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ONE PLANT, TWO HERBIVORE STRATEGIES: *LEMA INSULARIS* (CHRYSOMELIDAE: CRIOCERINAE) AND *ACORDULOCERIDEA COMPRESSICORNIS* (PERGIDAE: ACORDULOCERINAE) ON *DIOSCOREA MEXICANA* (DIOSCOREACEAE), WITH OBSERVATIONS ON A *LEMA* CO-MIMIC

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Abstract.—The apparently aposematic immature stages of a tropical shining leaf beetle, *Lema insularis*, are described, the host plant is revealed to be *Dioscorea mexicana*, and observations on the camouflaged larvae of a co-existing herbivore, the sawfly *Acordulocerideа compressicornis*, and the adults of a co-mimic, *Diabrotica godmani*, are made.

Key words: *Diabrotica godmani*, Galerucinae, life histories, Panama, sawfly.

The subfamily Criocerinae (Chrysomelidae) comprises 12 genera and an estimated 1,800 species, of which four genera (*Lema*, *Metopoceris*, *Neolema*, *Oulema*) and some 60–70 species are found in Central America. Larvae have been described for approximately 2% of all species, and host plants have been identified for roughly 5%.

Here we present the life history of *Lema insularis* Jacoby (Chrysomelidae: Criocerine), a common Panamanian beetle for which nothing has yet been published, and a partial life history of a coexisting herbivore, a sawfly, *Acordulocerideа compressicornis* (Rohwer) (Pergidae: Acordulocerinae), also for which nothing has been reported. The original purpose of rearing *L. insularis* was to obtain fresh fecula to analyze for the presence of the plant secondary compounds that these beetles use as a defensive shield against predators. The results of that study will be published elsewhere. The sawfly was encountered on the same plant and its cryptic strategy, in contrast to that of the apparently aposematic beetle, attracted our attention.

METHODS

All insects were collected and reared by one of us (AA) on leaves of *Dioscorea mexicana* Scheidw. (Dioscoreaceae), in Panama, Arraiján, Loma del Río, 8°56.45′N, 79°39.42′W, on the dates and under the lot numbers listed in Appendix 1.

Hyphenated numbers are Aiello lot numbers that appear on the labels of all reared specimens and their associated parts, and on corresponding lot sheets (daily data forms) maintained by Aiello at the Smithsonian Tropical Research Institute (STRI), Panama. Lot numbers consist of the year plus a sequential number. When more than one

individual was reared in a lot, an individual number (#) is appended. Thus "lot 1996-12 #5" refers to individual #5 of the 12th lot of insects collected at the same place and day, in the year 1996, and on the same plant species.

Beetle egg masses (still attached to their leaves), small beetle larvae, and sawfly larvae were kept with their leaves in individual petri dishes, inside of Ziploc® bags, each with a paper towel disk on the dish floor and a moistened folded paper towel strip on top of the cover to regulate humidity. Adult beetles and larger beetle larvae were maintained in Fabri-Kal®, 16 oz., clear plastic containers, with opaque-plastic snap-on lids, together with a sprig of their plant set into a small vial of water. Behavior was recorded at various intervals daily (with few exceptions).

Larvae were preserved by bringing them to a boil in distilled water, then dropping them into 80% ethanol. Adults were frozen, then pinned. A total of 23 *L. insularis* adults (1996-12, 1996-13, 1997-31) were obtained by rearing, plus about 60 first instars (1996-12 eggmass-1), one fourth instar (1996-13 #16), two prepupae (1996-12 eggmass-1 #7 & #8), dry cocoon material (1996-12 eggmass-1), and numerous egg wasps (1996-13). Only one *Acorduloceridea compressicornis* adult (2001-48) was obtained, as well as two prepupae (1996-15 #4 & #5).

In the description of the life stages, the larval stage is considered to have terminated with the cessation of feeding, and the wandering phase is included in "prepupa." The term "prepupa plus pupa" is used instead of "pupa" or "cocoon," in order to compensate for the fact that some individuals did not produce cocoons, and for those that did, there was no way to know just when pupation took place. The durations in these descriptions are based on all individuals completing a given stage. Durations for each stage for every individual are shown in Appendix 1.

