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Natural history of the tortoise beetle, *Discomorpha*
(*Discomorpha*) *biplagiata* (Guérin)
(Chrysomelidae: Cassidinae: Omocerini)

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Abstract. The first natural history account of *Discomorpha* (*Discomorpha*) *biplagiata* (Guérin) (Chrysomelidae: Cassidinae: Omocerini) from Ecuador is presented. Larvae and adults feed on the leaves and stems of *Cordia hebeclada* Johnst. (Boraginaceae), the first documented host plant for the species. Oviposition and pupation also occur on this host. Young larvae suffered heavy predation, especially from *Ectatomma* sp. (Formicidae: Ponerinae) and *Oplonus* nr. *marginalis* (Pentatomidae: Asopinae).

Resumen. Se presenta la primera cuenta de la historia natural para *Discomorpha* (*Discomorpha*) *biplagiata* (Guérin) de Ecuador. Las larvas y los adultos se alimentan de las hojas y tallos de *Cordia hebeclada* Johnst. (Boraginaceae), su primera planta hospedera documentada. La oviposición y la pupación también ocurren en este huésped. Las larvas jóvenes sufren depredación grave por *Ectatomma* sp. (Formicidae: Ponerinae) y *Oplonus* nr. *marginalis* (Pentatomidae: Asopinae).

Key Words. Ecuador, Cassidinae, *Discomorpha*, *Cordia*, larvae, fecal defense.

Introduction

The Neotropical tortoise beetle tribe Omocerini Hincks comprises 12 genera and ~145 species (Borowiec and Świętojańska 2015). The adults are almost circular in dorsal aspect (~1 cm long and wide) and commonly have conspicuous contrasting dorsal coloration of red and black or blue-black. *Borago* L. and *Cordia* L. host plants (Boraginaceae) are known as hosts for 13 species in the tribe (Fiebrig 1910; Bondar 1929; Costa Lima 1955; Windsor et al. 1992; Buzzi 1994; Flowers and Janzen 1997; Chaboo and Borowiec 2003; Nogueira-de-Sá et al. 2004; Borowiec and Moragues 2005; Flinte et al. 2008), and *Hyptis* Jacq. (Lamiaceae) has been documented as host for two species of *Omocerus* Chevrolat (Fiebrig 1910; Viana 1964; Jolivet 1997; Borowiec and Moragues 2005). Immature stages (larvae) are described for only three species in this entire tribe—*Cassidinoma denticulata* (Boheman), *Discomorpha* (*Discomorpha*) *languinosa* (Boheman), and *Omocerus* (*Nebroma*) *klugi* (Spaeth) (Candèze 1861; Fiebrig 1910). Some biological information has been captured in images for an additional four—*Canistra* (*Canistrella*) *rubiginosa* Guérin, *Polychalca* (*Desmonota*) *platynota* (Germar), *Discomorpha* (*Vulpia*) *nevermanni* (Spaeth), and *Discomorpha* *winkleri* (Spaeth) (Flinte et al. 2008; Świętojańska 2009; Discover Life 2015).

The tribe Omocerini is diagnosed by 13 synapomorphies, including some unique features of the prothoracic scoli and urogomphi (Fernandes 2011). Sampling of omocerines in modern phylogenetic studies has been limited but suggests monophyly (Hsiao and Windsor 1999: *Discomorpha* + *Omocera*; Chaboo 2007: *Canistra* + *Oxynodera* + *Prenea* + *Polychalca*). Fernandes (2011) found the relationship: (*Carlobruchia* (*Cassidinoma* (“*Polychalca*” + “*Omocerus*”))) + (*Canistra* (“*Cyclosoma*” + “*Discomorpha*”)) [“” denotes paraphyletic genera].

