

Immature stages of *Mechanitis polymnia casabranca* (Nymphalidae, Danainae)

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Abstract: The immature stages of the butterfly *Mechanitis polymnia casabranca* (Haensch, 1905) are described in detail. The eggs are ellipsoidal, taller than wide, white and laid in clusters on the upper surface of mature leaves of Solanaceae host plants. The larva passes through five instars. The first instar head capsule is black and the body is translucent white. From the second instar on, the head capsule changes to light brown, and the body changes to light gray, turning bluish yellow before pupation. Initially, the pupa is yellow with black markings, turning reflective silvery after the first day. The immature stages are similar to other species of *Mechanitis*, however it is possible to differentiate the larvae of *M. polymnia* by the light brown head capsule in the second and subsequent instars.

Resumen: Los estados inmaduros de la mariposa *Mechanitis polymnia casabranca* (Haensch, 1905) se describen en detalle. Los huevos son elipsoidales, más altos que anchos, blancos y colocados en grupos en la superficie superior de las hojas maduras de las plantas hospederas de Solanaceae. Las larvas pasan por cinco instares. La cápsula de la cabeza del primer instar es negra y el cuerpo es blanco translúcido. A partir del segundo instar, la cápsula de la cabeza cambia a marrón claro y el cuerpo cambia a gris claro, tornándose amarillo azulado antes de la pupación. La pupa temprana es amarilla con marcas negras, volviéndose plateada iridiscente después del primer día. Los estados inmaduros son similares a otras especies de *Mechanitis*, sin embargo, es posible diferenciar las larvas de *M. polymnia* por cápsula de cabeza marrón claro desde el segundo estadio.

Key words: Early stages, Ithomiini, life cycle, Mechanitina, Solanaceae.

Palabras claves: Estados inmaduros, Ithomiini, ciclo vital, Mechanitina, Solanaceae.

INTRODUCTION

The tribe Ithomiini (Danainae) comprises about 390 species that occur in humid forests in the Neotropical region at elevations from sea level to 3000 m, from Mexico to Argentina (Willmott & Freitas, 2006; De-Silva *et al.*, 2017). Virtually all ithomiine species are aposematic and unpalatable, and they are typically central models in Neotropical insect mimicry rings (Brown, 1984, 1985; Trigo & Brown, 1990). Immature stages have been described for many species in the tribe, representing all of the main lineages and the majority of described genera (see Brown & Freitas, 1994; Willmott & Freitas, 2006; Hill, 2006; Hill & Tipan, 2008; Greeney *et al.*, 2009; Giraldo & Uribe, 2012; Hill *et al.*, 2012; Giraldo *et al.*, 2013). However, despite their known importance for the taxonomy and systematics of Ithomiini (Brown & Freitas, 1994; Willmott & Freitas, 2006), for most species in the tribe the immature stages are still poorly described or unknown, including several common and widespread species.

With five recognized species and 47 described subspecies (Warren *et al.*, 2019), the genus *Mechanitis* is typical of the above scenario. Although some descriptions of the early stages have been published in recent decades (Ajmat de Toledo & Terán, 1970; Young & Moffett, 1979; Brown & Freitas, 1994; Motta, 1998; Giraldo & Uribe, 2010a,b; Anteparra *et al.*, 2011; Hill *et al.*, 2012; Giraldo & Uribe, 2012; Giraldo *et al.*, 2014), most are incomplete and poorly detailed, with thorough descriptions available for very few subspecies and populations. Detailed information on immature stages from multiple populations could help improve our knowledge of species limits and interpret phenotypic variation in adults, reveal the extent to which immature stage morphology is a reliable indicator of taxonomy, potentially help identify cryptic taxonomic diversity, and assist in conservation. The subject of this paper is a good example; *Mechanitis polymnia casabranca* (Haensch, 1905) is one of the most common ithomiine species occurring in eastern Brazil (Brown, 1979), yet no detailed descriptions of its immature stages have been published. Previous studies of

this taxon have included lists of host plants, brief descriptions of immature stages and a few ecological and behavioral studies (Drummond & Brown, 1987; Vasconcellos-Neto & Monteiro, 1993; Brown & Freitas, 1994; Portugal & Trigo, 2005). The main objective of this study is, therefore, to present a detailed description of the immature stages of *M. polymnia casabranca* in order to provide data that might help better understand species limits and variation within *Mechanitis*.