Specimens obtained from these rearings are distributed as follows: *Lema insularis*: Smithsonian Tropical Research Institute, Panama (STRI) (lot 1996-12, and their wild-caught parents; and lots 1996-13 #1, #5, #13, #14; 1996-15; 1997-31; and 2001-37, all material); Museo de Invertebrados "G. B. Fairchild," Universidad de Panamá (MIUP) (lot 1996-13 #3, and #9); and the collection of F. Vencl, SUNY Stony Brook, New York (lot 1996-13 #2, #4, #6, #7, #8, #10, #11, and #12). *Acorduloceridea compressicornis* (single adult): the collection of A. Aiello at STRI. Plant vouchers are deposited at Herbario Nacional, Universidad Nacional Autonoma de Mexico (UNAM) (*Aiello 1491*, *1492*) and at STRI (*Aiello 1489*, *1490*, *1491*, *1511*).

RESULTS

Natural History of *Lema insularis* Jacoby

Discussion. Adults of *L. insularis* (Fig. 4) and *Diabrotica godmani* Jacoby (Chrysomelidae: Galerucinae) (Fig. 1) were found intermingled on leaves of the same secondary growth vine, *D. mexicana*. Both beetles had red to orangish pronota and cream-colored to yellow elytra, with bold, dark markings; and though the two taxa were difficult to distinguish at a glance, in *L. insularis*, the pronotum was distinctly unmarginate, hourglass-shaped, and nearly twice as long as wide, and the elytral markings were black; whereas in *D. godmani* the pronotum was clearly marginate, nearly straight-sided, and about as long as wide, and the elytral markings were metallic blue. Adult *L. insularis* ate the leaves of *D. mexicana*, but an adult *D. godmani*, maintained for several days with

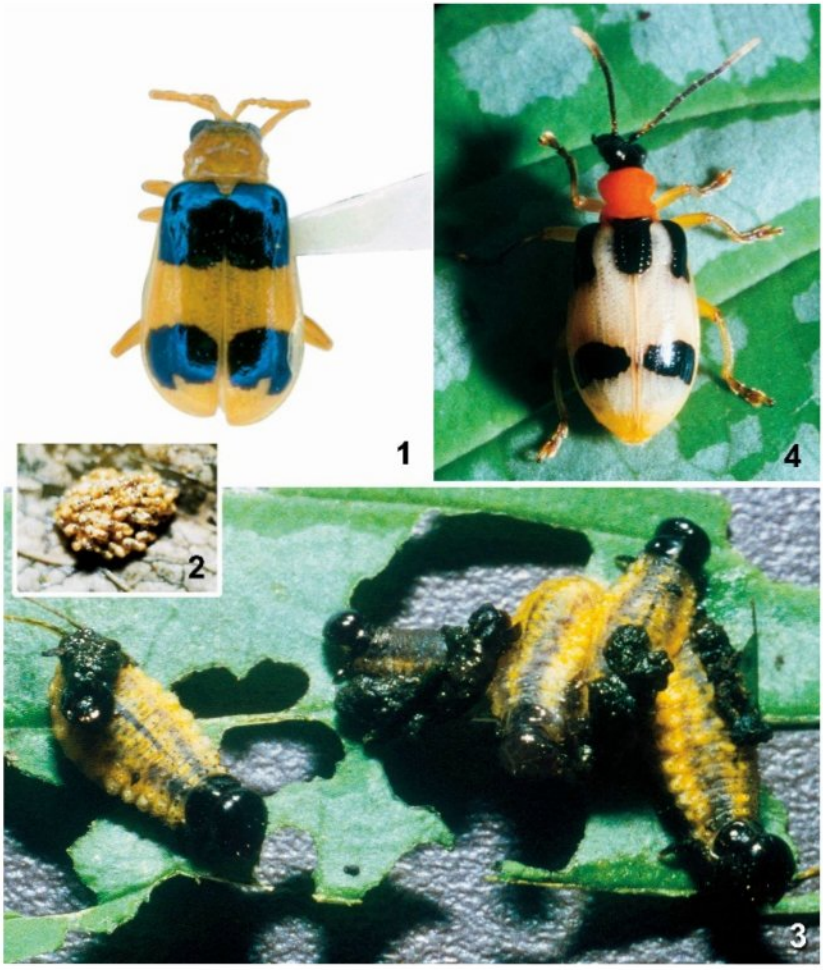


Fig. 1. *Diabrotica godmani* adult, collected in Arraiján, 22 January 1997.
Figs. 2–4. *Lema insularis*. Fig. 2. Egg shells (Aiello lot 1996-13). Fig. 3. Final instars (Aiello lot 1996-13). Fig. 4. Adult, the mother of the Aiello lot 1996-12 larvae.

that plant did not appear to eat. We have no explanation for its presence among *L. insularis*, but see comment in the discussion.

