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METAMASIUS CALLIZONA (COLEOPTERA: DRYOPHTHORIDAE): LONGEVITY AND FECUNDITY IN THE LABORATORY

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ABSTRACT

Metamasius callizona (Chevrolat) is native to southern Mexico and Guatemala. It was detected in Broward County, Florida, in 1989 and has spread to 20 counties in southern Florida, where it devastates populations of native epiphytic bromeliads and also attacks cultivated bromeliads. Larvae mine into stems of larger bromeliads, killing them. New data were obtained at ≈25°C and a photoperiod of 14:10 L:D to optimize cultures of this insect to serve as hosts for the production of biological control agents. After pairing with males, it took an average of 28.9 d (±17.8, range 8-89 d) for females to begin laying eggs; thereafter, each female laid eggs for the remainder of her life, or within just a few days of her death. The total duration of life of 75 ovipositing females averaged 156.4 d (±96.7, range 26-387 d); their lifetime egg production averaged 39.6 eggs (±40.0, range 2-188 eggs).

Key Words: Mexican bromeliad weevil, biological control, Florida, invasive species, adventive insects

RESUMEN

Metamasius callizona (Chevrolat) es nativo del sur de México y Guatemala. Fue detectado en el condado Broward de Florida en 1989. Ahora, ocupa 20 condados del sur de Florida donde destruye poblaciones nativas de bromeliáceas epífitas y ataca a bromeliáceas cultivadas. Las larvas minan los tallos de las bromeliáceas grandes causandoles la muerte. La nueva información presentada aquí es para mejorar las colonias de este insecto como huésped para agentes de control biológico. Después de aparearse, las 75 hembras bajo investigación mantenidas bajo 25°C y un fotoperíodo 14:10 luz:obscura iniciaron la oviposición en 28,9 días (±17,8 con un rango de 8-89) y continuaron oviposición durante toda la vida. La duración de vida de las 75 hembras fue de 156,4 días (±96.7 con un rango de 26-387); y la producción total de huevos por cada una fue de 39,6 (±40,0 con un rango de 2-188).
Translation provided by the authors.

Two Neotropical species of *Metamasius* arrived and became established in Florida in the 1980s. The first was *M. hemipterus* (L.), which is a secondary pest of sugarcane and some ornamental palms (Weissling & Giblin-Davis 1998). The second, with which we are concerned here, is *M. callizona* (Chevrolat), a pest of bromeliads (Larson & Frank 2004).

Metamasius callizona is one of many invasive insects in Florida (Frank & Thomas 2004). It was first detected in Florida in 1989, and is a pest of cultivated bromeliads such as *Ananas comosus* (L.) (pineapple) and numerous genera, species, and hybrids of ornamental bromeliads (Frank & Thomas 1994). It can be managed in plantings of cultivated bromeliads by applications of chemical insecticides. However, it is also a devastating pest of Florida's native bromeliad populations, and has spread to 20 counties in southern and central Florida. These 20 counties contain habitats for virtually all of the range of 11 of the 12 at-risk bromeliad species, and part of the range of the 12th species. Insecticides are impracticable for the control of *M. callizona* because of the epiphytic growth of all native Florida bromeliads, their occurrence in nearly all of south Florida including Federal, state, and county parks, and the potential environmental damage to non-target organisms on land and in water bodies from widespread spraying (Frank 2002). The weevil is destroying 'naïve' populations of 'protected' endangered and threatened native bromeliad species (Frank & Cave 2005).

Metamasius callizona arrived in Florida as a contaminant of ornamental bromeliads imported from Mexico (Frank & Thomas 1994). We believe that its large distribution within Florida occurred by movement of weevil-contaminated ornamental bromeliads. Thus, there is great risk in places that import ornamental bromeliads from Mexico and, now, from Florida. These include Hawaii, with its pineapple industry, and Puerto Rico, with

not only a pineapple industry but also a rich native bromeliad flora. Constant vigilance is needed to guard against this.

As part of a biological control program aimed at *M. callizona*, the development of eggs, larvae, and pupae was investigated in the laboratory (Salas & Frank 2001). To complement those studies, we report here on laboratory longevity and fecundity of adult females.

The weevil genus *Metamasius* was traditionally placed in the family Curculionidae (e.g., Anderson 2002). However, Anderson (2003) and others reassigned it and related genera to a family named Dryophthoridae, which previously was the subfamily Dryophthorinae (= Rhynchophorinae) of Curculionidae. Because of this and other changes in classification of Curculionoidea, the name 'weevil' seems to apply to insects of several families.