MATERIAL AND METHODS

Study Sites

Adults and immatures of *M. polymnia casabranca* were studied in three different localities in São Paulo State, southeastern Brazil: 1) Reserva Biológica Municipal da Serra do Japi, Jundiá (900–1100 m; 23°14'S, 47°06'W); 2) ARIE Mata de Santa Genebra, Campinas (600–620 m; 22°49'S, 47°06'W); and 3) Parque Estadual Xixová-Japuí, São Vicente (20–200 m; 23°59'S, 46°23'W). This butterfly is generally very common, and immature stages were observed several times by all authors in many different localities in southeastern Brazil.

Morphology and Taxonomy

Descriptions here are mostly based on material from Serra do Japi, from where 10 egg batches (n = 16 to 27 eggs) were collected on *Solanum robustum* H. L. Wendl. (Solanaceae) and then reared in the laboratory. Larvae were reared in plastic containers under controlled temperature (25 ± 2° C) and light (12 h light, 12 h dark). Larvae were fed with fresh leaves offered *ad libitum*. Data were recorded on behavior and development time for all stages. Dry head capsules and pupal exuviae were retained in glass vials. Immature stages were fixed in Kahle-Dietrich solution (Triplehorn & Johnson, 2005). Images were obtained using a JEOL® JSM-5800 scanning electron microscope (JEOL Ltd., Japan). The samples were prepared using a critical-point-drier (Bal-tec® - CPD030 equipment, Leica Microsystems, Germany), attached with double-sided tape to aluminum stubs and coated with gold/palladium with a Bal-tec® - SCD050 sputter coater (Leica Microsystems, Germany). Measurements were obtained using a Leica MZ7.5 stereomicroscope equipped with a micrometric scale. Egg size is presented as height and diameter, and head capsule size is the distance between the most lateral stemmata (as in Giraldo *et al.*, 2013). Maximum length was measured one or two days before each molt (when larvae reach maximum length). Terminology for egg descriptions follows García-Barros & Martín (1995) and for larvae and pupae follows Hinton (1946) modified after Stehr (1987). The taxonomy follows Lamas (2004) modified after Hill *et al.* (2012), where *M. mazaesus* and *M. messenoides* are considered as distinct species (see also Warren *et al.*, 2019).

RESULTS

Description of immature stages

Although the following descriptions and measurements are based on material reared from a single female from Serra do Japi, Jundiá, São Paulo, reared material from the other two localities mentioned above gave similar results in terms of morphology and measurements (data not shown).

Eggs (Figs. 1A-C, 2A-D). White, ellipsoid, taller than wide giving a typical elongated aspect, changing to light gray before hatching (parasitized eggs turn dark gray); depression is present in microcylar region at apex; 13 longitudinal ribs and 13-15 transverse ribs, forming rectangular cells at base and middle (those become rounded toward apex). Height 1.02 to 1.25 mm (mean = 1.12 mm, SD = 0.12 mm); diameter 0.62 to 0.73 mm (mean = 0.66 mm, SD = 0.05 mm) (n = 6). Duration 4 – 5 days (n = 20).

First instar (Figs. 1D, E, 3A-E). Head capsule width 0.50 to 0.54 mm (mean = 0.514 mm, SD = 0.0135 mm, n = 10). Head black, smooth, without any projections; body white, covered with several short white setae, becoming light gray after feeding; legs black, prolegs and anal plate white; uniordinal and uniserial crochets in prolegs (Figs. 1D and 3D). Maximum length 2.8 mm (n = 10). Duration 3 to 4 days (mean = 3.23 days, SD = 0.43 days, n = 10). Head and body chaetotaxy are presented in Fig. 4.

Second instar (Fig. 1F). Head capsule width 0.74 to 0.82 mm (mean = 0.788 mm, SD = 0.023 mm, n = 10). Head brown; body light gray, with a pair of short lateral projections from A1 to A8; legs black, prolegs and anal plate white. Maximum length 7 mm (n=10). Duration 2 to 3 days (mean = 2.30 days, SD = 0.48 days, n = 10).

Third instar (Fig. 1G). Similar to previous instar, darker, with lateral projections more developed, pointed and yellow at base and with a pair of short dorsolateral protuberances on prothorax. Head capsule width 1.10 to 1.20 mm (mean = 1.172 mm, SD = 0.0315 mm, n = 10). Maximum length 11 mm (n = 10). Duration 2 to 3 days (mean = 2.23 days, SD = 0.43 days, n = 10).