According to the online catalog of Cassidinae s. str. (Borowiec and Świętojańska 2015), *Discomorpha* Chevrolat, 1836 currently comprises 61 species in three subgenera—*Discomorpha* (52 species),

Paravulpia Spaeth, 1940 (1 species), and *Vulpia* Spaeth, 1913 (8 species). These species are primarily South American (Colombia to Argentina, Brazil, and Peru, but not in Chile); a few species occur in Central America (Belize, Costa Rica, Nicaragua, and Panama), and two species extend to the Caribbean island of Trinidad. The unusual record of one species, *Discomorpha tricolor* (Herbst), from India is inaccurate. It should be noted that Fernandes (2011) concluded that *Discomorpha* is paraphyletic with other omocerine genera.

The biology of *Discomorpha* species, apart from geographic records on specimen labels, is poorly known. Supplementary details on genitalia are available for *Discomorpha* (*Discomorpha*) *atahualpai* Borowiec, *Discomorpha* (*Discomorpha*) *davidsoni* Borowiec, and *Discomorpha* (*Discomorpha*) *howdenorum* Borowiec (Borowiec 2006). *Discomorpha* adults show a remarkable range of colored and immaculate forms, from black (e.g., *Discomorpha heikertingeri* (Spaeth)) to striking color contrasts of yellow and black (e.g. *Discomorpha* (*Discomorpha*) *ganglbaueri* (Spaeth)), orange-yellow (e.g., *Discomorpha* (*Discomorpha*) *howdenorum* Borowiec), or metallic green (e.g., *Discomorpha* (*Discomorpha*) *metallica* (Guérin)). A few species show sexually dimorphic coloration, e.g., *Discomorpha* (*Discomorpha*) *languinosa* (Boheman).

Cassidine life cycles are poorly known (Kosior 1975; Borowiec and Świętojańska 2014); juveniles have been documented for ~250 species (Świętojańska 2009). Images of immature stages of *Discomorpha* (*Vulpia*) *nevermanni* (Spaeth) are available online (Borowiec and Świętojańska 2015). In this paper, we present the first natural history report based on fieldwork and specimen collections for *Discomorpha* (*Discomorpha*) *biplagiata* (Guérin), which is known from Ecuador and the rest of northern South America.

Materials and Methods

Materials. The natural history and descriptions are based on specimens from ECUADOR: *Los Ríos Province*: Estación Experimental Tropical Pichilingue, Sector “Sta. Rita”, 01.07813°S, 079.46774°W, 71 m, ex *Cordia hebeclada* I.M. Johnst. (Boraginaceae), coll. R.W. Flowers, deposited at the Pontificia Universidad Católica de Ecuador (PUCE).

Field study. Author RWF studied beetle populations on a single host plant in Ecuador (Fig. 1–4) over two observational periods: 22 days during 13 September–10 December 2009, at the end of the local dry season, and 11 days during February to March 2011, during the local rainy season (which was unusually dry in 2009). In early 2010 the plant was chopped back (Fig. 1). During November–December 2010 it had regrown (Fig. 3) but was not occupied by beetles. In February 2011 the population was rediscovered with 96 larvae and 10 adults present. During both observation periods egg masses and larvae were reared in the entomology laboratory at Pichilingue to obtain adults. Immature stages were maintained in plastic containers and fed leaves from the host plant. Field photography was done by RWF with a Nikon Coolpix S7C. Images were minimally edited and arranged as plates using Adobe PhotoshopCS6.

Locality. The original lowland tropical rainforest has been cut for agriculture since the 1940s. The field station has patches of mature rainforest, which may be secondary or remnants of original forest. Average yearly temperature is moderate with monthly maximums of 15.7–29.5°C; rainfall is approximately 2.8 m annually, with single dry and wet (December–April) seasons annually. It appears that the regional climate is experiencing more extreme dry (longer season) and wet seasons (more rainfall) (El Universo 2010).

Host plant. *Cordia hebeclada* ranges from Colombia to Bolivia (Neotropical Flora 2015). It grows as a woody shrub (Fig. 1–4), and matures into a tall tree, up to 35 m (Vargas 2002).

