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External morphology of immature stages of *Zaretis strigosus* (Gmelin) and *Siderone galanthis catarina* Dottax and Pierre comb. nov., with taxonomic notes on *Siderone* (Lepidoptera: Nymphalidae: Charaxinae)

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ABSTRACT

The external morphology of immature stages of *Zaretis strigosus* (Gmelin, [1790]) and *Siderone galanthis catarina* Dottax and Pierre, 2009 **comb. nov.** from southern Brazil are described. Additionally, morphology of the adults and sequences of the mitochondrial gene cytochrome oxidase, subunit I, were analyzed in order to evaluate the taxonomy of *Siderone galanthis* Hübner, [1823]. Immatures were collected on *Casearia sylvestris* (Salicaceae) in Curitiba, Paraná, and Balneário Barra do Sul, Santa Catarina, Brazil, and reared at the laboratory. Morphological descriptions and illustrations are provided, based on observations through stereoscopic and optic microscopes attached to camera lucida; results are compared and discussed and immature stages of some other species of Charaxinae. The results indicates that the morphology of the immature stages of the studied species differ greatly from other Anaeini, representing a distinct lineage of leafwings butterflies. Morphology and molecular evidence indicate that *S. nemesis mexicana* Dottax and Pierre, 2009 and *S. nemesis catarina* Dottax and Pierre, 2009 are conspecific with *S. galanthis* (Cramer, 1775); additionally, *S. thebais* C. Felder and R. Felder 1862, *S. nemesis* var. *confluens* Staudinger, 1887, *S. nemesis* f. *leonora* Bargmann, 1928 and *S. nemesis* f. *exacta* Bargmann, 1929 are synonymized with *S. galanthis galanthis* (Cramer, 1775).

Introduction

Zaretis Hübner, [1819] and *Siderone* Hübner, [1823] are two closely related genera of leafwing butterflies widely distributed throughout the Neotropics. Although superficially different, both share several common characters, especially in the immature stages, and close relationship between them were acknowledged by both morphologic (Comstock, 1961; Rydon, 1971) and molecular studies (Wahlberg et al., 2009). *Zaretis* and *Siderone* are currently placed in the Anaeini (Lamas, 2004), but adults and immature stages are widely different from the rest of the genera included in the above cited tribe, as noted by Rydon (1971), who erected "Zaretidinae", to include *Zaretis*, *Siderone* and *Coenophlebia* C. Felder and R. Felder, 1862. The apparent lack of constant characters to establish solid species-level taxonomy, caused by the high intraspecific variation and sexual dimorphism in species of *Zaretis* and *Siderone*, yielded a number of debatable taxonomic names and different views on the number of valid species (Comstock, 1961; Vane-Wright, 1975; Willmott and Hall 2004; Dottax and Pierre, 2009). Both genera received recent species-level taxonomic treatments, *Zaretis* by Willmott and Hall (2004) and *Siderone* by Dottax and Pierre (2009), improving the taxonomic understanding of the genera; nevertheless, some uncertainties still remain to this date.

Zaretis strigosus (Gmelin, [1790]) (Figs. 1–4) and *S. galanthis catarina* Dottax and Pierre, 2009 **comb. nov.** (Figs. 5–8) are widely distributed in forest areas of South America east of the Andes, the *Z. strigosus* in the Amazon basin and Guyana through southern Brazil and northern Argentina; and *S. galanthis catarina* **comb. nov.**, recently described from the state of Santa Catarina, Brazil, in central, eastern and southeastern Brazil, being the most common species of these genera in its ranges. The immature stages of both species have been described in the past and are usually associated with species of *Casearia* (Salicaceae), but the descriptions are either old and rudimentary (e.g. Müller, 1886; Rydon, 1971) or lacking more complete morphological descriptions and illustrations (e.g. Morais et al., 1996; Teshirogi, 2004, 2005). As there is consensus

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Figs. 1–4. *Zaretis strigosus* (Gmelin, [1790]) (Santa Catarina, Brazil). 1 and 2: Male, dorsal and ventral. 3 and 4: Female, dorsal and ventral. Scale bar = 1 cm.

that information on immature stages are important to improve the generic and suprageneric groups in the Charaxinae (Rydon, 1971; Pyrcz and Neild, 1996), the purposes of this study are to describe in detail and compare the morphology of the immature stages of *Z. strigosus* and *S. galanthis catarina* **comb. nov.** and to provide taxonomic notes on the genus *Siderone*, on the basis of the morphology of the adults and molecular data.

