SYSTEMATICS, MORPHOLOGY AND PHYSIOLOGY

Immature Stages of *Adelpha malea goyama* Schaus (Lepidoptera: Nymphalidae, Limenitidinae)

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Estágios Imaturos de *Adelpha malea goyama* Schaus (Lepidoptera: Nymphalidae, Limenitidinae)

RESUMO - São descritos os estágios imaturos de *Adelpha malea goyama* Schaus na Estação Ecológica do Caiuá, PR. A espécie usa a liana nativa *Arrabidaea mutabilis* Bur. & K. Schum. (Bignoniaceae) como planta hospedeira no local de estudo. Os ovos isolados são colocados nos ápices das folhas, e são similares em forma àqueles descritos para outras espécies de *Adelpha* Hübner. As lagartas passam por cinco estádios durante 21 dias, e constróem trampolins de fezes do primeiro ao terceiro estádio. Em estádios mais avançados, as lagartas ficam na superfície superior das folhas, e têm seu corpo coberto por escolos rígidos ramificados. O perfil da pupa é alongado, com projeções curtas na região cefálica projetando lateralmente, e o segmento A2 é projetado e curvado anteriormente. Comparações com espécies próximas de *Adelpha* não são conclusivas, e mais espécies do gênero devem ser criadas para que um padrão claro de variação na morfologia dos imaturos se torne evidente.

PALAVRAS-CHAVE: *Arrabidaea*, Bignoniaceae, borboleta, ciclo de vida, Floresta Atlântica

ABSTRACT - The immature stages of *Adelpha malea goyama* Schaus are described from the Estação Ecológica do Caiuá, Paraná State, Brazil. The species uses the native liana *Arrabidaea mutabilis* Bur. & K. Schum. (Bignoniaceae) as larval hostplant in the study site. Isolated eggs are laid on leaf tips, and are similar in shape to those described for other species of *Adelpha* Hübner. Larvae pass through five stadia during 21 days, and first to third instars construct frass chains. Later instars rest on the upper leaf surface, and their body is covered by rigid branched scoli. The general profile of the pupa is elongated, with short head horns projecting laterally and with segment A2 projecting and curved anteriorly. Comparisons with closely related species of *Adelpha* are not conclusive, and more species in the genus need to be reared before a clear pattern of the variation in immature morphology becomes evident.

KEY WORDS: *Arrabidaea*, Bignoniaceae, butterfly, life history, Atlantic Forest

The Neotropical genus *Adelpha* Hübner (Lepidoptera: Nymphalidae) includes 209 taxa in 85 species (Willmott 2003b) distributed from western USA to Uruguay, and occurs in a wide variety of habitats from sea level to 3000 m (Aiello 1984, Willmott 2003b). As noted by Aiello (1984), species determination is usually not easy due to the strong convergence in wing patterns of many species in different groups. A recently published pictorial guide made species identification easier (Willmott 2003b). Aiello (1984) also noted the importance of the early stages in understanding the systematics of the genus, and defined eight species groups based on larval and pupal characters (Aiello 1984; see also Otero & Aiello 1996). Willmott (2003b) revised Aiello's species groups, and defined six groups that mostly reflected monophyletic groups based on cladistic analysis of immature and adult characters (Willmott 2003a). Willmott (2003b) also summarized information about the immatures of 39 species of *Adelpha*. However, as stated in his work, most of the information is incomplete or poorly illustrated (Willmott 2003b: 23). Larvae of the genus *Adelpha* are known to feed on a wide diversity of plant families; there are hostplant records for 42 species in the genus, covering 116 plant species in 22 families (Aiello 1984, DeVries 1987, Brown 1992, Diniz & Moraes 1997, Freitas *et al.* 2001, Willmott 2003b: 23).

Adelpha malea goyama Schaus (Fig. 1c) occurs in semidecidous forests of SE Brazil, Paraguay, eastern Bolivia and northern Argentina (Willmott 2003b), but despite being common in many places, its early stages and hostplants were still unknown. Because immatures are a valuable source of information for butterfly systematics (Freitas & Brown 2004,

Otero & Aiello 1996), the present paper describes the early stages and hostplant of *A. malea goyama* for the first time, and represents the first life history report for *A. malea* (C. & R. Felder).

