

# Immature stages of *Splendeuptychia ambra* (Nymphalidae: Euptychiina) and the diversity of immature morphology within *Splendeuptychia*

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**Abstract:** The immature stages are described for *Splendeuptychia ambra* (Weymer, [1911]). The eggs are rounded, pale yellow, smooth, and lack markings. The caterpillars pass through four instars; the first instar is pale cream with reddish longitudinal stripes and the head is black bearing a pair of very short scoli; the last (fourth) instar is beige with a pair of short caudal filaments on the last segment, laterally striped with thin lines and a darker dorsal stripe; the head is olive-brown with a pair of short scoli. The pupae are short and smooth, mostly light brown, mottled with dark brown stripes, with short rounded ocular caps and with very short paired subdorsal projections on the abdominal segments. The immature stages of *S. ambra* are compared with those of other species of the non-monophyletic genus *Splendeuptychia* that belong to three different clades within the subtribe Euptychiina.

**Resumo:** Os estágios imaturos de *Splendeuptychia ambra* (Weymer, [1911]) são descritos. Os ovos são esféricos, amarelo claros, lisos e sem marcas. As lagartas passam por quatro instares; o primeiro instar é bege com faixas longitudinais avermelhadas e a cabeça é preta com um par de escolos muito curtos; o quarto e último instar é bege com um par de filamentos caudais curtos no último segmento, com padrão de finas estrias laterais e uma faixa dorsal escura; a cabeça é marrom olivácea com um par de escolos curtos. A pupa é curta e lisa, predominantemente marrom claro marcada com faixas e pintas marrom escuras, com capas oculares curtas e pares de projeções laterais muito curtas nos segmentos abdominais. Os estágios imaturos de *S. ambra* são comparados com aqueles de outras espécies do gênero não monofilético *Splendeuptychia* pertencendo a três diferentes clados dentro de Euptychiina.

**Key words:** Atlantic Forest, Brazil, Satyrinae, Satyrini

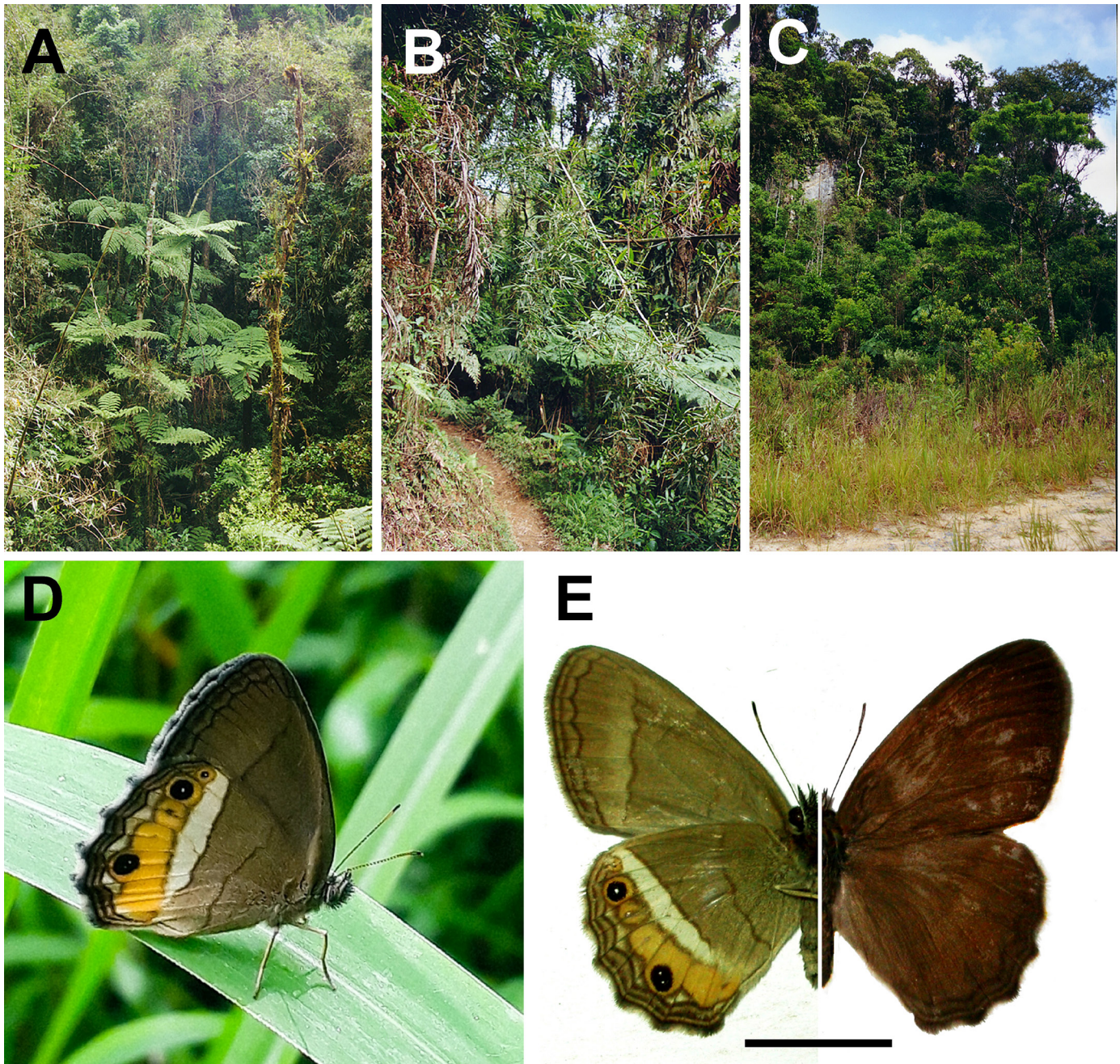
**Palavras chave:** Brazil, Mata Atlântica, Satyrinae, Satyrini