Other arthropods on this plant. Spiders, several ant species (especially *Ectatomma* Smith, Ponerinae), stinkbugs (Heteroptera: Pentatomidae, Asopinae), Diptera, and Lepidoptera (caterpillars) were present on the plant. Several ant species were present, but *Ectatomma* (known locally as *la hormiga tostada* [toasted ants]) were most common on all plants in this habitat.

Specimens. Specimens of all life stages (1 ootheca; 25 larvae; 10 pupae; 1 adult) were collected into 70% ethanol, under permit from the Agencia Ecuatoriana de Aseguramiento de la Calidad del Agro (AGROCALIDAD, Ecuador) to RWF. Voucher insect specimens are deposited at the Museo Ecuatoriano de Ciencias Naturales (MECN), Quito, Ecuador. The plant was identified as *Cordia hebeclada* Johnst. (Boraginaceae) at the Herbario Quito–Católico, PUCE, and a specimen of the host plant are deposited in the PUCE, Quito.

Discomorpha species identification. We identified this as the immaculate form of *D. (D.) biplagiata*, which lacks the red-colored patches on the elytral margin, after discussion with cassidine experts Lech Borowiec (Poland) and Rob Westerduijn (Netherlands). The color variation may reflect a local variety. A revision of the 61 species of this genus will help clarify the outstanding questions of monophyly and the evolutionary status of the species.

Results and Discussion

Females lay eggs grouped in oothecae, which were numerous on the plant in both dry and wet seasons but more so in March 2011 (after February rains). A maximum of 10 oothecae were observed in October 2009. These oothecae were placed ventrally on the mid- or lateral ribs of upper leaves (Fig. 5, 6, respectively), and glued directly to the leaf surface (no stalk). Oothecae were occasionally densely spaced, with several on the same leaf (Fig. 5); in one case, two oothecae seemed to be fused. Oviposition was not observed. Fresh oothecae are pale tan colored but darkened slightly by the following day. Their texture was papery and firm but became spongy in ethanol. Apparently-fresh oothecae were tagged on the plant, and hatching was observed 5 days later (Fig. 7). The maximum number of neonates observed hatching from an ootheca was 36. Several oothecae were damaged, with a distinct chewing pattern—completely chewed medially—suggesting ant predation, but attacks were not directly observed. Adults laid oothecae on the uppermost leaves of the host plant, but by the time the eggs hatched the plant had grown additional upper leaves, creating leaf cover for the newly hatched larvae. Adults chew large holes in the leaves during feeding. Generally only one or two adults were found, but when the population was rediscovered in 2011 ten adults were initially present, probably due to recent emergence from grouped pupae.

Several clusters of newly hatched larvae were observed throughout the 2009 season, but all larvae disappeared before maturing to later instars. The neonate larva has a black head, a yellowish-brown thorax with black markings, and yellowish-brown abdomen (Fig. 7). Younger larvae clustered together, but older instars were more loosely arranged over the plant. Larvae generally do not show cycloalexy. A weak cycloalexic aggregation was observed only once in a group of 1st instars.

Neonates migrated to the apex of the leaf and began feeding by scraping the upper surface. The group damaged the leaf heavily, which then dried and curled. About a day after hatching, 1st instars had created a small black fecal shield comprising a few filaments (Fig. 8, 9). When larvae detected movement nearby they agitated their fecal shields.

The 2nd instars fed gregariously by scraping, leaving “windows” and small holes on the leaf (Fig. 10). They maintained a moist fan-shaped fecal shield. The 3rd instars were initially tan and black (Fig. 11) but became blackened by late 3rd instar (Fig. 12). The 3rd and 4th instars were also gregarious and maintained a shield (Fig. 12, 13); they were still tan-and-black coloration. The 5th instars had a pinkish tan background body color, with black spots (Fig. 14). Older larvae produced a lot of feces, which were deposited as semisolid filaments on the substrate and could accumulate on the leaf (Fig. 15). Later instars made irregular holes in the host leaves, similar to adult feeding damage.