Materials and Methods

A greenhouse culture of *M. callizona* had been maintained since the early 1990s at the Entomology and Nematology Department, University of Florida. The original stock was collected in various Broward County parks in southern Florida. It was augmented from time to time with freshly-collected specimens to promote genetic diversity. The greenhouse was heated in winter and cooled in summer to eliminate temperature extremes. By 1995, pineapple crowns, discarded by grocery stores, were adopted as the sole food for adults, ovipositional substrate, and site for development of the immature stages. By 2001, the rearing was concentrated within cages of various sizes in the greenhouse to reduce escape from the greenhouse by adults, and predation by frogs (*Hyla* sp.) and lizards (*Anolis* sp.). Provided that air humidity was high (natural air humidity supplemented by watering from a garden hose with sprinkler head once every 2 d), this system was adequate for maintenance of the weevil culture. It eliminated need for culture of potted bromeliads and it minimized labor. The most laborious aspect was to extract weevil pupae from cocoons, and these as well as adults and larvae, from pineapple crowns, once development of most of each cohort within a cage had reached the pupal stage.

Beginning in August 2004, weevil pupae, extracted from cocoons in the greenhouse culture, were brought indoors to a rearing room and housed individually in plastic vials. The rearing room was maintained at ± 25°C (high 25.4 ± 0.3, low 24.3 ± 0.3, n = 449 d). Air humidity was supplemented by two electrical humidifiers (RH high 48.1 ± 5.8%, low 40.2 ± 5.8%, n = 449 d) although it was perhaps of little consequence to the weevils within the closed vials with moist pineapple leaves. A photoperiod of L:D 14:10 was maintained with overhead fluorescent lighting (495 lux) in the windowless room. This allowed the exact date of emergence of the resultant adult weevils to be recorded. Within 3-5 d of its emergence, each female was assigned a code number and paired with a coded male of similar age and placed in a transparent plastic vial (7 cm h, 3.8 cm internal diam.) with snap cap. Immediately, four lengths of pineapple leaf (≈ 5 cm) were added as food and ovipositional substrate. Those leaves had been kept chilled since their collection from grocery stores, and within each vial they provided moisture. Pineapple leaf lengths were replaced in each vial (with a living weevil) once every 2 d.

We examined each vial daily for survival of adult weevils and, using a dissecting microscope, for presence of eggs. As soon as the first egg was detected within each vial, the male weevil was removed and placed in a separate vial. Most eggs were oviposited singly in pockets cut by females in pineapple leaf lengths, but some were detected being held against the floor or the walls of the vials by moisture. Every egg observed was recorded and removed. Removal often resulted in destruction of the egg; therefore, fertility was not recorded. Female weevils were initiated to this regime until 75 of them had begun to oviposit. Data were recorded daily until all 75 females had died, and then were analyzed statistically.

The question of whether oviposition declines within the lifetime of a female was addressed by comparison of the number of eggs laid during the initial and final halves of the reproductive period. To achieve this, we recorded on spreadsheets an absolute scale (day of emergence to day of death) **a** (first egg laid) and **b** (death). We subtracted **a** from **b** to calculate midpoint (**x**) for each female that oviposited. Thus, we defined the initial and final halves of the reproductive period, then noted the number of eggs laid in each of those two periods, to present descriptive statistics. For this analysis, the two periods had to be of equal duration in whole days; to equalize them when there was a midpoint day, we ignored any data for that midpoint day; thus the total number of eggs recorded in this analysis is very slightly less than the actual total number recorded. For convenience, we considered these to be the two halves of the reproductive period although we acknowledge that the reproductive period could be deemed to end on the day the last egg was laid (which varied from 2 to several days earlier).

Results and Discussion

The total duration of life of the 75 ovipositing females studied averaged 156.4 d (± 96.7 [SD], range 26-387 d); their lifetime egg production averaged 39.6 eggs (± 40.0, range 2-188 eggs). After pairing females with males, it took an average of 28.9 d (± 17.8, range 8-89 d) for females to begin laying eggs.

The daily oviposition by the 75 females that oviposited (after pairing) is shown in Fig. 1A. In the first 14 d after pairing, only one egg had been laid because almost all females were still in the preoviposition period. Not until d 89 were all surviving females in the group contributing eggs. However, by then, considerable mortality had occurred (Fig 1B). A graph of ovipositing females that survived 100 d (plotted but not shown) indicates a gradual build-up in daily oviposition until about d 89 cf. a rapid build-up after ≈ d 14.

Oviposition does not decline within the life of a female. We compared the number of eggs that females laid during the initial and final halves of the reproductive period. Thirty females laid more eggs in the initial half of their reproductive period, 39 in the final half, and six equally. Seven of eleven females that survived > 300 d laid more eggs in the final half of their reproductive period than in the initial half. Despite halving of the number of ovipositing females by d 140 (Fig. 1) there was no evidence of a decline in numbers of eggs laid daily. There was thus no evidence that fecundity declined as females aged. Rather, the evidence suggests that each female continued ovipositing until shortly before death.

The median interval between last oviposition and death was 5 d (mean 8.3 ± 8.8 d). If we accept that the oviposition rate was either 0.32 eggs/female/day (from first egg laid until death), or one egg every 3 d (see below), then there is virtually no room for an explanation other than senescence for cessation of oviposition.