## INTRODUCTION

With 437 described species (Zacca *et al.*, 2021), the subtribe Euptychina (Nymphalidae: Satyrinae) is one of the most species-rich butterfly groups, but also one of the less well known. Despite a recent large collaborative international project aiming to fill several knowledge gaps in Euptychiina (<http://www.flmnh.ufl.edu/museum-voices/euptychiina/>), there are still important areas beyond taxonomy and systematics that need study, such as behavior, ecology and natural history. One of these areas concerns the description of their immature stages, and even considering a number of recent efforts (e.g. Freitas *et al.*, 2019a,b, 2021a,b; Nakahara *et al.*, 2020, 2022; Tejeira *et al.*, 2021 and references therein), immature stages are mostly unknown for the subtribe, with entire genera lacking any information concerning their life cycle, such as *Caeruleuptychia* Forster, 1964, *Emeryus* Zacca, Casagrande & Mielke, 2020 and *Malaveria* Viloria & Benmesbah, 2021. Moreover, for some large genera, immature stages are described for only a couple of species, for example *Euptychia* Hübner, 1818, *Forsterinaria* Gray, 1973, *Magneuptychia* Forster, 1964 and *Splendeuptychia*

Forster, 1964, among others (e.g. DeVries, 1987; Kaminski & Freitas, 2008; Freitas *et al.*, 2016a,b, 2019a; See *et al.*, 2018; Janzen & Hallwachs, 2021).

The genus *Splendeuptychia* currently includes 25 described species and a similar number of undescribed species occurring from Mexico to northern Argentina (Lamas, 2004; Rosa *et al.*, 2021 and references therein, Zacca *et al.*, 2021). As with several other large Euptychiina genera, *Splendeuptychia* is non-monophyletic with species spread over three different clades within the tribe (Peña *et al.*, 2010; Marín *et al.*, 2017; Freitas *et al.*, 2018; Espeland *et al.*, 2019, Rosa *et al.*, 2021). Published information on the immature stages of *Splendeuptychia* is surprisingly limited considering it contains almost 50 species, with detailed accounts only available for *Splendeuptychia quadrina* (Butler, 1869) (See *et al.*, 2018) and *Splendeuptychia furina* (Hewitson, 1862) (Corahua-Espinoza *et al.*, 2022), and a brief textual description of *Splendeuptychia kendalli* Miller, 1976 (Kendall, 1978). Accordingly, in an attempt to improve knowledge of the immature stages of *Splendeuptychia*, the present paper describes for the first time the immature stages of *Splendeuptychia ambra* (Weymer, [1911]), an uncommon