Study Sites and Methods

Immatures were observed and collected in the Estação Ecológica do Caiuá (22°34'S, 52°52'W, altitude ca. 300 m), a 1423-ha Forest Reserve in Diamante do Norte, Paraná State, southern Brazil. In November 2005, a female was observed ovipositing on an *Arrabidaea mutabilis* Bur. & K. Schum. vine (Bignoniaceae). Inspection of nearby leaves of the same vine yielded three more eggs and four larvae, which were collected and reared in the lab.

Larvae were reared in plastic cages cleaned daily, following Freitas (1991). Adults, head capsules and pupal skins and immatures preserved in Kahle solution (Borror & DeLong 1971) have been deposited in the Museu de História Natural (Unicamp).

Hostplants, Oviposition, and Immature Behavior

The hostplant of *A. malea goyama* in the study site (*A. mutabilis*), is one of the most common vines in the study site, growing in secondary habitats and forest gaps. Around 12:00 h, the female *A. malea goyama* was observed in the forest edge ovipositing on mature leaves of the hostplants at about 1.5 m above ground. Eggs (Fig. 1a) were laid on the leaf tips on the upper surface (based on two observed oviposition events and collected eggs, Fig. 1b). Oviposition took only a few seconds, after rapid inspection of the plant by the female by touching several leaves of different vines.

The young larva ate part of the chorion after hatching and, after about 30 minutes, it fed on the leaf tip and constructed a frass-chain on which it took refuge. Frass-chains were constructed by 1st through 3rd instars, but 4th and 5th instars rested on the upper surface of the leaves. Initial instars, usually rested in "straight" or "front-curved" positions (Fig. 1f), and the fourth, and especially last instar usually rested in a "front-arched-rear-up" position (see Young 1974 and Aiello 1984 for more details about these postures).

Descriptions of Immature Stages

Egg (Fig. 1a)**.** Greenish yellow, sculptured with hexagonal pits, with spines arising from the pit junctions, and consistent with eggs described for other *Adelpha* species. Height 1.0 mm, diameter 1.1 mm. Duration: five days (n = 1).

First instar (Fig. 1d)**.** Head capsule rounded, pale brown, with short pale setae and without ornamentation. Head capsule width 0.65 - 0.70 mm (n = 2). Body pale greenish brown, with short pale setae about 0.05 mm long (body chaetotaxy very similar to that of *Adelpha syma* (Godart) described in Freitas *et al.* 2001); general aspect wrinkled with four pairs of subdorsal bumps in T2, T3, A2 and A8; legs, prolegs and suranal platelight yellow. Maximum length 5 mm. Duration: three days (n = 2).

Second instar (Fig. 1e)**.** Head capsule rounded, dark brown, with several short light colored chalazae. Head capsule width 0.90 - 0.92 mm (n = 2). Body brown, wrinkled, with several small spines and protuberances. Body scoli become more conspicuous than previous instar, especially the subdorsal scoli in T2, T3, A2 and A8. Legs and prolegs yellow; anal cap brown. Maximum length 8 mm. Duration: four days (n=2).

Third instar (Fig. 1f)**.** Head capsule rounded, dark brown, with several short white chalazae. Head capsule width 1.26 - 1.40 mm (n = 3). Body brown with a sublateral poorly defined white stripe and a lateral pattern of oblique stripes visible especially in the abdominal segments; wrinkled, with several small spines and protuberances. Subdorsal scoli in T2, T3, A2 and A8 short and thick, with a dense covering of spines; scoli of A2 arching posteriorly. Legs and prolegs light brown; anal cap brown. Maximum length 11 mm. Duration: three days (n = 3).

Fourth instar (Fig. 1g)**.** Head capsule rounded with several short light brown and cream colored chalazae; general color light brown, with two frontal dark vertical stripes. Head capsule width 2.28 - 2.30 mm (n = 2). Body greenish brown with a poorly defined sublateral white stripe and a lateral pattern of oblique stripes visible especially in the abdominal segments. Subdorsal scoli in T2, T3, A2 and A8 short and thick, with a dense covering of spines; scoli of A2 arching posteriorly; additional very short subdorsal scoli in A3 - A7 and A10 and lateral scoli in T2 - A8. Legs and prolegs light brown; anal cap brown. Maximum length 19 mm. Duration: four days (n = 2).