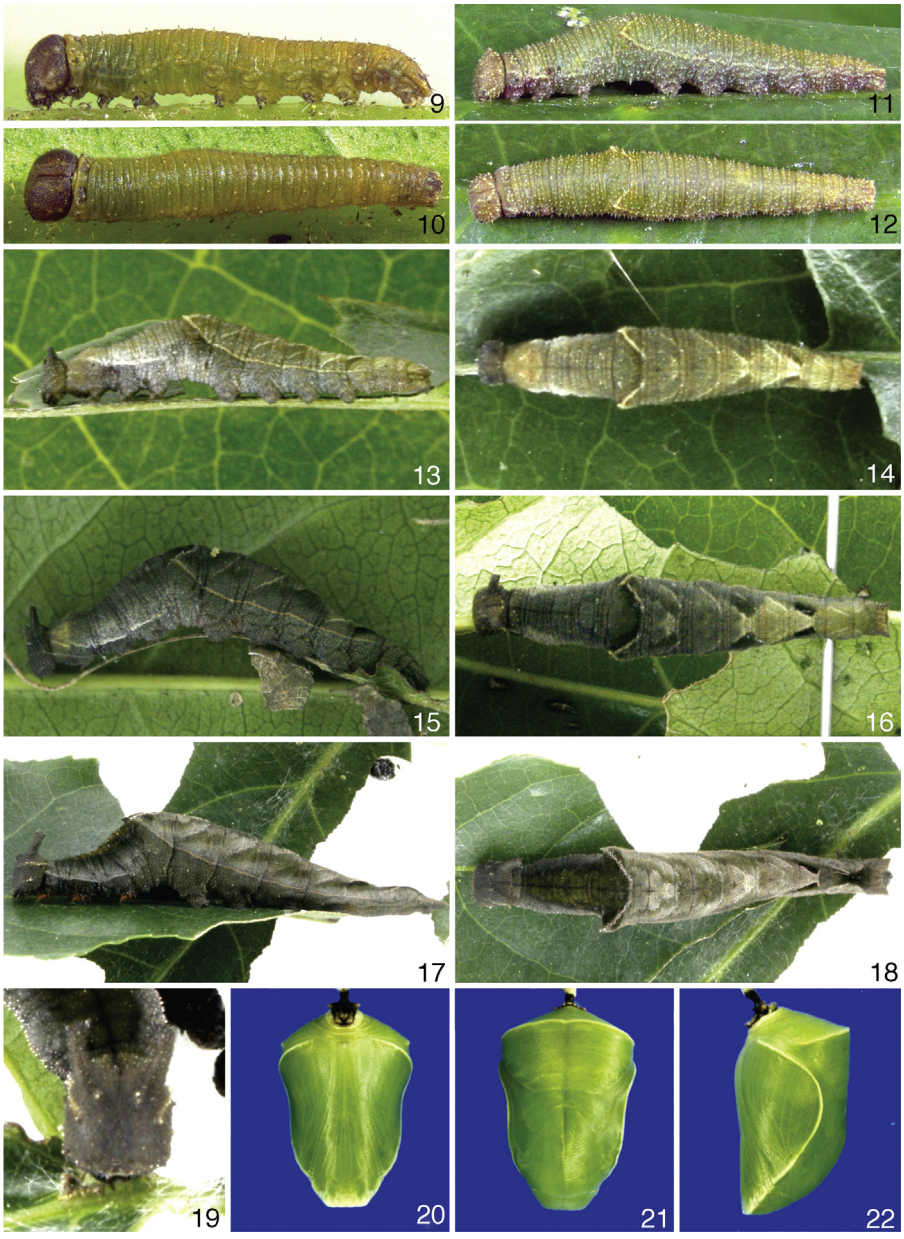
Material and methods

Immature stages were observed and collected in several occasions between July 2008 and April 2011 at Centro Politécnico, Universidade Federal do Paraná (UFPR) (25°27′S, 49°14′27″W; c.a. 900 m) and Parque Municipal Barigui (25°25′36″S, 49°18′32″W; c.a. 950 m a.s.l.), Curitiba, Paraná, Brazil (*Z. strigosus*) and Balneário