Lema insularis was reared from one of two egg masses (1996-12) produced by a pair of wild-caught adults, and from two wild-collected egg masses (1996-13 and 1997-31). A fifth egg mass (2001-37) was obtained from a second wild-caught female. All were encountered on leaves of *D. mexicana* (see Appendix 1 for details). The bright yellow eggs (Fig. 2) and striking yellow and black larvae (Fig. 3) were in sharp contrast to the leaves of their plant, and apparently are aposematic. The larvae produced wet fecula from a dorsal anus, and carried the soppy accumulation directly on their backs. This arrangement is in contrast to cassidine larvae, which have the anus in the conventional

position and carry their fecula on a specialized bifurcate structure, the urogomphi ("fecal fork").

The two *L. insularis* adults began to mate four days after capture, and remained coupled for five days, the female carrying the male on her back. The first egg mass appeared five days after the parents separated, and the second mass four days after the first. The beetles mated again the day of the second egg mass, and still again four days later, but produced no more eggs. The adults were placed in the freezer on 15 July.

At least 80 first instars emerged from egg mass-1 after five days of development, and a similar number hatched from egg mass-2 after nearly eight days. About 60 first instars were preserved from egg mass-1. The remaining 20 individuals were reared through four well-synchronized larval stadia. At maturity, three larvae prepared cocoons, from which adults later emerged. Fifteen others died as late fourth instars, and two pupated without producing cocoons and later died. The first instars of egg mass-2 were released on their original plant the day after hatching.

The larval development of 14 individuals reared from a wild-collected egg mass (1996-13) also involved four well-synchronized stadia. At maturity, 13 larvae prepared cocoons that yielded adults. Following five days of quiescence, the final individual pupated without a cocoon, and the adult emerged 10 days later. Many eggs failed to hatch and were maintained in a petri dish awaiting possible further activity. They yielded four tiny egg wasps (Eulophidae: Entedoninae) on 5 July, 12 days after the beetle larvae emerged from healthy eggs and were preparing to pupate. Fifteen more wasps emerged three days later. We have no way to know how many wasps emerged per egg.

The fourth *L. insularis* egg mass (1997-31), yielded 36 first instars over three days. The remaining eggs did not hatch. Though emergence and the molt to second stadium were staggered, by the time the larvae reached the molt to the final larval stadium, they had become synchronous except for larva #9, which delayed one day. The molt from second to third instar was not observed for this lot, and for that reason these stadia are not included in the durations given in the descriptions. Most larvae died at various stages, leaving only six individuals that survived to adults. Many of the eggs that did not hatch had cream-colored contents at each end, and a dark green, pulsating mass in the center, and it was those eggs that produced numerous tiny adult wasps (Eulophidae: Entedoninae) at about the same time the beetles were preparing to pupate.

The fifth *L. insularis* egg mass (2001-37) was produced by a wild-caught female at about 13:00 hr on the day of capture. The larvae hatched 6 days later, and were released the next day. The female was pinned.

Development and behavior

Eggs: Yellowish, soft, spindle-shaped with rounded ends, each approximately 1.00 mm long and 0.48 mm wide, oriented more or less parallel to one another to form a roughly elliptical mass about 6 mm long, and several eggs deep. Two masses deposited on upper surface of leaf, two on under surface. Duration: 5 days ($N = \geq 80$), 6 days, ($N = \geq 60$), 8 days ($N = \geq 80$).

First larval stadium: Hatchling head, pronotum, and legs densely black; body bright yellow, with small, black crescent above and partially encircling the thoracic spiracle. The anus was dorsal. Initial fecula white, presumably due to egg shell consumption. Larvae fed along the upper surface of the leaf margin, in a closely unified group; their body color soon changed to watery yellowish green and they began to carry their now wet green fecula on their backs. They regurgitated when handled. The fecal shield

turned black within a few hours and remained so thereafter. Duration: 2 days (N = 40), 3 days (N = 6).