Fifth instar (Fig. 1h-i)**.** Head capsule rounded with several short light brown and cream colored chalazae; general color light brown, with two frontal dark vertical stripes. Head capsule width 3.09 - 3.19 mm (n = 2). Body green with many white and brown marks, especially in the lateral region, that bear a lateral pattern of oblique stripes visible especially on segments A3 – A6. Subdorsal body scoli on T1, T2, A2, A7 and A8 long and branched; scoli of A2 directed posteriorly; subdorsal scoli on A3-A6 very short and branched. Legs and prolegs light brown; anal cap brown. Prepupa (Fig. 1j) suspends itself by the anal prolegs two days before pupation; the green color disappears and the larva turns entirely brown. Maximum length 28 mm. Duration: 7-8 days (n = 2).

Pupa (Fig. 1k-m)**.** General color beige with dark lines on the wing pads and no reflective areas. The head horns are very small and pointed, and curved outwards from the sides of the head. General profile elongated, with segment A2 projecting and curved anteriorly, and segment T2 pointed and directed posteriorly. Length 20-21 mm. Duration: 9-10 days (n = 2).

Discussion

Even after the complete revision and phylogeny of the genus *Adelpha* by Willmott (2003b), there are still many open questions concerning systematic relationships within

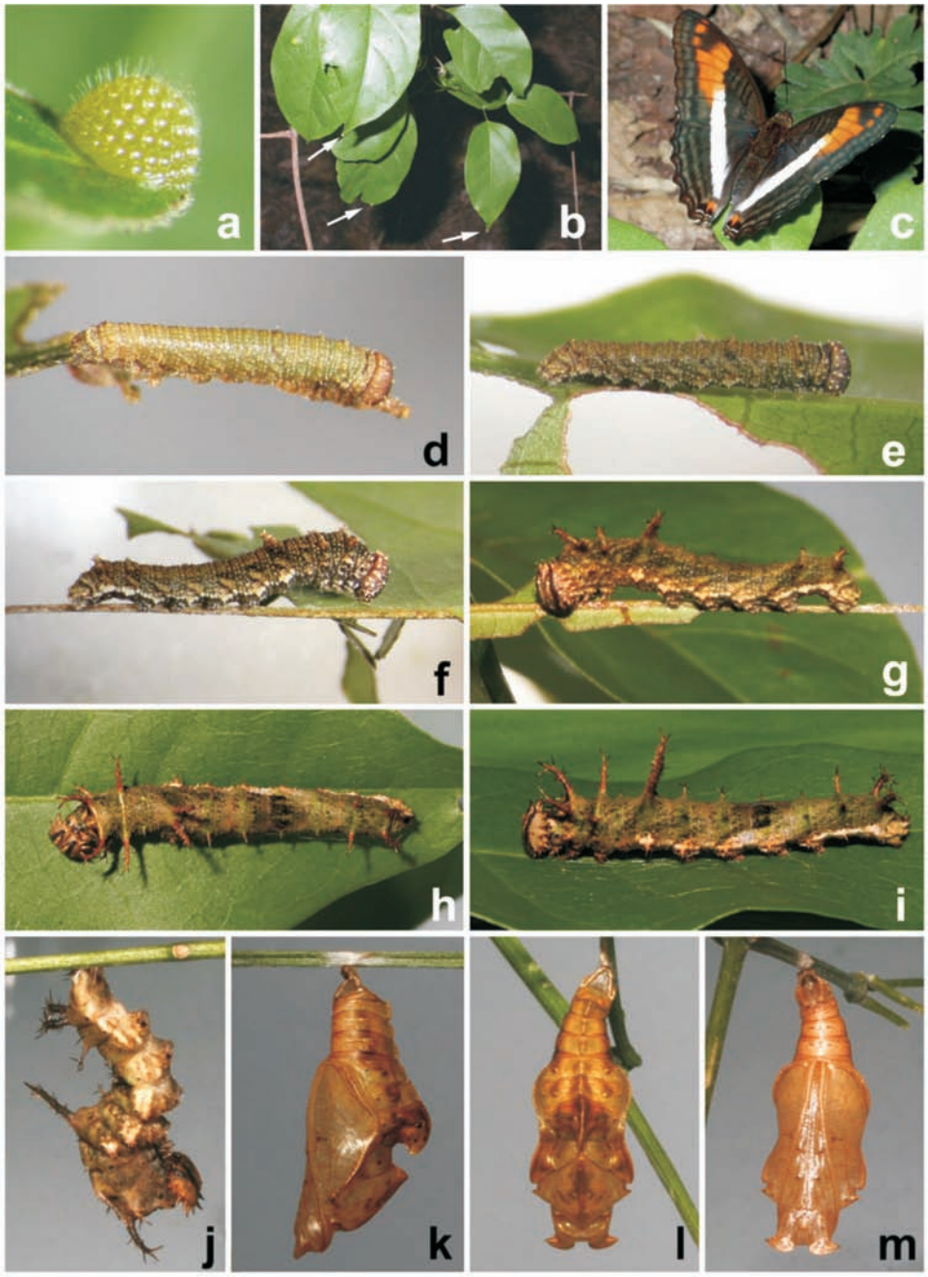

Fig. 1. Life stages of *A. malea goyama*. a) egg; b) three eggs (white arrows) on leaf tips of *A. mutabilis* (Bignoniaceae); c) adult perching near the ground; d) first instar; e) second instar; f) third instar; g) fourth instar; h-i) fifth instar dorsal (left) lateral (right); j) prepupa; k-m) pupa (left to right, lateral, dorsal and ventral).

this genus. The species groups proposed by Aiello (1984) were revised and redefined based on both larval and adult characters, but not all species were assigned to a group, and even these groups are still provisional (Willmott 2003b: 19-20). Additionally, several species were not assigned to any group, and the systematic position of others is not well supported. This is the case of *A. malea*; in the cladistic analysis by Willmott (2003a) the position of *A. malea* is unresolved in the strict consensus tree, or basal to the *phylaca*-group of species in the successive weighting tree.