Fifth instars (Fig. 14, 16, 17) retained the shield of the previous instar but did not add to the shield; if the shield fell off, they did not replace it (Fig. 18). By late instar, all 5th instars lost the exuvio-fecal shield. These older larvae significantly impacted the plant, by skeletonizing the leaf, consuming even the ribs. Pupation was gregarious, on the ventral surface of leaves (Fig. 16, 19). Pupae did not retain a fecal shield but retained only the 5th-instar exuviae, with the urogomphus displayed (Fig. 19, 20).

Ectatomma ants were observed interfering with younger larvae. Adult stinkbugs (Pentatomidae: Asopinae: *Oplomus* nr. *marginalis*) (Fig. 21, 22) frequently attacked mature larvae and pupae; curiously, clusters of apparently dead pupae had 1st-instar stinkbug nymphs hidden underneath, suggesting that

they had fed on and killed the *Discomorpha* pupae. A spider was observed interfering with 2nd instars (Fig. 23). Fig. 24 shows an adult *Discomorpha*.

The natural history data we present suggest several interesting questions and potential evolutionary patterns. First, many tortoise beetles show aggregated egg masses, but only a few appear to have oothecal arrangements, with multiple membranous layers as in the present *Discomorpha* species (see Chaboo 2007). The ornate ootheca may provide protection from enemies. Second, we observed that these *Discomorpha* juveniles experienced severe predation pressure. Ants in the genus *Ectatomma* attacked young larvae, and most cohorts observed were gone the next morning. A spider (unknown identification) ate most of a cohort as they hatched. Based on our observations of this population, it appears that the larvae of *Discomorpha biplagiata* have very low survivorship in the first two larval instars but the chance of their surviving to adulthood improves if they can survive to the 3rd instar. The most salient aspect of this study was how difficult it was for this species to establish a subsequent generation of offspring at Pichilingue. Most newly hatched larvae quickly disappeared from their feeding aggregations, most likely due to ant predation. An unknown set of conditions at the beginning of 2011 (when RWF was not in Ecuador) apparently enabled a colony to establish itself, and the larvae to grow large enough to fend off ant attacks (although they were still vulnerable to predatory stink bugs).