Figs. 5–8. *Siderone galanthis catarina* Dottax and Pierre, 2009 **comb. nov.** (Santa Catarina, Brazil). 5 and 6: Male, dorsal and ventral. 7 and 8: Female, dorsal and ventral. Scale bar = 1 cm.

Table 1
Accession numbers (Sample ID) and collection data of the sequences used in the molecular study. Sequences are available at http://www.boldsystems.com (Ratnasingham and Hebert, 2007). n/a = data not available.

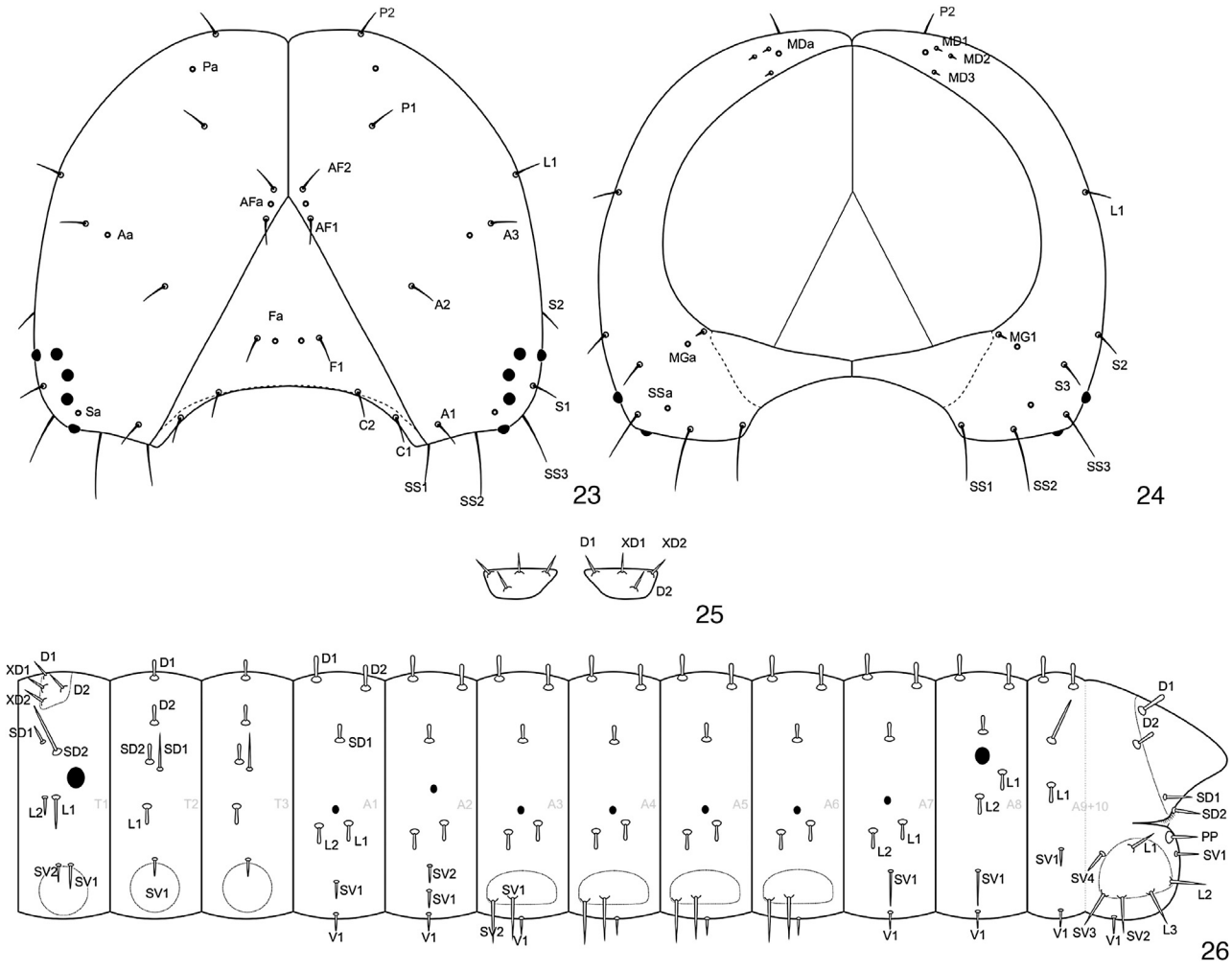
Sample ID	Voucher ID	Species	Subspecies	Collection date	Country	State/province	Locality
FLMNH-05006	FLMNH-05006	*Coenophlebia archidona*	n/a	13-Oct-2005	Ecuador	Orellana	Napo Wildlife Center
KC133009	LEP03365	*Coenophlebia archidona*	n/a	n/a	n/a	n/a	n/a
DZ20270	DZ20270	*Siderone syntyche*	*mars*	13-Jul-1981	Peru	Huanuco	Tingo Maria
DZ19116	DZ19116	*Siderone galanthis*	*catarina*	16-May-1980	Brazil	Distrito Federal	Brasília
DZ19121	DZ19121	*Siderone galanthis*	*catarina*	17-Dec-2007	Brazil	Santa Catarina	Joinville
DZ20371	DZ20371	*Siderone galanthis*	*catarina*	06-Nov-2010	Brazil	Santa Catarina	Joinville
DZ20614	DZ20614	*Siderone galanthis*	*catarina*	16-May-1980	Brazil	Distrito Federal	Brasília
DZ19884	DZ19884	*Siderone galanthis*	*galanthis*	01-Aug-2008	Brazil	Acre	Senador Guiomard
DZ20662	DZ20662	*Siderone galanthis*	*galanthis*	16-May-2011	Brazil	Maranhão	Feira Nova do Maranhão