Attempts to assign *A. malea* to one of Aiello's (1984) species groups were not conclusive, as the immatures show a combination of characters found in different species groups. For example, the head capsules of later instars are striped, similar to those of larvae in species group I, such as *A. serpa celerio* (H. W. Bates) (= *A. celerio* in Aiello

1984) and *A. serpa serpa* (Boisduval) (Müller 1886 and pers. obs.). However, striped head capsules are also present in *A. syma* (although not stated in Freitas *et al.* 2001), a species belonging to a clade related to the *phylaca*-group of species (Willmott 2003a). The pupa of *A. malea* has pupal head horns "shaped like tiny asymmetrical leaves" (following Aiello 1984). According to Aiello (1984), this feature is present in species in group VII, such as *A. cocala* (Cramer) (Freitas *et al.* 2001) and *A. leucophthalma* (Latreille) (see also Young 1974), and in some species in group II, such as *A. thesprotia* (C. & R. Felder) (= "*A. delphicola*" in Aiello 1984) and *A. mesentina* (Cramer) (see also Moss 1933). This character was also observed in *A. syma* and *A. jordani* Fruhstorfer (unpublished data from Acre State, Brazil), and more developed in *A. mythra* (Godart) (Freitas *et al.* 2001) and *A. capucinus* (Walch) (= "*A. thesprotia*" in Moss 1933). The process in A2 is somewhat similar to that described for *A. syma* (Freitas *et al.* 2001), but the overall variation in this structure is enormous and apparently continuous, and more data are needed before detailed comparisons can be done.

Previous to this study, the use of Bignoniaceae as hostplant was reported only for *A. thesprotia* (= *A. juruana* in Jørgensen 1924). This does not necessarily imply close relationship between *A. malea* and *A. thesprotia*, inasmuch as the patterns of host use in *Adelpha* still need further investigation (Willmott 2003b). Furthermore, given that this is the only previous record for any *Adelpha* feeding on Bignoniaceae, and has not been verified by examination of a photograph or voucher specimen, it is possible that Jørgensen's (1924) observation may have been of a misidentified *A. malea goyama*, which is very similar in wing pattern.

Even though such recommendation seems repetitive and redundant, additional descriptions and comparative information of immatures of *Adelpha* are still needed to provide a better definition of the species groups in this genus.

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