Fourth instar (Fig. 1H). Head capsule width 1.60 to 1.78 mm (mean = 1.694 mm, SD = 0.062 mm, n = 10). Head brown; body light gray with a pair of pointed lateral projections from A1 to A8, each yellow at base with a small central black dot; a pair of short dorsolateral protuberances on prothorax; legs black, prolegs and anal plate white. Maximum length 18 mm (n=10). Duration 2 to 3 days (mean = 2.07 days, SD = 0.27 days, n = 10).

Fifth instar (Fig. 1I-M). Head capsule width 2.20 to 2.36 mm (mean = 2.266 mm, SD = 0.055 mm, n = 10). Similar to fourth instar (see Figs. 1I and 1K), changing in last one or two days to dark bluish at either end, with a pale-yellow dorsal stripe and bright yellow lateral stripes (Figs. 1J, L), finally changing to entire yellow just before pupation (Fig. 1M). Maximum length 25 mm (n = 10). Duration 4 to 5 days (mean = 4.46 days, SD = 0.51 days, n = 10).

Pupa (Fig. 1N-Q). Reflective metallic, general profile elongated. Translucent yellow initially (Fig. 1N), changing to metallic with some black markings after 24 h; cremaster black; a slightly protruding dorsal edge on dorsal A3. Adult wing pattern becomes evident on wing cases one day before emergence. Length 13.15 to 20.29 mm (mean = 16.29, SD = 1.5 mm, n = 10). Duration 7 to 8 days (mean = 7.46 days, SD = 0.51 days, n = 10).

Behavior and natural history

Mechanitis polymnia casabranca (Fig. 1R) is a relatively common butterfly throughout its distribution, in central, southeastern and southern Brazil (see distribution map in Brown, 1979), where it is known to use more than 20 species of Solanaceae as host plants. These include cultivated species such as the tomato *Lycopersicon esculentum* Mill., and the butterfly shows a marked preference for species in the section *Leptostemonum* (see Brown, 1987 and Drummond & Brown, 1987). The subspecies is present in several habitats, including old growth and secondary forests, orchards and urban parks and residential areas, and the host plants are widespread in the landscape. In Serra do Japi, the host plants used most are *Solanum robustum* H. L. Wendl., *Solanum mauritianum* Scop., *Solanum scuticum* (Dunal) M. Nee and *Solanum variabile* Mart. (Carvalho *et al.*, in prep.). The species has been reported from sea level to 2000 m altitude, although it is more common at lower altitudes (up to 800 m). Males are highly attracted to flowers of Asteraceae, especially in the tribe Eupatorieae, and can be easily observed feeding on flowering plants in forest edges and clearings. In marked seasonal habitats (such as Campinas and Jundiá), adults form large congregations (“ithomiine pockets”) with thousands of individuals during the dry season. However, these pockets are not established in non-seasonal habitats

