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LIFE HISTORY AND DAMAGE OF A NEW BARADINAE WEEVIL (COLEOPTERA: CURCULIONIDAE) ON AMARYLLIS

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ABSTRACT

A small Baradinae weevil that feeds on amaryllis plants has been known in Florida for over 15 years. It is yet to be named taxonomically and its life history has not been studied previously. Observations on weevil damage were made on containerized amaryllis (*Hippeastrum* hybrids) plants naturally infested in a greenhouse or used for colony rearing. Laboratory studies were conducted at ambient room temperature (75°C) with excised leaves to obtain information on weevil life history. Adults lived about 3 months, and fed on basal versus apical leaf tissue. Females inserted eggs near the thickened leaf base, and eggs were 0.65 ± 0.02 mm long by 0.40 ± 0.01 mm wide. Females laid >400 eggs over their lifetime, with egg production increasing over the first 7 weeks and then tending to decline. Eclosion ranged from 51% for eggs removed from host tissue within 24 h to 84% for eggs removed from host tissue after 24 h of oviposition. In tests with excised leaf tissue, eggs hatched after 7.1 d and larval development was complete after 28.8 d, of which 9.9 d were spent as prepupae. In no-choice tests, survival was lower and pupal developmental time period was longer when larvae were reared on excised bulb versus excised leaf tissue. Although larval development was poorer on bulbs versus leaves in the laboratory studies, in intact plants larvae tunnel through leaf tissue towards the bulb where they feed and complete development. In severe infestations, larvae hollow out the inside of the bulb and may cause plant death. Adult damage is primarily to the foliage through feeding and oviposition. This is the first report to quantify the life history of this weevil.

Key Words: Amaryllidaceae, oviposition, fertility, damage

RESUMEN

En Florida por más de 15 años se ha conocido un pequeño picudo (gorgojo) de la subfamilia Baradinae que se alimenta sobre las plantas de amarilis. Todavía no se le ha dado un nombre taxonómico y su ciclo de vida no ha sido estudiado anteriormente. Se hizo observaciones sobre el daño causado por el picudo en plantas de amaryllis (*Hippeastrum* hybrids) en recipientes infestadas naturalmente en un invernadero o plantas usadas para criar la colonia. Se realizaron estudios de laboratorio a la temperatura ambiental del cuarto (75°C) con hojas cortadas para obtener información sobre el ciclo de la vida del picudo. Los adultos vivieron aproximadamente 3 meses, y se alimentaron sobre el tejido basal versus el tejido apical de la hoja. Las hembras insertaron los huevos cerca de la base engruesada de la hoja, y los huevos fueron 0.65 ± 0.02 mm de largo por 0.40 ± 0.01 mm de ancho. Las hembras pusieron > 400 huevos por su ciclo de vida, con un aumento en la producción de huevos en las primeras 7 semanas y luego tendiendo a bajar. El rango de eclosión fue desde el 51% para los huevos quitados del tejido del hospedero en el rango de 24 horas, hasta 84% para los huevos quitados del tejido del hospedero 24 horas después de la oviposición. En pruebas con tejido de hojas cortadas, los huevos se eclosionaron después de 7.1 días y el desarrollo de larva fue completo después de 28.8 días, de la cual 9.9 días pasaron como prepupas. En pruebas de no-opción, la supervivencia fue mas baja y el periodo del tiempo del desarrollo de la pupa fue mas largo cuando las larvas fueron criadas en bulbos cortados versus tejidos de una hoja cortada. Aunque el desarrollo de larvas fue pobre en bulbos versus en las hojas en los estudios del laboratorio, en plantas intactas las larvas hacen túneles por el tejido de la hoja hacia el bulbo donde se alimentan y completan su desarrollo. En infestaciones severas, las larvas hacen un hueco adentro del bulbo y pueden causar la muerte de la planta. El daño hecho por el adulto es principalmente al follaje por su alimentación y oviposición. Este es el primer informe para cuantificar la historia de vida de este picudo.