**Figure 1.** Habitats and adults of *S. ambra*. **A, B, C.** Three views of the wet montane forests in the region of Morro Grande State Reserve, Cotia, São Paulo; **D.** Live adult of *S. ambra* from Teresópolis, Rio de Janeiro (photograph by Luan Felipi P. de Andrade); **E.** A reared adult of *S. ambra* (present study), ventral left, dorsal right (black bar = 1 cm).

species from the Atlantic Forest in southeastern Brazil, and compares them with other species of Euptychiina.

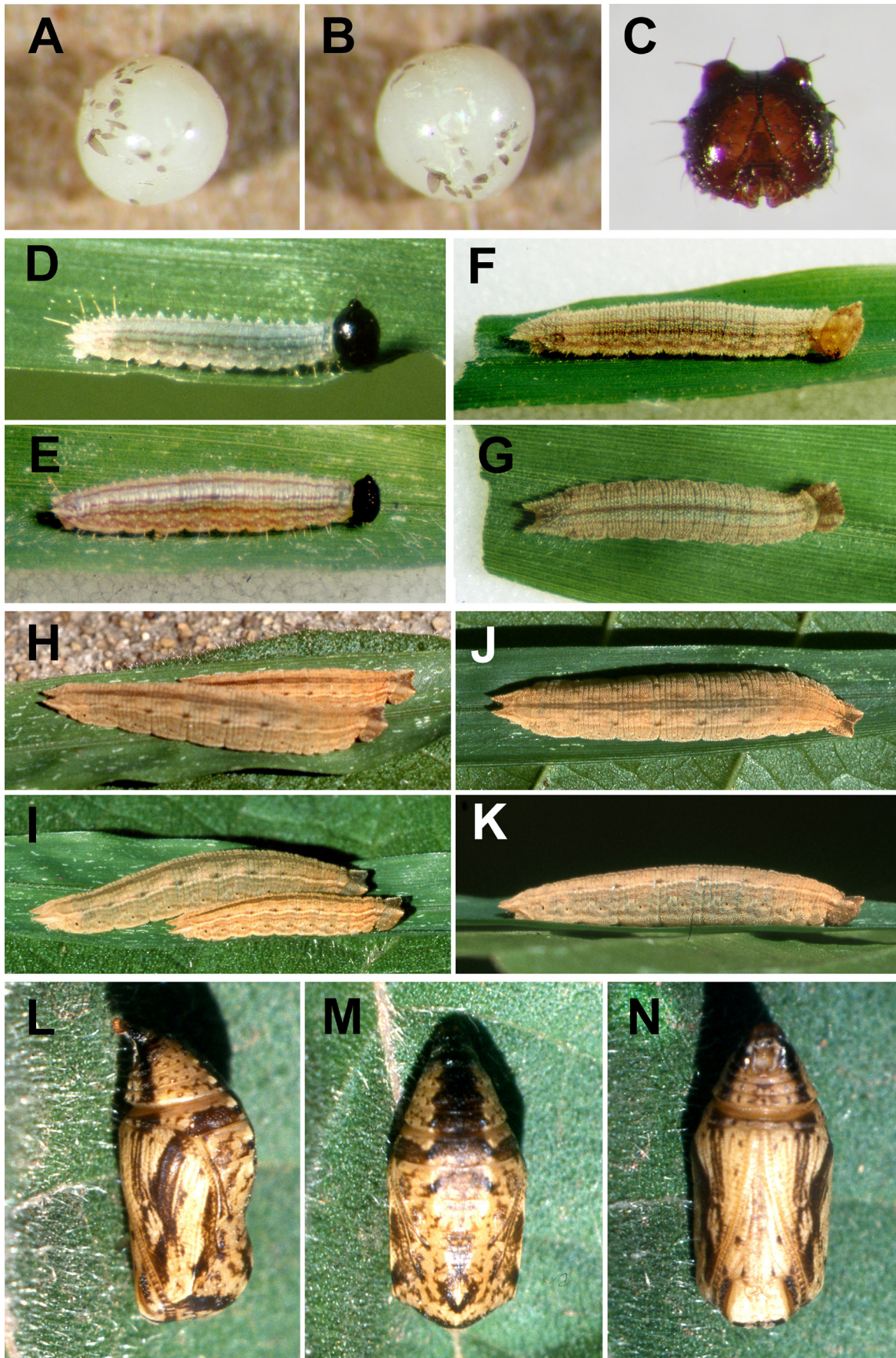
#### MATERIAL AND METHODS

Adults and immatures of *S. ambra* (Figs. 1, 2) were studied in April 2002 in Morro Grande State Reserve (23°39'–23°50' S, 46°55'–47°01' W) in the Atlantic Forest of southeastern Brazil, a large block of forest (> 10,000 ha) mostly in advanced stages of succession, but also containing large patches of well-preserved original montane forest (Fig. 1A, B, C). Elevation varies from 900 to 1000 m, average monthly temperatures vary

from 11°C to 27°C and the average rainfall is 1400 mm (see details of the study area in Uehara-Prado *et al.*, 2004, 2007).

Eggs were obtained from a wild-captured female kept in a plastic bag and provided with leaves of a Brazilian native bamboo species (Poaceae), following Freitas (1991). Larvae were reared in plastic containers cleaned daily and provided with fresh plant material every two or three days (following Freitas, 2007). Data were recorded on morphology and development time were recorded for all stages. Dry head capsules and pupal cases were retained in glass vials. Immature stages were fixed in Kahle-Dietrich solution (Triplehorn & Johnson, 2005). Voucher specimens of the immature stages and adults were deposited