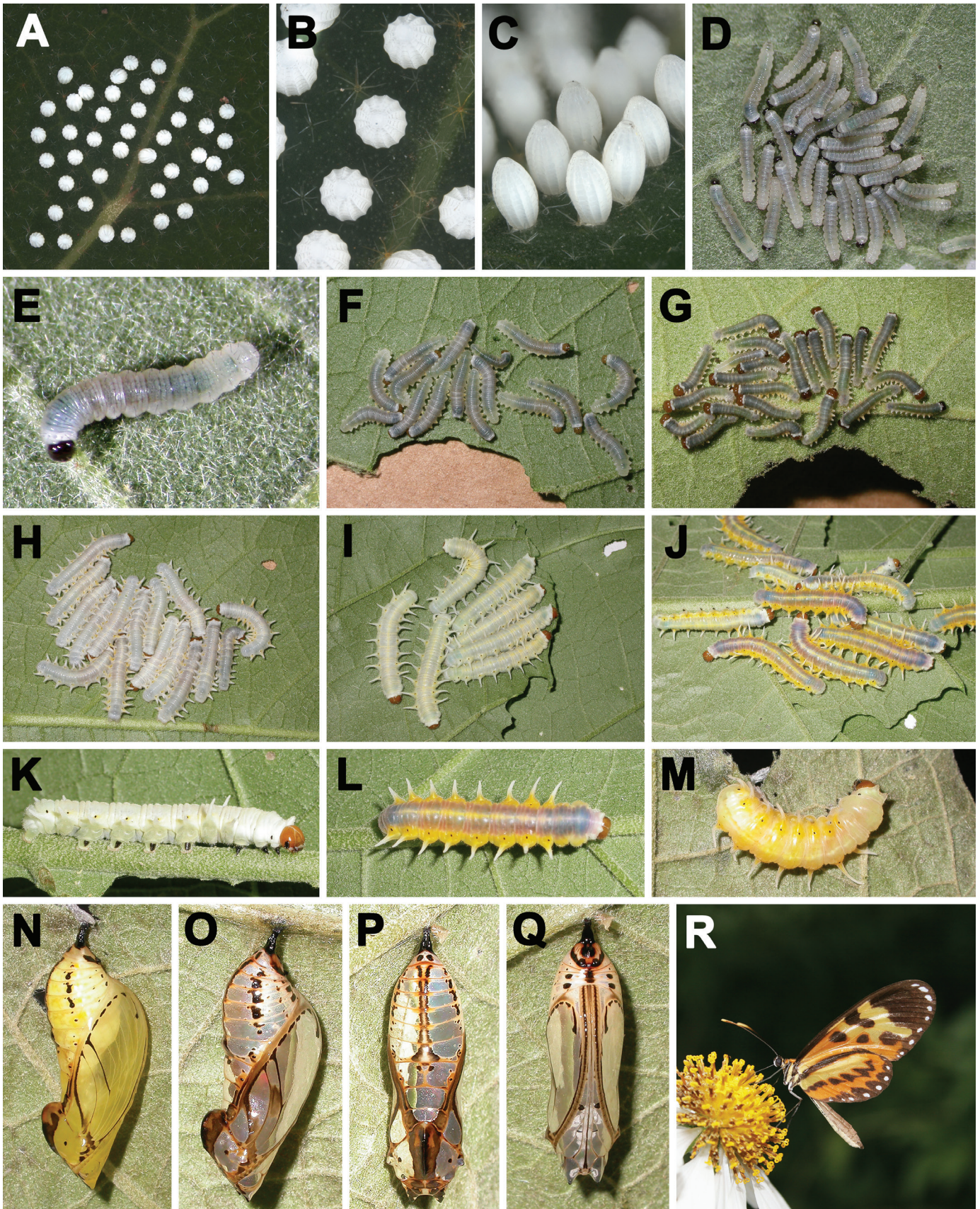


Figure 1. Life stages of *Mechanitis polymnia casabranca* from Jundiá, São Paulo, Brazil. A. general view of a clutch of eggs; B, C. magnified view of eggs, dorsal and lateral, respectively; D. group of first instars; E. close-up view of first instar; F. group of second instars; G. group of third instars; H. group of fourth instars; I. group of fifth instars; J. group of late fifth instars showing change in color pattern; K. magnified view of early fifth instar (lateral); L. magnified view of late fifth instar (dorsal); M. prepupa (dorsolateral); N. first day pupa (lateral); O, P, Q. pupa (lateral, dorsal, ventral); R. adult male from Campinas, São Paulo, Brasil.