Second larval stadium: Coloration black and watery yellowish green as before. During the molt, larvae shed their fecal protection along with the head capsule and skin, but soon accumulated fresh, black fecula on their backs. Duration: 2 days (N = 36).

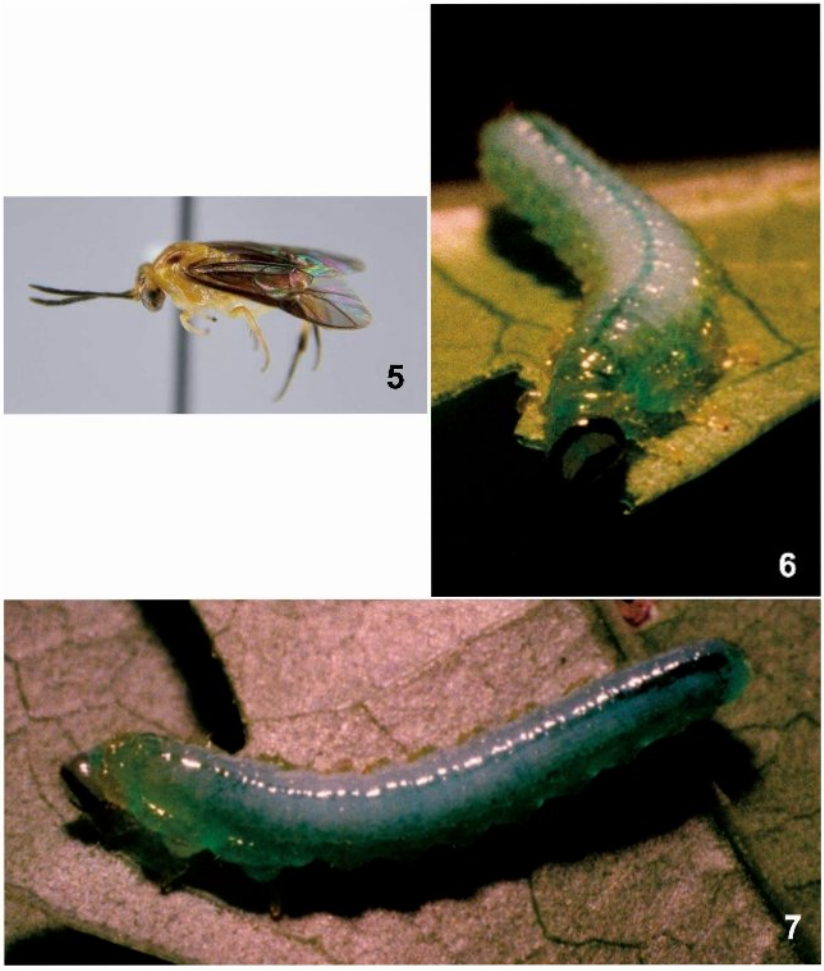
Third larval stadium: Larger version of second instar. Molt carried out in similar fashion. Duration: 2 days (N = 16), 3 days (N = 20).

Fourth larval stadium: Head, pronotum, legs, and body chalazae black; body short, pudgy, widest toward posterior end, bright yellow, apparently due to yellow fat body, and contrasting strongly with their leaf. Molted skin embedded in the fecal shield. Larvae very active, snapping the body side to side whenever disturbed. They remained as a group until cessation of feeding prior to pupation, and became obese at maturity. Duration: 4 days (N = 28), 5 days (N = 4), 6 days (N = 3).

Prepupa plus pupa: Pupa yellow, with clear appendages, darkening as adult eclosion approached. Pupation took place within a white, oral foam cocoon, produce by the larva. Eight of the 26 individuals that survived to pupation failed to secrete cocoons; they pupated naked, after remaining quiescent for a few days among the paper toweling. Three of these eight died and five survived to adults. Prepupa duration: 5 days (N = 1), 6 days (N = 2), 7 days (N = 2), 8 days (N = 1). Pupa duration: 10 days (N = 2), 11 days (N = 3).