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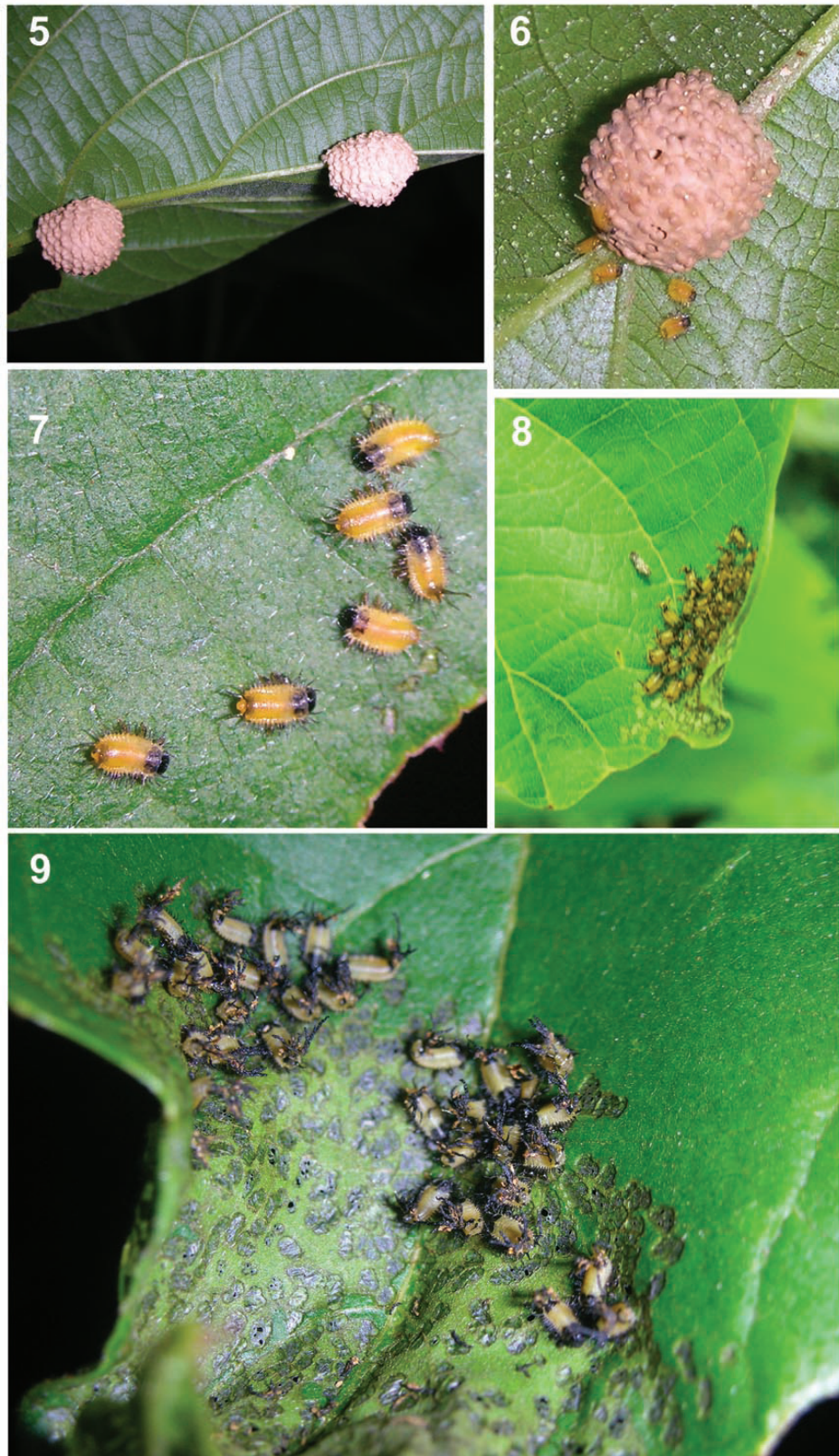
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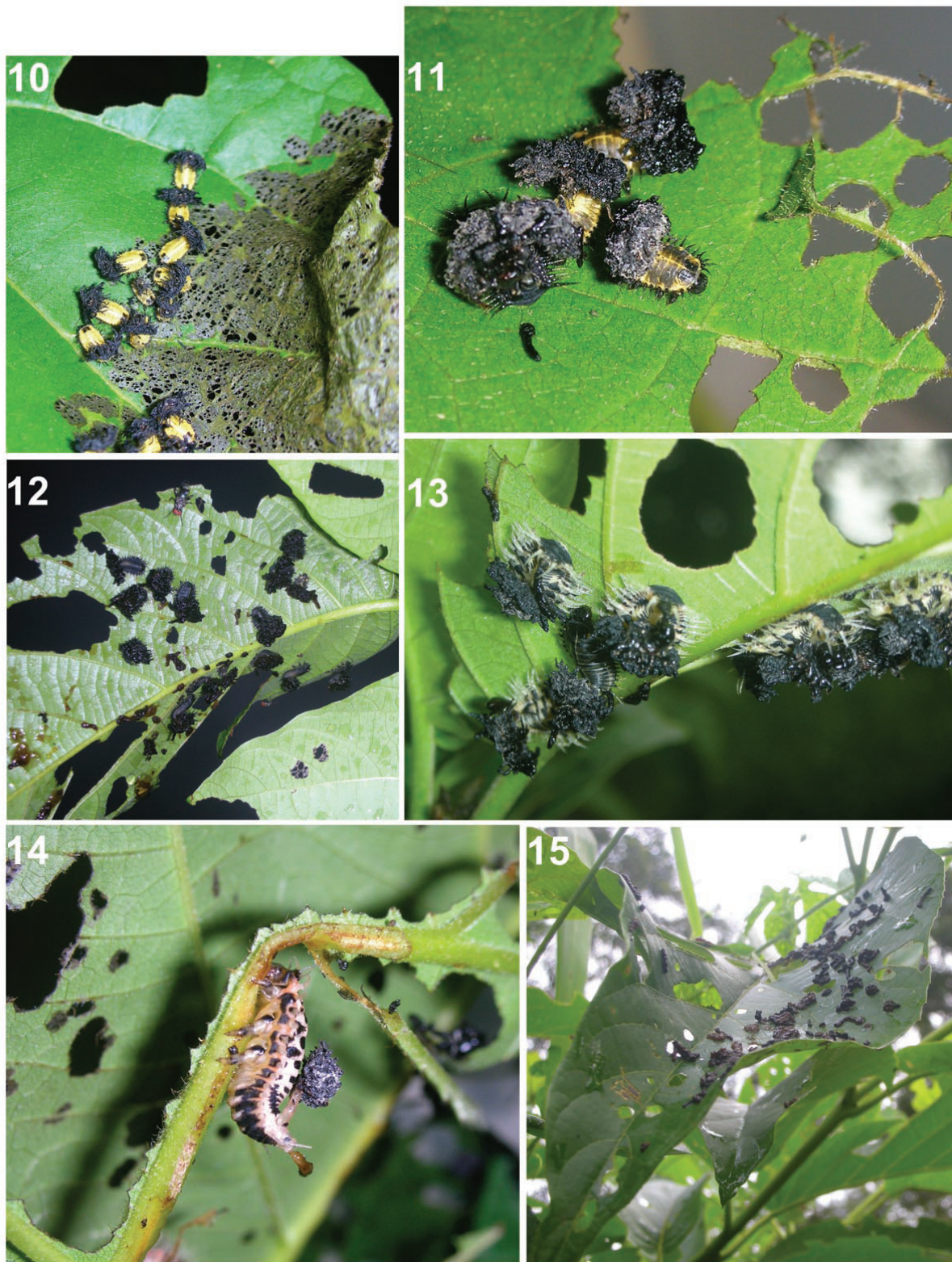