Weevils in the subfamily Baridinae have been described as difficult to characterize taxonomically and little is known about many of the species outside of their original descriptions (Anderson 2002). Of the species that have been studied, larvae tend to bore in flowers, petioles, stems, and roots of herbaceous dicots, and some infest palm fruits, grasses, and other monocots (Marvaldi 2003). Several Baridinae weevils have been identified as pests or potential pest. For example, *Palmelampius heinrichi* O'Brien, is a pest of fruit of the palm *Bactris gasipaes* H.B.K. in South America (O'Brien & Kovarik 2000). *Madarellus undulatus* (Say), *Ampeloglypter ater* (Riley), *A. sesostris* (LeConte) and *Desmoglyptus crenatus* (LeConte) are weevil species known to feed on vines of the genus *Vitis* (Vitaceae) in North America (Bouchard et al. 2005). *Stethobaris ovata* (LeConte) is a pest of native orchids (Orchidaceae) in North America (Dunford et al. 2006). Others are considered beneficial insects as palm pollinators (Barfod & Uhl 2001) or as weed biological control agents (Horner 2003).

In the early 1990s, a 5-mm long, solid black weevil was observed feeding on and occasionally killing amaryllis (Amaryllidaceae) plants in Florida, and it was determined to be an unknown genus and species in the subfamily Baridinae (Thomas 2005). Reported host plants include amaryllis *Hippeastrum* Herb. spp., spider lily *Hymenocallis* Salisb. spp., swamp lily *Crinum* L. spp., and Amazon lily *Eucharis* × *grandiflora* Planch. & Linden (Thomas 2005). In Sep 2005, we sent out surveys to 30 amaryllis growers/distributors in the southeast US, including 26 in Florida, 2 in Georgia, and 1 each in Virginia and West Virginia. The survey included background information, photos of adult weevils and damage to amaryllis plants, and a questionnaire that included the following questions on the new weevil: Have they seen it, heard of it, or observed similar damage? What are their growing conditions and pest control practices? One Florida grower reported damage but no insects, 1 Florida grower reported weevils and damage on *Hymenocallis* spp., and 1 Florida distributor indicated that they had been contacted by customers about insect damage to *Hippeastrum*. Since Nov 2005, extension personnel in Florida and in Georgia have been contacted by a landscaper and a homeowner, respectively, about insect damage to *Hymenocallis* spp. and *Hippeastrum* spp., respectively, presumably due to this weevil (N.D.E., unpublished data).

The USDA/ARS, Subtropical Horticulture Research Station (SHRS) located in Miami, FL, has a *Hippeastrum* hybridization program, and plants at the station have been subject to attack by this weevil. Because little was known about this insect, studies were initiated to quantify aspects of weevil life history including developmental time, adult longevity, oviposition, and fecundity.

Materials and Methods

Insects

The insects used in this study were obtained from a colony initiated from naturally infested containerized amaryllis (*Hippeastrum* hybrids) grown in a greenhouse at the USDA-ARS station in Miami, FL. The colony was maintained on containerized amaryllis plants held in 3 screened enclosures (1.5 m wide by 1.2 m deep by 2.3 m tall). The screened enclosures were attached to a building on one side and had a roof that gave some protection to rain and direct sunlight, but the enclosures were exposed to naturally fluctuating temperature and relative humidity. To initiate the colony and to augment the colony with wild stock periodically, adults (Fig. 1A) that had been collected by hand with a manual aspirator and infested amaryllis plants (Fig. 1B, C) from the greenhouse were added to the enclosures. Un-infested amaryllis plants in 3.8- and 7.6-L pots were added as needed to maintain active infestations. When needed for experiments, adults were collected by hand with a manual aspirator. To obtain adults of known age, soil within plant culture containers was sifted and pupae were collected. Pupae were placed individually in glass vials (10 mm diam. by 55 mm) and vials were filled half way with moistened sand. Vials were checked daily and adult emergence date was recorded. Experiments on weevil life history were all conducted under laboratory conditions under ambient temperature (75°C) and relative humidity. Experiments were conducted in rooms that had windows to provide natural lighting and that were supplemented with room lights set to a photoperiod of 12:12 (L:D) h.

Feeding Location

Preferred feeding location was determined from choice tests. Three-cm long basal and apical pieces of leaf tissue were added to a large Petri dish (100 × 15 mm) lined with water-moistened filter paper. Two mated adults were added to each arena, for a total of 10 replicates. Feeding damage and frass production were determined after 24 hr. Damage was reported as percent of total feeding on either the basal or apical piece in each arena.