Natural History of *Acordulocerídea compressicornis* (Rohwer)

Discussion. The first attempt to rear *Acordulocerídea compressicornis* failed (1996-15). Six well-camouflaged larvae, two together under the same leaf, were found on a *D. mexicana* vine adjacent to that of *L. insularis*. The head was blue-green, framed by a black crescent and with a black bar above the mandibles; the body was blue-green as well. All six larvae remained beneath the base of their blades, with their bodies curved to follow the contours of their feeding damage and, unlike the colorful beetle larvae, they matched the color of the leaves so well that they were nearly invisible. Like the beetle larvae they ate along the blade margin. The anus was in the standard, posterior position, and the larvae produced short, black fecal pellets, which they flicked away. Each larva molted twice, so if they had five larval stadia, as many insects do, they were in their second larval stadium at the time of collection. Molting was not synchronous. Each of the 6 larvae failed to pupate, and died. Efforts to locate further larvae were unsuccessful until more than five years later, when a single larva (2001-48) (Figs 6 & 7) was found in a container of *D. mexicana* leaves that had been collected eight days earlier to feed to an unrelated insect. Apparently the larva was a fourth instar by the time it was noticed, because 3 shed larval cuticles were found in the container. The larva molted the next day to what we assume was the fifth larval stadium. The head was colored and patterned as were the larvae of lot 1996-15, and likewise the body was blue-green and well camouflaged against the leaf, and had a dark green middorsal line. Two days later, the larva molted again and soon after began to shorten and discolor and to wander in search of a pupation place. Typical of sawflies, this final stage larval did not eat. Clay, from along a fence where *D. mexicana* grows, was added to the petri dish, and water was added to one end to provide a moisture gradient. By late afternoon the larva had disappeared into the clay. Around mid day, ten days after the molt to the non-feeding stage, an adult sawfly (Fig. 5), *Acordulocerídea compressicornis*, emerged. It was orange,



Figs. 5–7. *Acorduloceridea compressicornis* (Aiello lot 2001-48). Fig. 5. Adult. Figs 6 & 7. Larva.

with black antennae, eyes, wings, and metatarsi; the antennae had 5 flagellomeres; the meso- and meta-tibia each had a pair of curved, needle-like spurs and a similar preapical spur.

Development and behavior

Larva at collection: Head clear, with a single stemma, and framed by a black band that was widest across the frontal and stemmatal area; body slender, cylindrical, same green as the leaf. The larvae flick their fecal pellets away.

Next larval stadium: Head as before; body aqua blue, with a dark green middorsal stripe, and with a lateral, yellow swelling on each segment. Duration: 1 day (N = 2), 2 days (N = 4).

Final larval stadium: Coloration as before, until maturity, at which time the larvae faded to yellow-green (15 July), and the paper towel became tinted blue by the pigment draining from their bodies. After emptying the gut, the larvae went to the sides of the petri dish and rolled around, probably in an attempt to enter the soil. Duration: 1 day (N = 2), 2 days (N = 4).

Cocoon: The day after fading, one larva spun a smokey-colored and slightly shaggy-textured cocoon. By 24 July, four larvae had died. By 3 August, when the remaining two larvae began to dry out, and it became obvious that neither ever would pupate, they were preserved by dropping them and the cocoon directly into 80% ethanol.

LARVAL FOOD PLANT

Dioscorea mexicana is a spineless, twining, herbaceous vine, whose pubescent stems and leaves become glabrous with age, and whose slender, auriculate leaves, bear irregular silvery markings that resemble insect blotch mines. The leaves are similar in shape to those of certain other vines that grow in the same habitat, *i.e.*, some Convolvulaceae, some *Smilax* L. (Smilacaceae), and *Byttneria aculeata* (Jacq.) Jacq. (Sterculiaceae), the latter two of which also are silvery blotched. Although the *D. mexicana* voucher specimens were in sterile condition, Dr. Oswaldo Téllez Valdes (UNAM) was able to identify them readily.

DISCUSSION

The majority of criocerine taxa for which host plants are known tend to be associated with monocotyledons, *i.e.*, *Crioceris* Müller on *Asparagus* L. (Liliaceae), *Liliocerus* Reitter on *Dioscorea* L. (Dioscoreaceae) and Liliaceae, *Neolema* Monros on *Commelina* L. (Commelinaceae), *Oulema* Des Gozis on *Commelina*, *Peperomia*, and Poaceae. This neat pattern is disrupted by *Lema* Fabricius (*s.l.*), the largest criocerine genus, whose species have been reported on plants of several dicotyledonous families, and which in the New World are associated primarily with members of the Solanaceae. However, recent field work in the Central American Neotropics indicates that at least 10 *Lema* species, now including *L. insularis*, are found on *Dioscorea* (Vencl et al., 2004).