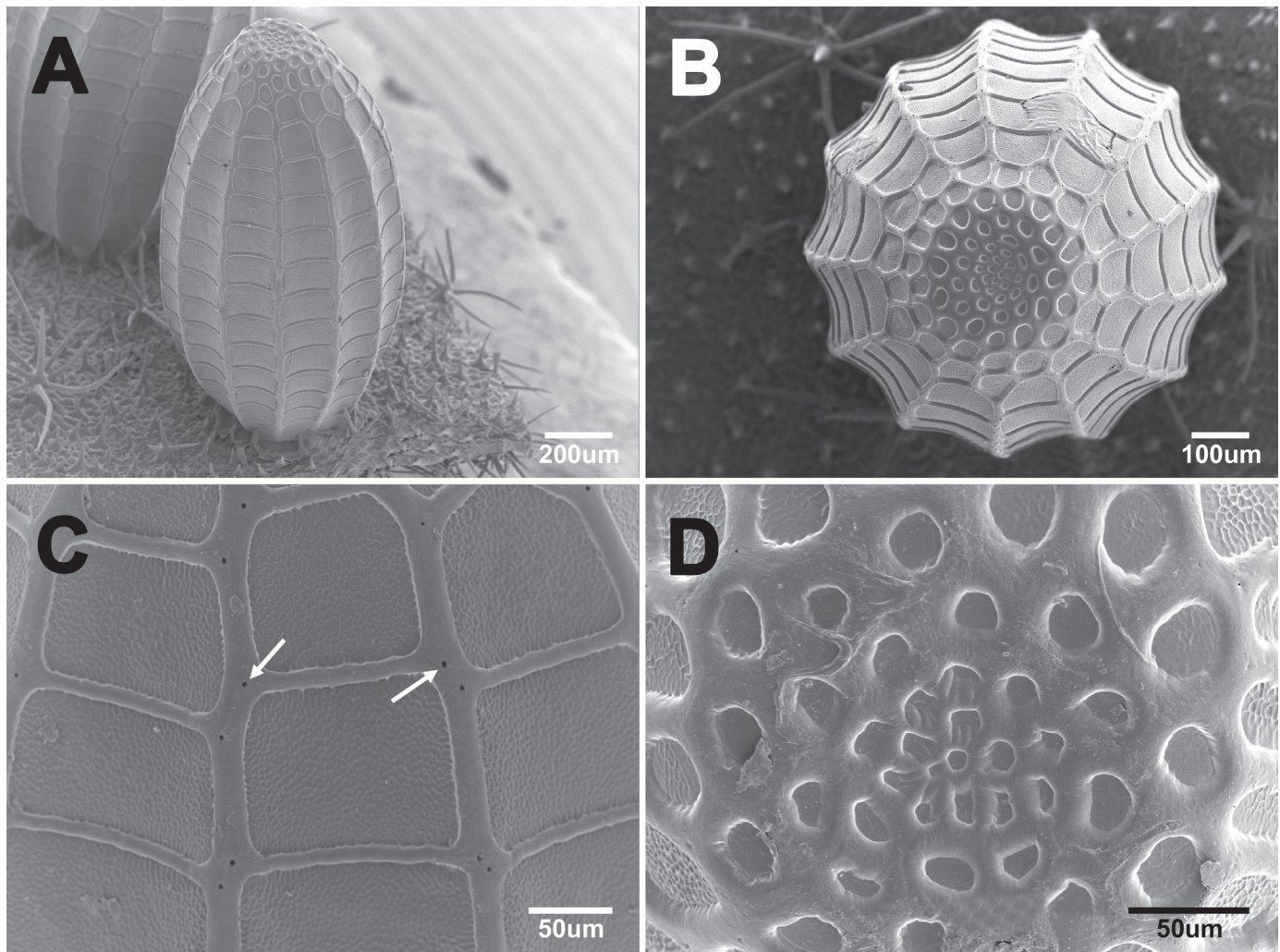


Figure 2. Ultrastructure of eggs of *Mechanitis polymnia casabranca*. A. Lateral view; B. view of the apical region; C. rectangular cells of the exochorion with aeropyles in the rib intersections (white arrows); D. detailed view of the micropylar region.

such as São Vicente, in the coastal region (see Freitas, 1996). Although mating pairs are sometimes observed in the pockets, adults are in reproductive diapause and oviposition is seldom seen (on the few observed occasions, the eggs did not hatch). These groups disperse after the first rains at the beginning of the wet season, when reproduction begins.

After approaching a potential host plant, ovipositing females begin to inspect the top and bottom of leaves, hovering and touching leaves with the legs and antennae. Subsequently, oviposition occurs on the upper surface of the leaf. Eggs are laid in groups of up to 50 eggs (typically 20 eggs) and are laid approximately 1 mm from one another. After hatching, the first instar eats the chorion and moves to the under surface of the leaf. Larvae are gregarious in all instars, and they feed synchronously. First instars start feeding by making small holes in the leaf, then moving to the leaf margin. From the third instar on, they cut the central and lateral veins of the leaves before starting feeding (Fig. 5), a behavior that was observed on all four main host plants at Serra do Japi. When not feeding, larvae rest in groups, shaking their heads and regurgitating when disturbed.

