 6.4 days for the first 15 pupae reared at 26°C with uncontrolled humidity. Current observations at high humidity reduced the range to 9-15 days with mean 11.8 ± 1.5 days. Pupal duration of *M. ritchiei* is reported to have a range of 18-24 days (Gowdey 1923), and that of *M. hemipterus* is reported as 10 days (Woodruff & Baranowski 1985), 14 days (Restrepo et al. 1982), and 22-24 days (Risco 1967). It is likely that lower temperature prolongs the pupal period, and lower humidity may do the same. The pupal duration of *Rhynchophorus palmarum* was 20-38 days (Restrepo et al. 1982).

Life Cycle

For *M. callizona* in Florida, we suggest a minimal generation time of 10 weeks with mean generation time of 13-17 weeks. *Metamasius ritchiei* is reported to have a larval developmental period of 8-10 weeks, and a pupal period of 18-24 days, thus a minimal developmental period of 11+ weeks (Gowdey 1923). Data from Restrepo et al. (1982) suggested a minimal generation time of 9 weeks for *M. hemipterus* in Colombia, with mean generation time of 11+ weeks (this obtained by adding half the duration of the 34-day ovipositional period). Risco (1967) gives a minimum development time of 12-18 weeks (egg + larva + pupa) for *M. hemipterus* in sugarcane in Ecuador. It is not clear to what extent these differences are due to interspecific differences and to what extent to different rearing conditions.

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