As reported by Smith (1995), many sawflies of temperate regions are associated with wind-pollinated angiosperms and lower plants, such as ferns and conifers, and very few species are associated with the higher angiosperms. Little is known of tropical sawfly larval food plants, but the few taxa reared by one of us (AA) suggest that a wide variety of angiosperm families are involved, e.g., Polygonaceae, Rubiaceae, Tiliaceae. And, many Australian Pergidae are closely associated with the Myrtaceae, including *Eucalyptus*, and are well-defended by secondary compounds obtained from their host plants (MacDonald & Ohmart, 1993).

Although adult *Diabrotica godmani* were found intermingled with adult *Lema insularis*, they were not seen to eat *Dioscorea*. The larvae of Galerucinae (Chrysomelidae), including the genus *Diabrotica* Chevrolat, are known predominantly as root feeders. *Diabrotica* adults, which eat their host's leaves, have been reported on more than 50 plants families, but principally on Poaceae and Cucurbitaceae well known for producing bitter cucurbitacins, which the beetles use as a feeding cue as well as for their own defense (Jolivet and Hawkeswood, 1995; Eben, 1999).

Though they eat the leaves of the same plant species, the larvae of *L. insularis* and *A. compressicornis* contrast sharply in color pattern and behavior. Criocerine larvae retain their excrement on top of their abdomens as a defensive chemical shield against predators, and preliminary analysis indicates that their shields are fortified with host-derived fatty acids and sapogenins, whose deterrent and toxic properties are well known (Morton and Vencl, 1998). *Acorduloceridea compressicornis* larvae flick their fecal pellets away, leading us to suspect that they lack any sort of chemical defense and rely for their protection primarily on crypsis and occult behavior. Though little is known of Neotropical sawfly biology, we can say that a broad range of behaviors can be expected and that the cryptic behavior of *A. compressicornis* is not necessarily representative. For example, the larvae of an unidentified species of sawfly, on Barro Colorado Island, Panama, eat the leaves of *Pterocarpus rohrii* Vahl (Fabaceae) and carry their fecal pellets on their bodies (AA in litt., lot 1978-54).

Lema insularis and *A. compressicornis* larvae attack different areas of the blade. The blue-green *A. compressicornis* larvae feed inconspicuously on the basal undersurface, whereas the yellow and black, aposematic larvae of *L. insularis* feed exposed on the upper surface, where potentially they are more vulnerable to predation. And, they are more vulnerable in time as well as space; *Acorduloceridea compressicornis* larvae spend one or two days in the final feeding stadium, compared with four to six days for *L. insularis*.

The eggs of *L. insularis*, though yellow and well-exposed on the leaf, do not seem to be chemically protected, at least not from the eulophid wasps that parasitize them. We did not see the eggs of *A. compressicornis*.

The details of the corresponding markings of the adults and their mingling on vegetation suggest that *L. insularis* and *D. jacoby* are co-mimics. Both have a metallic sheen, yellow-tipped black antennae, black heads, red or orangish pronota, and cream-colored to yellow elytra, with dark markings. Similar mimetic resemblances involving other species of *Lema* and *Diabrotica* have been reported by Gahan (1891) and by Balsbaugh and Fauske (1991). Adults of both genera are thought to be protected by noxious compounds, suggesting that the mimicry is Müllerian. However, the chemical content, origin, and effectiveness of these secretions remain unexplored.

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Appendix 1. *Lema insularis* and sawfly collection and development data (number of days in each stadium) and outcomes. Numbers include days spent preparing for molting or pupation, i.e., not eating. PP+P stands for "pre-pupa plus pupa," as explained in text. Final date is the date of eclosion, death, or preservation, and is not included in durations. Minimum durations (≥) are given for the stages collected or for stages cut short by preservation or natural death. A ≈ indicates a molt that occurred on a day when observations were not made. All specimens were collected in Panama Province, Arraiján, Loma del Río, 8°56.45′N, 79°39.42′W, on *Dioscorea mexicana* (Dioscoreaceae), by AA.