Oviposition

Recently emerged adults (<7 d old) were set up in Petri dishes with moist filter paper and excised leaf tissue. Mixed sex adults were held together for 48 h to provide sufficient time for mating. After 48 h, individual weevils were placed in small Petri dishes (60 × 15 mm) lined with moist filter paper and were provided with a piece (2.54 cm) of basal amaryllis leaf. Adults that did not produce

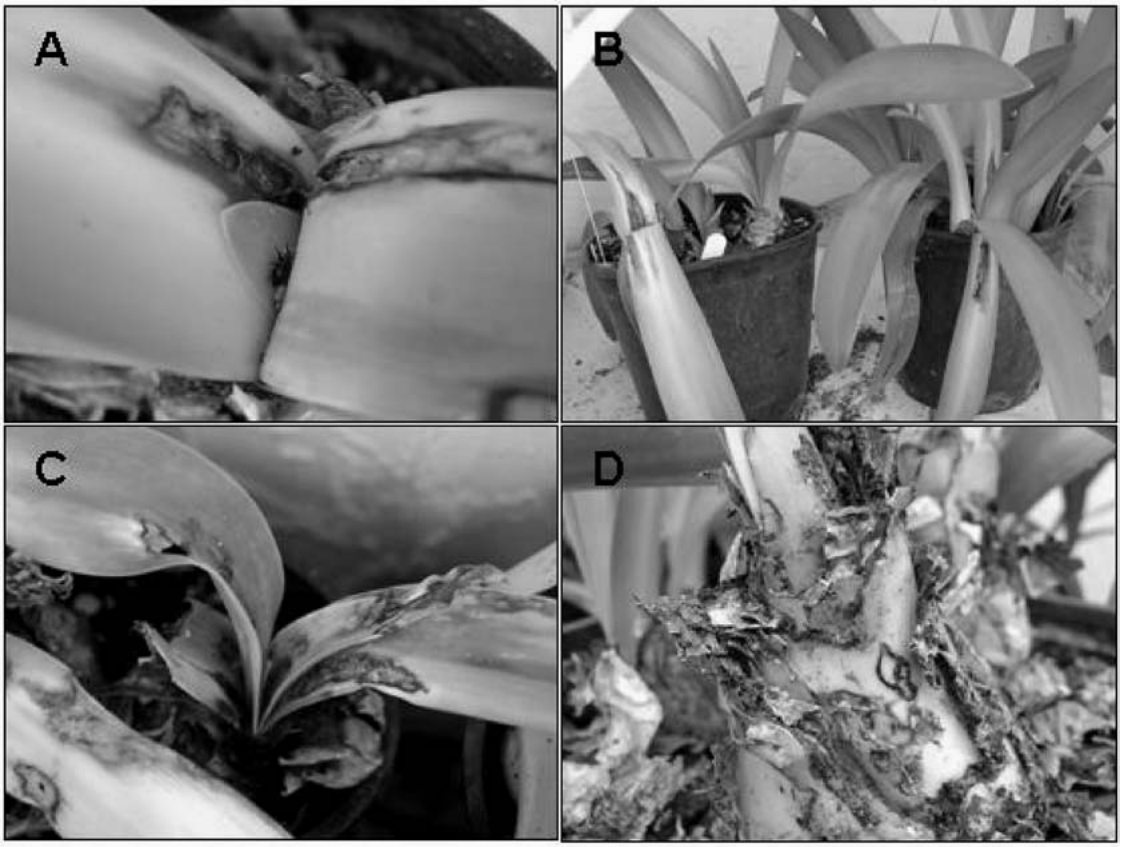

Fig. 1. (A) Adult weevil finding harborage between leaf bases on an amaryllis plant. Dark brown streaks on adjacent leaves are typically of damage due to adult feeding and oviposition activities. Amaryllis plants showing signs of (B) light, (C) moderate and (D) heavy foliar damage due to adult weevil feeding and oviposition activity.

eggs within 2 weeks were discarded from the study. Every 2-5 d, the leaf piece was removed and carefully checked for eggs, and another basal leaf piece was added. Sampling was continued until the female died. Leaves were examined under a stereomicroscope, the numbers of egg clutches and the total numbers of eggs were recorded. Egg production data were collected from 12 females.

In a separate experiment, 2 or 3 leaves from potted plants in cages containing weevils were collected and dissected. The distance eggs were laid from the bulb was recorded, and egg length and width were measured under a stereomicroscope. There were 7 replicate collections.

Egg Viability

Eggs that had been oviposited within a 48-h time period were collected by dissecting leaf tissue under a stereomicroscope and egg viability was determined from percentage hatch. Eggs were placed either on the surface of an excised piece of leaf tissue or on moist filter paper in a small Petri dish. There were 12 replicates of sets of 10 eggs per dish.