No regular periodicity in oviposition by any female was detected, so the irregularities of the data presented in Fig. 1A are the result of random variation. Variation in numbers of eggs laid daily by any female was 0-4, with 0 (76.95%) followed by 1 (20.47%), 2 (2.34%), 3 (0.22%), and 4 (0.02%) calculated from day of pairing. The total fecundity of each female was highly correlated (n = 75, r = 0.7693, P < 0.001) with longevity, but yet 23% (1.00-0.77) of the variation was not explained by longevity. The longevity of males, held separately, appeared to match that of females.

The 75 females laid a total of 2,973 eggs. The sum of oviposition days, if calculated (**a**) from pairing to death of each female, was 11,505, but if calculated (**b**) from first egg to death was 9,392. An oviposition rate (eggs/female/day) might be calculated as (**a**) 2973/11505 = 0.26 or (**b**) 2973/9392 = 0.32. On the above evidence, we might expect ≈ 3,194 eggs from every 100 females treated similarly, assuming that 80.6% of them oviposit. In attempts to mass-produce weevils as hosts for a laboratory-reared biological control agent, it should be remembered that older females continue to oviposit at an unreduced rate.

The proportion of female *M. callizona* that laid eggs (80.6%) was very similar to that of *M. hemipterus* (76%) as was their preovipositional period (28.9 d) compared with that of *M. hemipterus* (27.0

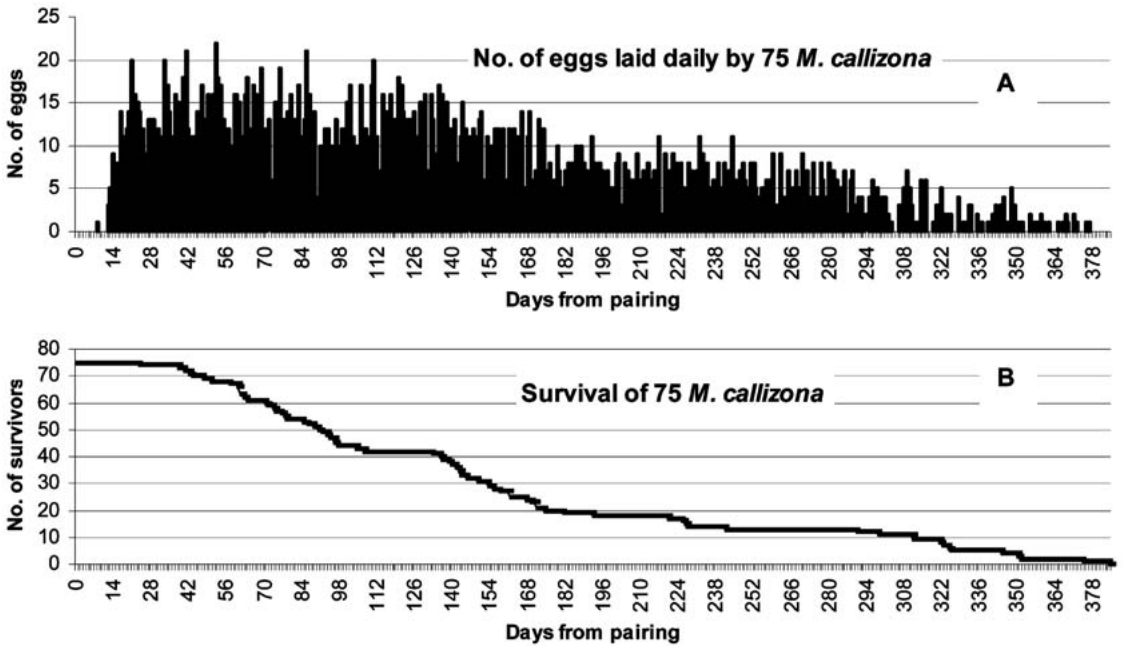

Fig. 1. A. Number of eggs laid daily by 75 *Metamasius callizona* females from day of pairing (3-5 d after emergence from the pupal stage) until the last died. B. Survival of those same 75 females over the same time period.

d) as reported by Weissling et al. (2003). The lifetime egg production (fecundity) per female *M. callizona* was 20% less (39.6 vs 51.6 eggs) in a slightly longer life (156.4 vs 142.3 d), and with maximal recorded lifespan longer (387 d vs 204 d). However, because of necessarily different substrates used and different procedures and temperature regimes, the reported differences are not statistically valid. We may only conclude that these characteristics of the two weevil species are similar. Weissling et al. (2003) calculated mean egg production during the oviposition period of *M. hemipterus* as 1.1 eggs/female/d ± 0.02, but did not explain the calculation method; we, however, calculate 0.32 eggs/female/d (see above) for *M. callizona* for which we cannot give an SD because of our method of calculation; the two values differ widely. One reviewer argued that the range of fecundity in our study was so enormous as to be unlikely unless some females had not mated successfully. However, only the 75 females that began to oviposit (80.6% of the total) were included in the study, variation in longevity was enormous, and 77% of variation in fecundity was explained by longevity.

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