DISCUSSION

In general, the immature stages of *M. polymnia casabranca* are similar to those of other known *Mechanitis* (Brown & Freitas, 1994; Motta, 1998; Giraldo & Uribe, 2010a,b; Anteparra *et al.*, 2011; Hill *et al.*, 2012; Giraldo & Uribe, 2012; Giraldo *et al.*, 2014; Ruiz *et al.*, 2015), including the tall ellipsoid eggs laid in clusters on the upper leaf surface of the host plants, the larvae that are gregarious in all instars, the pair of short dorsolateral protuberances on the prothorax and the presence of fleshy lateral projections on the abdominal segments. Besides being present in all known *Mechanitis*, the above characteristics are also shared with *Forbestra*, although in the latter the protuberances are reduced or absent (see below), and eggs are laid in smaller clutches or isolated (Brévignon, 2003; Hill, 2006). All other genera of Mechanitina (*Thyridia*, *Sais* and *Scada*) lay isolated eggs, usually on the under-surface of leaves (females of *Sais* and *F. olivencia* sometimes lay their eggs on petioles and twigs) (Brown & Freitas, 1994; Freitas & Brown, 2002; Hill, 2006; AVLF unpublished).

The fleshy lateral projections on the abdominal segments is a character shared with most other species of Mechanitina,

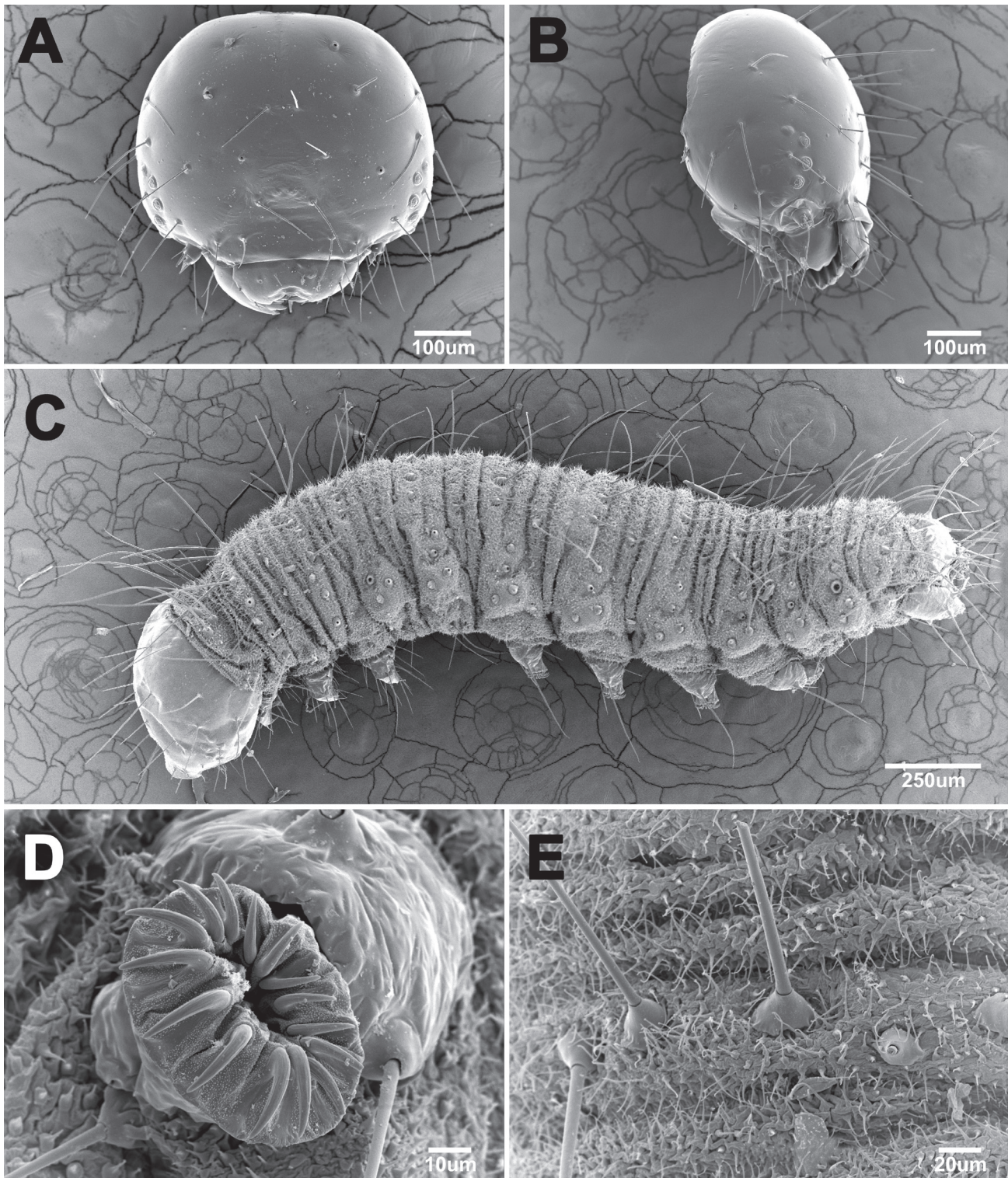


Figure 3. Ultrastructure of first instar of *Mechanitis polymnia casabranca*. A, B. head capsule (frontal, lateral); C. first instar (lateral); D. proleg crochets; E. magnified view of body setae.