Developmental Time Period

Weevil developmental time period was determined for individuals reared on amaryllis foliage in experiment one. In experiment 2, developmental time period for individuals reared on amaryllis foliage was compared to that of individuals reared on bulb tissue (2.54 cm^3). Eggs of known age were obtained by removing leaf pieces that had been placed with mixed sex adults for 24 h. Eggs were dissected from the leaf tissue and placed individually in plastic cups (12 mL) on either moistened filter paper or on foliage (experiment 1), or on either foliage or excised bulb (experiment 2). For experiment 1, eggs were dissected from the leaf tissue within 24 h of oviposition. Additional neonates were obtained from eggs of unknown age that were placed in small Petri dishes lined with moistened filter paper. Because of lower percentage hatch and potential damage in dissecting

eggs too soon after oviposition (see Results) in experiment 1, eggs were dissected from leaf tissue at least 24 h after oviposition for experiment 2. After hatch, neonates (with leaf or bulb) were moved individually into plastic cups with a layer of vermiculite (0.5-1 cm). Neonates from dishes with moistened filter paper were transferred to an excised piece of leaf tissue. Cups were checked daily, leaf and bulb tissue replaced as needed, and date of death, hatch, prepupal appearance, pupation, and adult emergence were recorded. Descriptive statistics are presented as means and standard deviations. Two sample *t*-tests from Proc TTEST (SAS Institute 2000) were used for comparison of developmental time periods on leaf versus bulb tissue in experiment 2.

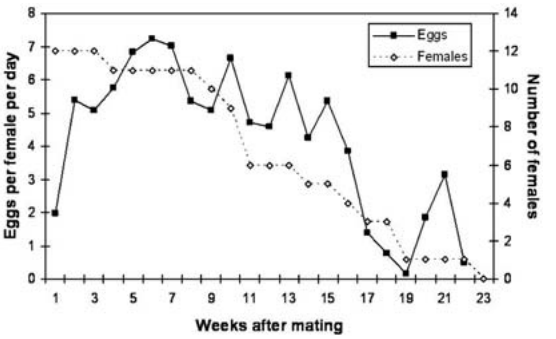

Fig. 2. Mean number of eggs per day per female (black squares, solid line) in excised amaryllis leaf tissue and survival (open diamond, dotted line) of female weevils over time (weeks).

Results and Discussion

Feeding Location

In the field, adults were observed spending considerable time seeking harborage and apparently feeding on the leaf bases (Fig. 1, T.J.W. personal observation). Adults were observed tunneling into the leaf base, and abandoned galleries were common in older leaves. Less frequently, adults were found feeding on the surface of bulbs just below the soil level. Results of the laboratory choice test indicate a strong preference for adult feeding on basal versus apical leaf tissue (97.0% ± 3.0 and 3.0% ± 3.0, respectively). Feeding was confirmed by visual observation and the presence of frass in the arenas. Preference for basal leaf tissue could be due to several factors including differences in nutrition and/or tissue quality. In addition, basal sections of amaryllis leaves are thick (2.7 ± 0.8 mm, n = 20) while apical pieces are thin (0.6 ± 0.1 mm, n = 20). Thicker tissue provides more opportunity for harborage and weevils readily bore into the thicker leaf bases.

Oviposition

After pairing recently emerged males and females, it took as few as 5 d for females to begin laying eggs. Females inserted eggs into the tissue near the thickened leaf base. Average diameter of oviposition holes measured on the leaf surface was 0.2 mm and eggs measured 0.65 ± 0.02 mm long by 0.40 ± 0.01 mm wide. Females lived 89.0 ± 38.8 d (range 21-160 d) and laid 441.1 ± 241.6 eggs (range 127-821 eggs). Eggs were laid 27.4 ± 4.9 mm (range 5-65 mm) from the leaf base.

Mating during the 48 h that females were held with males resulted in the transfer of adequate quantities of sperm to fertilize eggs without subsequent mating. The number of eggs laid per day increased steadily through the first 7 wk (Fig. 2). In general, egg production per female and female survival steadily declined after the first 7 wk, with only three females remaining alive by 18 wk and all females dead by 23 wk (Fig. 2). Eggs were laid in clutches, averaging 2.7 ± 0.7 eggs/clutch (range 1-5) and 2.7 ± 1.6 clutches/day (range 0.3-7). Percentage hatch averaged 83.6 ± 67.3% (range 0-97.2).

Developmental Time Period

Data on developmental time period and survival were obtained from 213 eggs of known age and 83 eggs of unknown age, for a total of 296 eggs evaluated (Table 1). The lower percentage hatch (51.2% survival) obtained from these eggs com-

Table 1. Within stage survival and developmental time (days) of a Baridinae weevil reared in the laboratory on excised amaryllis leaf tissue.