Name, lot, collection data	Indiv#	Oviposition	Egg	Instar 1	Instar 2	Instar 3	Instar 4	Instar 5	PP+P	Final date	Outcome
***Lema insularis*, lot 1996-12**											
Adult male and female, 22 June 1996											
Egg mass-1 had ≥80 eggs; 60 were preserved as first instars											
1996-12, egg mass-1	1	5 Jul	5	2	2	3	4	-	18	8 Aug	Adult beetle
1996-12, egg mass-1	2	5 Jul	5	2	2	3	4	-	20	10 Aug	Adult beetle
1996-12, egg mass-1	3	5 Jul	5	2	2	3	4	-	21	11 Aug	Adult beetle
1996-12, egg mass-1	4	5 Jul	5	2	2	3	4	-	≥1	22 Jul	Larva died, discarded
1996-12, egg mass-1	5	5 Jul	5	2	2	3	4	-	≥2	23 Jul	Larva died, discarded
1996-12, egg mass-1	6	5 Jul	5	2	2	3	4	-	≥2	23 Jul	Larva died, discarded
1996-12, egg mass-1	7	5 Jul	5	2	2	3	4	-	≥3	24 Jul	Larva died, preserved
1996-12, egg mass-1	8	5 Jul	5	2	2	3	4	-	≥3	24 Jul	Larva died, preserved
1996-12, egg mass-1	9	5 Jul	5	2	2	3	4	-	≥4	25 Jul	Larva died, discarded
1996-12, egg mass-1	10	5 Jul	5	2	2	3	4	-	≥4	25 Jul	Larva died, discarded
1996-12, egg mass-1	11	5 Jul	5	2	2	3	4	-	≥4	25 Jul	Larva died, discarded
1996-12, egg mass-1	12	5 Jul	5	2	2	3	4	-	≥4	25 Jul	Larva died, discarded
1996-12, egg mass-1	13	5 Jul	5	2	2	3	4	-	≥4	25 Jul	Larva died, discarded
1996-12, egg mass-1	14	5 Jul	5	2	2	3	4	-	≥4	25 Jul	Larva died, discarded
1996-12, egg mass-1	15	5 Jul	5	2	2	3	4	-	≥4	25 Jul	Larva died, discarded
1996-12, egg mass-1	16	5 Jul	5	2	2	3	4	-	≥4	25 Jul	Larva died, discarded
1996-12, egg mass-1	17	5 Jul	5	2	2	3	4	-	≥4	25 Jul	Larva died, discarded
1996-12, egg mass-1	18	5 Jul	5	2	2	3	4	-	≥5	26 Jul	Larva died, discarded
1996-12, egg mass-1	19	5 Jul	5	2	2	3	4	-	≥6	≈27 Jul	Larva died, discarded
1996-12, egg mass-1	20	5 Jul	5	2	2	3	4	-	≥6	≈27 Jul	Larva died, discarded

Appendix 1. Continued.