although only in *Mechanitis* are they long and pointed, being short in all other genera (Brown & Freitas, 1994; Freitas & Brown, 2002; Hill, 2006). The only exception is *F. equicola*, where the lateral projections are apparently absent (Brévignon, 2003). The paired short dorsolateral protuberances on the prothorax are present in all known *Mechanitis* and in *Forbestra olivencia*, although these are short and more rounded in *F. olivencia* but are absent in larvae of all other *Mechanitina*

(including *F. equicola*) (Brown & Freitas, 1994; Freitas & Brown, 2002; Brévignon, 2003; Hill, 2006; AVLF, unpublished data).

Compared to other species of *Mechanitis*, *M. polymnia casabranca* is quite distinct in several aspects, including: 1) the brown head capsule (these are predominantly black in the other species, but see Giraldo & Uribe (2010a)); 2) the light gray body (in other *Mechanitis* the general body color elements are more

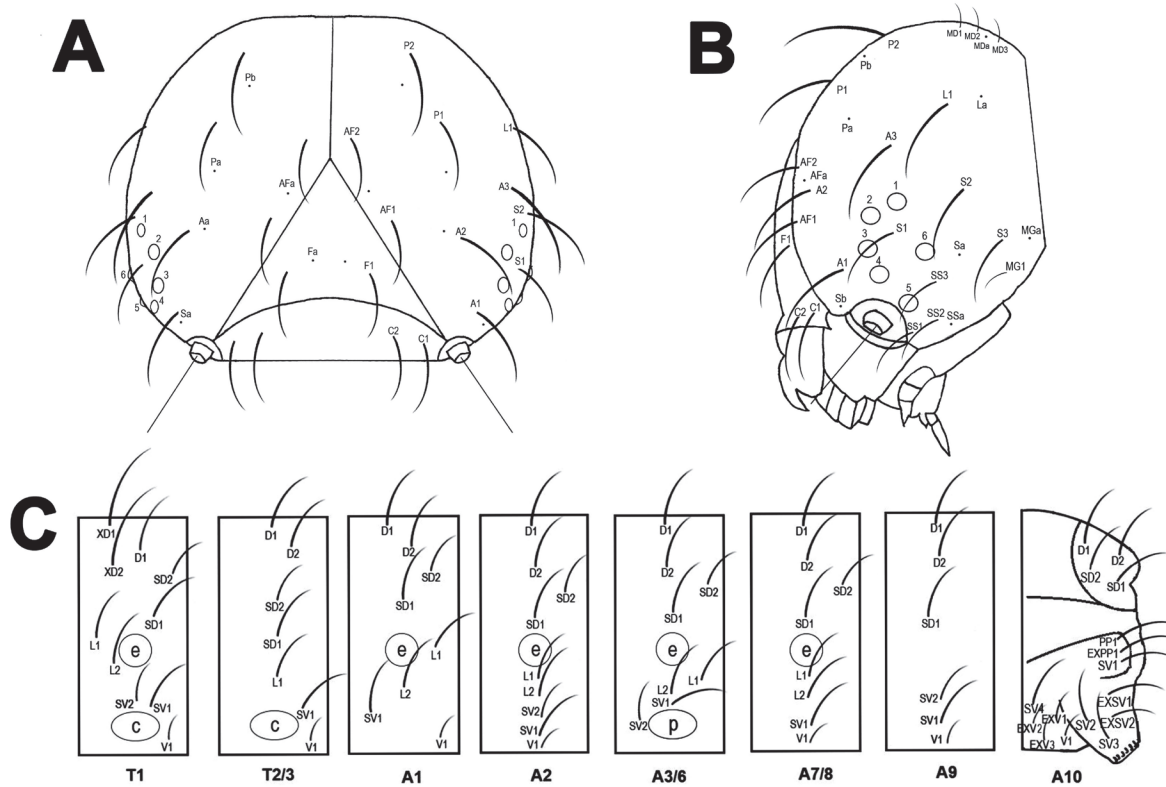


Figure 4. Larval chaetotaxy of first instar of *Mechanitis polymnia casabranca*. A. head in frontal view; B. head in lateral view; C. body diagram in lateral view. For chaetotaxy abbreviations see Stehr (1987).