Stage	Within stage Survival (%)	n*	Days per stage			
			Mean	Std Dev	Min	Max
Egg**	51.2	104	7.1	1.19	5	12
Larvae	74.0	43	28.8	2.75	20	35
Pupa	94.3	17	14.2	1.47	12	17

*Number of individuals from which developmental time data was obtained.
**Eggs were dissected from amaryllis tissue within 24 h of oviposition.

Fig. 3. Weevil larvae and heavy damage to an amaryllis bulb due to a high level of larval infestation.

pared with that obtained in the oviposition study (above) may be because eggs were dissected from the plant tissue within 24 h of oviposition (experiment 1) versus between 24 and 48 h of oviposition (oviposition study), respectively. Total time period from oviposition to adult eclosion averaged 47.4 ± 3.7 d. Larvae stayed within the leaf tissue so number of instars was not determined. Late instars exited the tissue, moved into the vermiculite and became non-feeding prepupae. Of the larval developmental time, 9.9 ± 2.9 d (range 3-16 d) were spent as prepupae. Newly eclosed, teneral adults were light brown in color and did not feed. It took an additional 3.8 ± 1.1 d (range 1-6 d) for adults to become solid black and begin feeding.

When neonates hatched from eggs placed directly on the cut edge of leaf tissue, they immediately burrowed into and fed within the leaf parenchyma tissue. As the old tissue was consumed, new leaf tissue was added to the cups and larvae readily moved into the new leaf. Except for movement to new leaves, larvae remained in the leaf until exiting and becoming prepupae. In our laboratory colony, however, larvae are often recovered from bulbs of containerized amaryllis plants used for rearing. Experiment 2 compared developmental time periods for larvae on bulb tissue versus foliage. There was no difference between larval developmental time period for larvae reared on foliage versus bulb tissue (32.8 ± 2.8 d versus 31.3 ± 2.2 d, respectively; $t = 1.28$, $df = 20$, $P = 0.2139$). However, more larvae survived to the pupal stage on foliage versus bulb tissue, 17 of 31 (55%) versus 5 of 26 (19%), respectively. Pupal developmental time period was shorter for foliage-reared versus bulb-reared larvae (17.0 ± 1.7 versus 22.3 ± 3.1, respectively; $t = 4.31$, $df = 15$, $P = 0.0005$). There was 82% eclosion (14 of 17) for pupae from foliage-reared larvae versus 60% eclosion (3 of 5) for pupae from bulb-reared larvae.

Adults primarily damage amaryllis foliage through feeding and oviposition activities (Fig. 1B). However, they will tunnel through leaves and on occasion feed on the outside of bulbs (Fig. 1C, D). Eggs are laid in the leaf tissue, early instar larvae tunnel through leaf tissue towards the bulb where they feed and develop. If infestation level is high enough, as we have observed in some greenhouse-grown amaryllis or in plants used for rearing weevils for this study, larvae can severely damage the bulb (Fig. 3). Upon reaching maturity, larvae exit the bulb and enter the soil to pupate (Fig. 4). Under laboratory no-choice conditions, larvae completed their development on excised leaf tissue and on bulb tissue, but were more successful on leaf tissue. Presumably larvae feeding on intact plants could choose among leaf and/or bulb tissue, which may increase survival and decrease developmental time period obtained in our studies.

Due to their cryptic nature, infestations of amaryllis bulbs by weevils are difficult to determine until host injury is expressed. Based on developmental times, several generations a year are possible in south Florida. The host range is unknown at this time but subsequent studies on host plant preference by the weevil will result in better choices for plant culture in regions with pest infestations. Some varieties appear to be attacked more often or are more susceptible to weevil infestation (A.W.M., unpublished data). The emphasis of commercial breeding for improved *Hippeastrum* hybrids has been on large flower size and other favorable properties such as long-lasting flowers with an unusual color range (Meerow 2000). Identification of weevil resistant varieties would be an important tool for integrated pest management and control of this new amaryllis pest.

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Fig. 4. Weevil pupae that exited the amaryllis bulb as larvae and pupated in the soil.

manuscript. Voucher specimen have been placed with Dr. C. O'Brien (FL A & M Univ., Tallahassee) and are held at the USDA/ARS, Miami, FL. This study was partially supported by a grant from The Fred C. Gloeckner Foundation, Inc. (T.J.W. & A.W.M.). This article reports the results of research only. Mention of a proprietary product does not constitute an endorsement or recommendation by the USDA for its use.

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