**Figure 2.** Life stages of *S. ambra*. A, B. Egg fixed in Kahle-Dietrich solution (lateral, dorsal); C. First instar head capsule; D, E. First instar (early lateral and late dorsal, respectively); F, G. second instar (lateral, dorsal); H, I, J, K. fourth (last) instars in different views; L, M, N. Pupa (lateral, dorsal, ventral).



in the André V. L. Freitas collection, part of the Zoological Collection of the Museu de Diversidade Biológica (ZUEC-AVLF), Universidade Estadual de Campinas, Campinas, São Paulo, Brazil.

Measurements were taken for all life stages and morphology was studied 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 external stemmata (as in Freitas, 2007). Terminology for the early stages description follows García-Barros & Martín (1995) for eggs and Stehr (1987) for larvae and pupae.

## RESULTS

**Egg** (Fig. 2A, B). Rounded, pale yellow, smooth, with no visible markings and ridges (Fig. 2). Height and diameter 1.3 mm (n = 1); duration 6 days (n = 5) and 2 days (n = 1).

**First instar** (Fig. 2C, D, E). Head capsule width 0.72-0.8 mm; head scoli 0.10-0.12 mm (n = 4). Head pale brown, bearing a pair of very short scoli on vertex, each with two long narrow black setae. Third stemma larger than other stemmata. Body beige with reddish longitudinal stripes; a pair of short caudal filaments on last abdominal segment. Legs and prolegs light brown. Maximum length 5 mm. Duration 7-8 days (n = 4).

**Second instar** (Fig. 2F, G). Head capsule width 1.02-1.08 mm; head scoli 0.22-0.28 mm (n = 3). Head dark brown, with two short scoli on vertex. Body brown, laterally striped with dark brown longitudinal lines, including a conspicuous dorsal stripe; caudal filaments short. Legs and prolegs light brown. Maximum length 10 mm. Duration 5-6 days (n = 4).