Name, lot, collection data	Indiv#	Oviposition	Egg	Instar 1	Instar 2	Instar 3	Instar 4	Instar 5	PP+P	Final date	Outcome
1996-12, egg mass-1	21-≥60	5 Jul	5	≥1	-	-	-	-	-	11 Jul	Preserved
Egg mass-2 slightly smaller than mass-1; first instars were released on *D. mexicana*											
1996-12, egg mass-2	1-≥60	9 Jul	8	≥1	-	-	-	-	-	18 Jul	Released larvae
***Lema insularis*, lot 1996-13** Egg mass with ≥40 eggs, 22 June 1996											
1996-13	1	- -	≥1	2	2	2	6	-	15	20 Jul	Adult beetle
1996-13	2	- -	≥1	2	2	2	4	-	19	22 Jul	Adult beetle
1996-13	3	- -	≥1	2	2	2	4	-	19	22 Jul	Adult beetle
1996-13	4	- -	≥1	2	2	2	4	-	19	22 Jul	Adult beetle
1996-13	5	- -	≥1	2	2	2	4	-	19	22 Jul	Adult beetle
1996-13	6	- -	≥1	2	2	2	4	-	20	23 Jul	Adult beetle
1996-13	7	- -	≥1	2	2	2	4	-	20	23 Jul	Adult beetle
1996-13	8	- -	≥1	2	2	2	4	-	20	23 Jul	Adult beetle
1996-13	9	- -	≥1	2	2	2	4	-	21	24 Jul	Adult beetle
1996-13	10	- -	≥1	2	2	2	5	-	20	24 Jul	Adult beetle
1996-13	11	- -	≥1	2	2	2	5	-	20	24 Jul	Adult beetle
1996-13	12	- -	≥1	2	2	2	5	-	20	24 Jul	Adult beetle
1996-13	13	- -	≥1	2	2	2	5	-	23	26 Jul	Adult beetle
1996-13	14	- -	≥1	2	2	2	6	-	22	26 Jul	Adult beetle
1996-13	15	- -	≥1	2	2	2	6	-	≥4	≈9 Jul	Larva died in cocoon, discarded
1996-13	16	- -	≥1	2	2	2	≥3	-	-	2 Jul	Larva preserved
1996-13	17	- -	≥1	2	≥1	-	-	-	-	26 Jun	Larva died, discarded
1996-13, unhatched eggs		- -	≥13-15	-	-	-	-	-	-	5-8 Jul	19 adult wasps (Eulophidae) 5 pointed, rest 80% ethanol

Appendix 1. Continued.

Name, lot, collection data	Indiv#	Oviposition	Egg	Instar 1	Instar 2	Instar 3	Instar 4	Instar 5	PP+P	Final date	Outcome
***Lema insularis*, lot 1997-31** Egg mass, 9 November 1997											
1997-31	1	- -	≥4	3	≈2	≈2	≈4	-	19	13 Dec	Adult beetle
1997-31	2	- -	≥4	3	≈2	≈2	≈4	-	18	12 Dec	Adult beetle
1997-31	3	- -	≥4	3	≈2	≈2	≈4	-	21	15 Dec	Larva died in cocoon, discarded
1997-31	4	- -	≥4	3	≈2	≈2	≈4	-	21	15 Dec	Adult beetle
1997-31	5	- -	≥4	3	≈2	≈2	≈4	-	≥1	25 Nov	Larva died, discarded
1997-31	6	- -	≥4	3	≈2	≈2	≈4	-	17	11 Dec	Adult beetle
1997-31	7	- -	≥5	2	≈2	≈2	≈4	-	18	12 Dec	Adult beetle, poor eclosion
1997-31	8	- -	≥5	2	≈2	≈2	≈4	-	10	4 Dec	Pupa died, discarded
1997-31	9	- -	≥6	2	≈2	≈2	5	-	17	13 Dec	Adult beetle
1997-31, unhatched eggs	many	- -	≥19	-	-	-	-	-	-	28 Nov	Adult wasps (Eulophidae)
***Lema insularis*, lot 2001-37** Adult female, 25 November 2001 Oviposited same afternoon at 1300 hours											
2001-37	-	25 Nov	6	≥2	-	-	-	-	-	2 Dec	Released larvae
***Acorduloceridea compressicornis*, lot 1996-15** Larvae, probably second instars, 11 July 1996											
1996-15	1	- -	-	-	≥1	2	2	-	≥18	3 Aug	Larva preserved
1996-15	2	- -	-	-	≥1	2	2	-	≥8	24 Jul	Larva died, discarded
1996-15	3	- -	-	-	≥2	1	2	-	≥8	24 Jul	Larva died, discarded
1996-15	4	- -	-	-	≥2	1	2	-	≥8	24 Jul	Larva died, preserved
1996-15	5	- -	-	-	≥2	2	1	-	≥8	24 Jul	Larva died, preserved
1996-15	6	- -	-	-	≥2	2	1	-	≥18	3 Aug	?, preserved

Appendix 1. Continued.

Name, lot, collection data	Indiv#	Oviposition	Egg	Instar 1	Instar 2	Instar 3	Instar 4	Instar 5	PP+P	Final date	Outcome
***Acorduloceridea compressicornis*, lot 2001-48**											
Collected undetected, as egg or early stadium larva, 9 December 2001											
2001-48	1	- -	≥1	?2	?2	?2	?2	2	10	30 Dec	Adult sawfly