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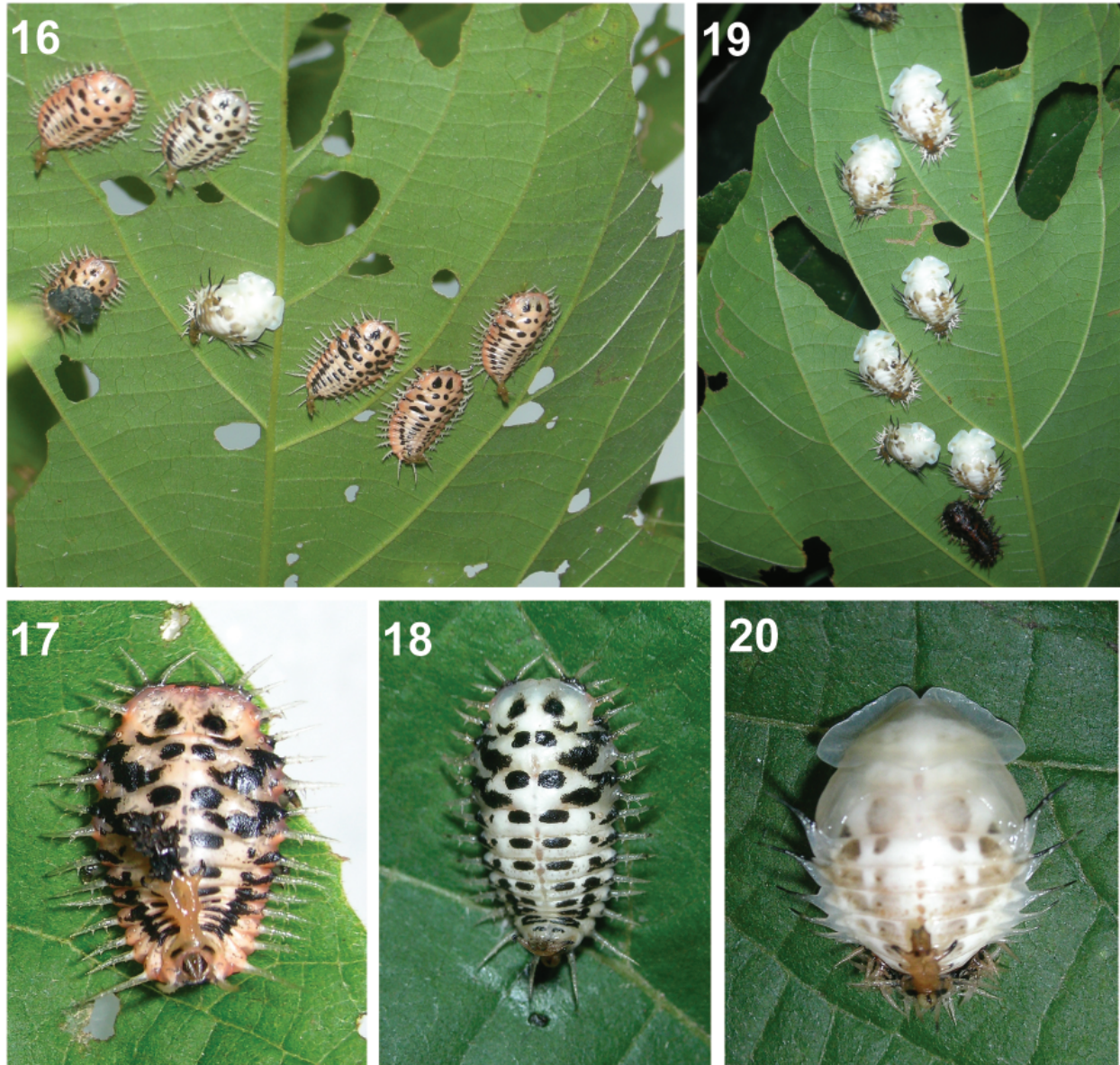
Figures 1–4. *Cordia hebeclada* Johnst. (Boraginaceae), host plant of *Discomorpha* (*Discomorpha*) *biplagiata* in Ecuador. **1)** Resprouting host plant on Pacific side of Ecuador, March 2011. **2)** Host plant, regrowing. **3)** Host plant, regrown. **4)** Feeding damage of older larvae and adults.