vivid in yellows and blues); 3) the small yellow patch at the base of the lateral abdominal projections (much enlarged in *M. menapis* or merging to subdorsal yellow stripes in *M. lysimnia*, *M. mazaesus* and *M. messenoides*). Finally, the dorsolateral protuberances on the prothorax in *M. polymnia* are shorter compared to *M. menapis*, *M. mazaesus* and *M. messenoides* (they are also relatively short in *Mechanitis lysimnia*) (Brown & Freitas, 1994; Motta, 1998; Giraldo & Uribe, 2010a,b; Anteparra *et al.*, 2011; Giraldo & Uribe, 2012; Hill *et al.*, 2012; Giraldo *et al.*, 2014; Ruiz *et al.*, 2015; AVLF unpublished).

The behavior of cutting leaf veins (Fig. 5) has been previously observed in larvae of other species of Ithomiini and Danaini, especially those feeding on latex-containing plants (Young, 1978; Compton, 1987), although, surprisingly, this behavior has not been previously reported for any species of *Mechanitis*. In Ithomiini, similar behavior has been observed in the Apocynaceae-feeding *Aeria* and *Tithorea* (Young, 1978; Compton, 1987). Among Solanaceae feeding species, a somewhat similar behavior has been reported in *Melinaea*, whose early instars made circular ‘trenches’ on the leaves, feeding preferentially on the inner leaf blade (McClure & Elias, 2017; AVLF unpublished), and in *Megoleria*, whose larvae partially isolate the leaf tip on which they feed (Willmott & Lamas, 2008). Since this behavior has been suggested as a way to overcome the deterrent effects of plant latex by phytophagous insects (Compton, 1987; Lewinsohn, 1991) it would be interesting to investigate the function of this behavior in larvae of *Mechanitis* and other ithomiines.

It is noteworthy that the above comparisons among *Mechanitis* species are based on information from only a few populations in all examined taxa. For *M. polymnia*, for example,

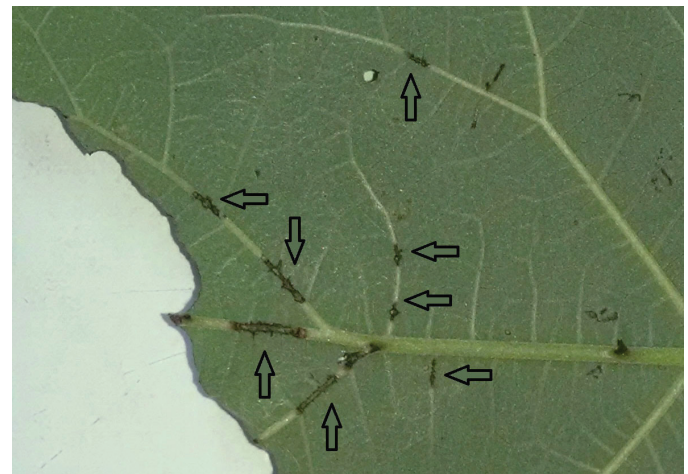


Figure 5. Typical feeding damage inflicted by *Mechanitis polymnia casabranca* on its host plants, in which larvae cut the central and lateral veins of the leaves before starting to feed (black arrows).

data are available for *M. polymnia casabranca* (present study), *M. polymnia caucaensis* (Giraldo & Uribe, 2010a, 2012), *M. p. proceriformis* (Anteparra *et al.*, 2011), *M. polymnia* ssp. (Ruiz *et al.*, 2015) and *M. polymnia ca. dorissides* (AVLF, unpublished data) (descriptions of *M. polymnia isthmia* by Young & Moffett (1979) lack enough details to be assessed). Although the geographic sampling is fairly broad, these observations correspond to only five out of the 22 known subspecies of *M. polymnia*. The validity of the above comparisons rests on how consistent are the characters of immature stages within each species of *Mechanitis*, a question that can only be answered when more populations are appropriately studied and described.

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