**Third instar**. Head capsule width 1.40-1.50 mm; head scoli 0.34-0.40 mm (n = 4). Similar to second instar in color and general shape. Maximum length 16 mm. Duration 8 days (n = 4).

**Fourth (last) instar** (Fig. 2H, I, J, K). Head capsule width 1.96-2.00 mm; head scoli 0.58-0.60 mm (n = 3). Head olive-brown with pale cream rounded markings. Body similar to third instar but larger; beige, with a weakly marked pattern of longitudinal thin lines; a subdorsal pale undulating stripe with dark patches in the intersegmental regions and a dorsal dark stripe. General profile thick and stout; a pair of short caudal filaments on last abdominal segment. Maximum length 22 mm. Duration 17 days (n = 2).

**Pupa** (Fig. 2L, M, N). Very short and smooth; mostly pale brown, mottled with dark brown stripes, with very short rounded ocular caps; cremaster broad and dark laterally; abdomen with a broad dorsal dark brown stripe, with very short paired subdorsal projections, slightly curved in last segments. Total length 9 mm. Duration 13 days (n = 2).

**Behavior and natural history.** *Splendeuptychia ambra* is known from a few localities of montane rain forest in the Atlantic Forest of southeastern Brazil, at elevations from 800-1400 m, with the exception of one record at lower elevation (220-250 m) from northern Argentina (Bustos, 2008; see additional records in Santos *et al.*, 2018). Oviposition behavior was not observed in the field, and the natural host plant is unknown. In the laboratory, larvae easily accepted the small bamboo *Chusquea*