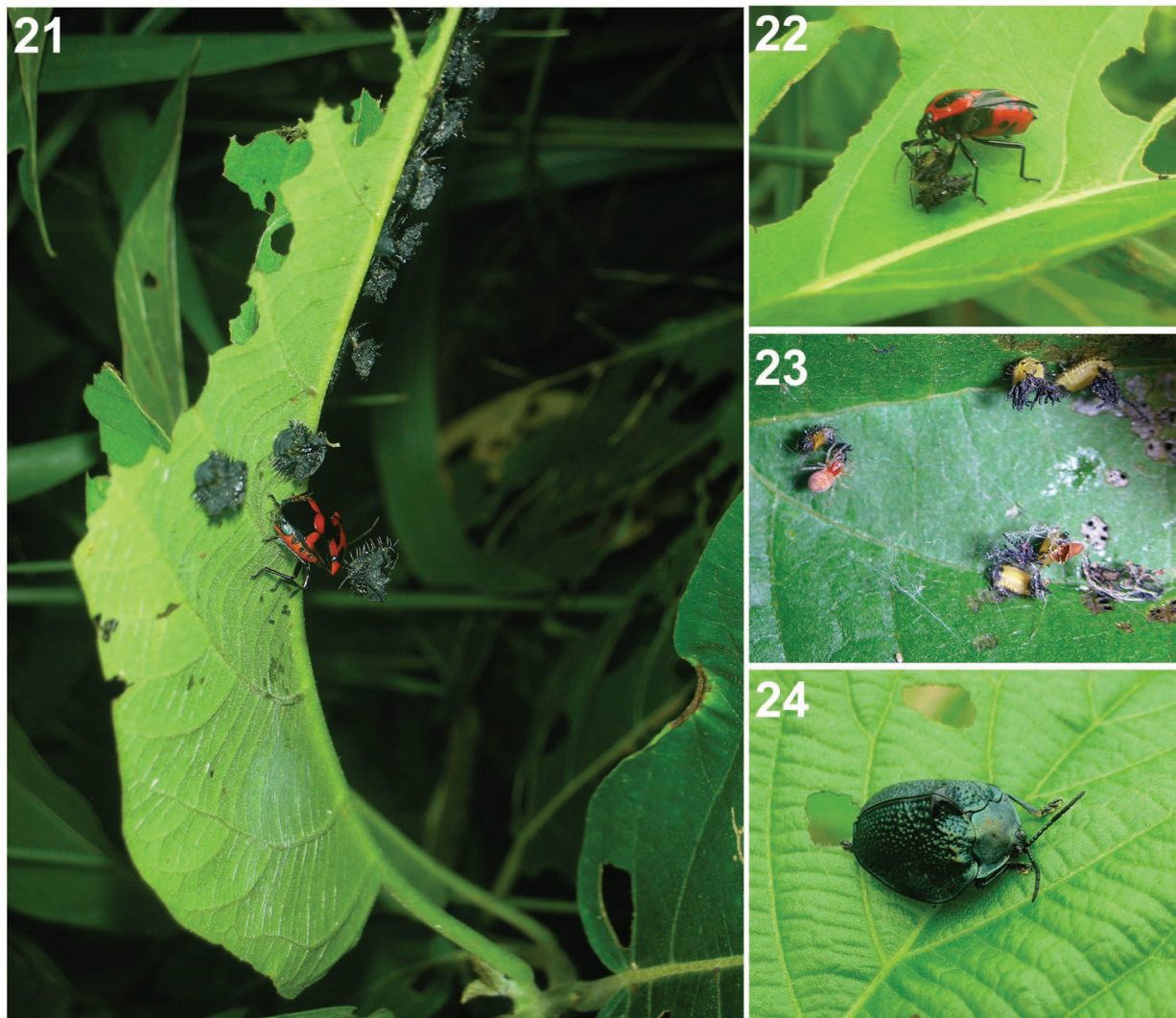
Figures 5–9. Juvenile stages of *Discomorpha* (*Discomorpha*) *biplagiata*. **5)** Two oothecae attached to midrib. **6)** Ootheca attached to lateral rib. **7)** 1st instars. **8)** 1st instars, shields not yet developed. **9)** 1st instars feeding gregariously at leaf apical margin, with shields developing.



Figures 10–15. Juvenile stages of *Discomorpha* (*Discomorpha*) *biplagiata*. **10)** 2nd instars, hardened shields well developed and feeding gregariously. **11)** 3rd instars feeding in smaller groups, and exhibiting color darkening. **12)** Late 3rd instars, body blackened and shields moist, still feeding gregariously by chewing leaf (not scraping; fly undetermined). **13)** 4th instars, with shields intact, feeding on leaf midrib after skeletonizing leaf. **14)** 5th instar. **15)** Larval feces on leaf.



Figures 16–20. Pupation of *Discomorpha (Discomorpha) biplagiata*. 16) Gregarious pupation, early stage. 17) 5th instar. 18) Prepupa. 19) Pupal group. 20) Pupa with color change and exuvial shield formed by cast skin of 5th instar; note urogomphus of 5th-instar exuviae.



Figures 21–23. Arthropod enemies of *Discomorpha* (*Discomorpha*) *biplagiata*. **21)** Larvae under attack by pentatomid adult. **22)** Pentatomid preying on larva. **23)** Spider attacking larva. **24)** Adult *Discomorpha biplagiata*.