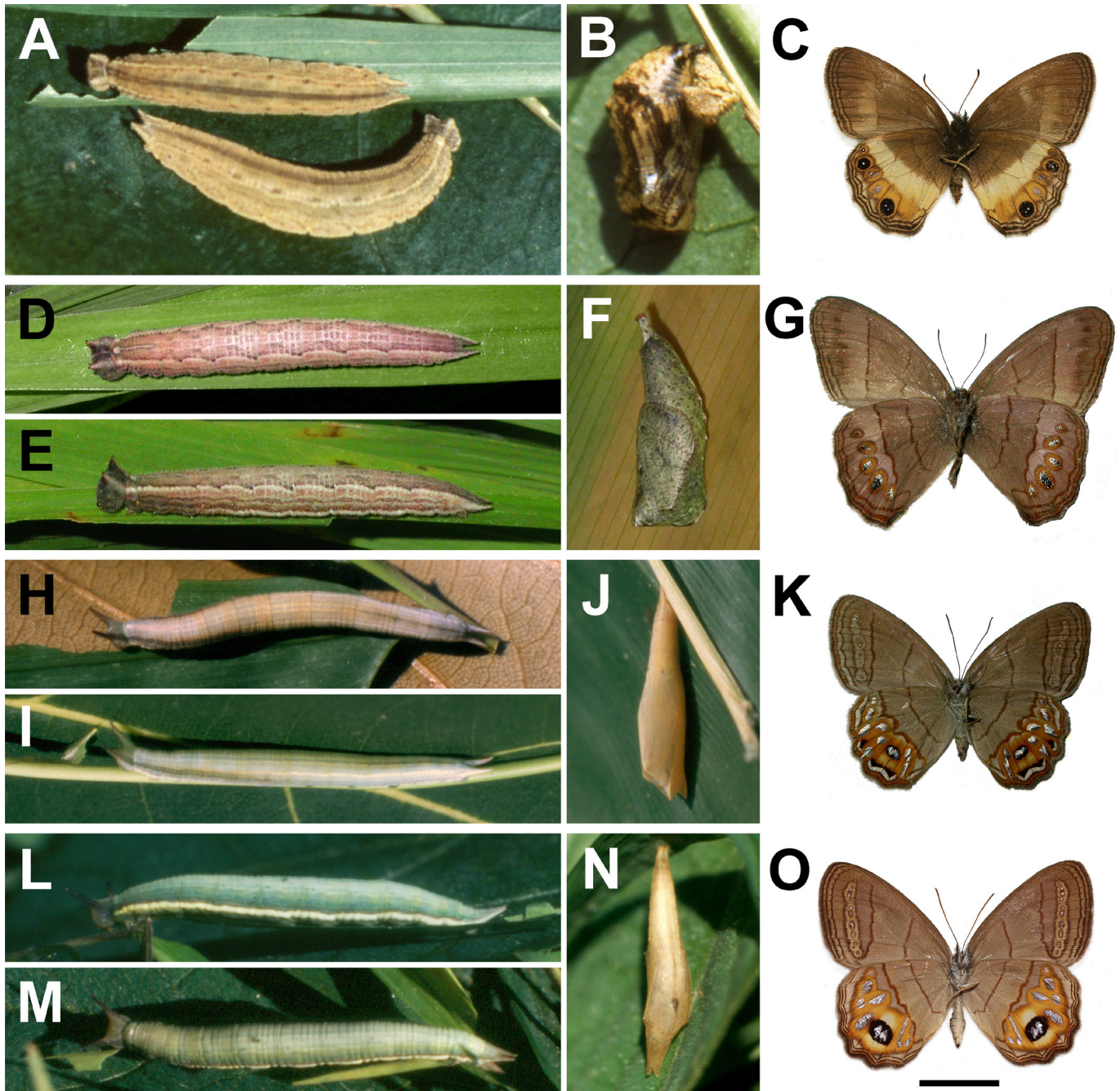
*cf. ramosissima*, a native species from the region of Campinas, São Paulo (about 200 km far from the collecting site). Larvae are solitary and moved slowly and passed through four larval instars. Adults (Figs. 1D, E) are seldom observed in nature; in another study, only seven individuals (six males and a single female) were captured in baited traps over 36,000 trap-hours at the study site (Uehara-Prado *et al.*, 2005), all in areas where bamboos were common inside a large block of well-preserved forest. Behaviors such as territorialism and courtship were not observed.

## DISCUSSION

As previously mentioned, the genus *Splendeuptychia* is clearly non-monophyletic, with the species in this genus appearing in three distinct lineages of Euptychiina, namely: 1) the '*Splendeuptychia* clade', which includes the type species of the genus, *Splendeuptychia ashna* (Hewitson, 1869); 2) the '*Pareuptychia* clade'; and 3) the '*Amphidecta* clade' (clades names and composition following Espeland *et al.*, 2019, and Rosa *et al.*, 2021). Considering that the immature stages of butterflies usually provide important evidence of systematic relationships (e.g. Freitas & Brown, 2004, and Willmott & Freitas, 2006), the genus *Splendeuptychia* could be a good model group for testing this pattern within the Euptychiina.

Morphology and molecular data indicate that *S. ambra* is closely related to *S. ashna* within the '*Splendeuptychia* clade' (Barbosa & Freitas, unpublished). Consistent with this hypothesis, its immature stages present several similarities with those of other species in this clade, such as the thick larvae, beige to brownish colored, bearing short head horns and a short stubby pupa with also short ocular caps and short paired lateral abdominal projections. These features are quite similar to those of other species in the '*Splendeuptychia* clade', such as *Splendeuptychia* sp. (Fig. 3A-C), *Magneuptychia libye* (Linnaeus, 1767), "*Cissia*" *confusa* (Staudinger, 1887), "*Magneuptychia*" *pallema* (Schaus, 1902), *Paryphthimoides poltys* (Prittwitz, 1865) and *Malaveria grimon* (Godart, [1824]) (Singer *et al.*, 1983; DeVries, 1987; Kaminski & Freitas, 2008; Janzen & Hallwachs, 2021; AVLF, unpublished).

In contrast, while the immature stages of *S. ambra* are similar to those of other members of the '*Splendeuptychia* clade', they are quite distinct from other known species of *Splendeuptychia* belonging to the other two clades. For example, the immature stages of *Splendeuptychia doxes* (Godart, [1824]), *Splendeuptychia furina* (Hewitson, 1862), and *Nhambikuara mima* (Butler, 1867), all closely related and members of the '*Pareuptychia* clade', have slender larvae bearing short head horns, and the pupae are slender, with short ocular caps (Fig. 3D-G; Corahua-Espinoza *et al.*, 2022; AVLF, unpublished). These are reminiscent of the immature stages of *Taydebis melobosis* (Capronnier, 1874) and *Pareuptychia ocirrhoe* (Fabricius, 1776), both from the same clade (Freitas, 2003; Freitas *et al.*, 2016). Finally, the immature stages of the *Splendeuptychia* species belonging to the '*Amphidecta* clade' are distinct from all of the above. In *Splendeuptychia libitina* (Butler, 1870), *S. pagyris* (Godart, [1824]), *Splendeuptychia hygina* (Butler, 1877) and *Splendeuptychia quadrina* (Butler,



**Figure 3.** Immature stages of *Splendeuptychia* species (all from Brazil). **A, B, C.** *Splendeuptychia* sp., fourth (last) instar, two larvae, pupa (lateral), reared adult (ventral), Alta Floresta, MT; **D, E, F, G.** *Splendeuptychia doxes*, fourth (last) instar (dorsal, lateral), pupa (lateral), São Luiz do Paraitinga, SP, adult (ventral), Caucaia do Alto, SP; **H, I, J, K.** *Splendeuptychia libitina*, fourth (last) instar (two dorsal views), pupa (latero-ventral), reared adult (ventral), Morro do Diabo State Park, Teodoro Sampaio, SP; **L, M, N, O.** *Splendeuptychia pagyris*, fourth (last) instar (lateral, dorsal), pupa (dorsal), reared adult (ventral), Morro Grande State Reserve, Cotia, SP. Acronyms for Brazilian states: SP = São Paulo, MT = Mato Grosso. All adults to scale; black bar = 1 cm.

1869), larvae are very slender and elongate, usually with greenish tones, bearing long head horns and long caudal filaments and their pupae are slender with conspicuous pointed ocular caps (Fig. 3H-O, See *et al.*, 2018; AVLF, unpublished). However, although these characteristics roughly match those observed in *Amphidecta reynoldsi* Sharpe, 1890 (Freitas, 2004), there is not enough knowledge of the immature stages of the ‘*Amphidecta* clade’ to allow more thorough comparisons.

The slender larvae with long head horns and the elongated pupae of the *Splendeuptychia* species belonging to the

‘*Amphidecta* clade’ could benefit from camouflage when resting on narrow, elongated bamboo leaves that they feed on, as appears to be the case for the Pronophilina species *Eteona tisiphone* (Boisduval, 1836) (Freitas, 2002). Similar cases were reported in other species of Euptychiina and Hesperiiidae, whose larvae feed on bamboos and other plants with thin leaves or leaflets, and have larvae slender bodies and a color patterns that suggest camouflage (Freitas, 2018, 2020; Freitas *et al.*, 2019b). However, the present data show that bamboo-feeding Euptychiina do differ in some specific morphological structures

of their larvae and pupae, such as body profile, size of the head horns and pupal shape (including the species of *Splendeptychia* discussed here), suggesting that a number of factors are involved in the evolution of the morphology of Euptychiina immature stages (see also Corahua-Espinoza *et al.*, 2022). A promising way to study the evolution of the early stages of Euptychiina is by mapping the major morphological characteristics onto the comprehensive and well supported phylogenies that are now available. In this way, as more information from immature stages becomes available, understanding of morphological and ecological evolution in the Euptychiina will be improved, opening new avenues of investigation in this species-rich and diversified butterfly clade.

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