02-SRNP-15808	02-SRNP-15808	*Siderone galanthis*	*mexicana*	22-Jul-2002	Costa Rica	Guanacaste	Área de Conservacion Guanacaste
04-SRNP-14059	04-SRNP-14059	*Siderone galanthis*	*mexicana*	24-Sep-2004	Costa Rica	Guanacaste	Área de Conservacion Guanacaste
04-SRNP-14439	04-SRNP-14439	*Siderone galanthis*	*mexicana*	08-Oct-2004	Costa Rica	Guanacaste	Área de Conservacion Guanacaste
04-SRNP-14464	04-SRNP-14464	*Siderone galanthis*	*mexicana*	24-Oct-2004	Costa Rica	Guanacaste	Área de Conservacion Guanacaste
04-SRNP-14547	04-SRNP-14547	*Siderone galanthis*	*mexicana*	26-Oct-2004	Costa Rica	Guanacaste	Área de Conservacion Guanacaste
04-SRNP-24548	04-SRNP-24548	*Siderone galanthis*	*mexicana*	20-Oct-2004	Costa Rica	Guanacaste	Área de Conservacion Guanacaste
04-SRNP-24612	04-SRNP-24612	*Siderone galanthis*	*mexicana*	13-Oct-2004	Costa Rica	Guanacaste	Área de Conservacion Guanacaste
05-SRNP-22384	05-SRNP-22384	*Siderone galanthis*	*mexicana*	15-Jul-2005	Costa Rica	Guanacaste	Área de Conservacion Guanacaste
05-SRNP-2286	05-SRNP-2286	*Siderone galanthis*	*mexicana*	03-Jun-2005	Costa Rica	Alajuela	Área de Conservacion Guanacaste
05-SRNP-40836	05-SRNP-40836	*Siderone galanthis*	*mexicana*	05-May-2005	Costa Rica	Alajuela	Área de Conservacion Guanacaste
AIV096	n/a	*Siderone galanthis*	*mexicana*	15-Mar-1982	Mexico	Quintana Roo	Felipe Carrillo Puerto
AIV097	n/a	*Siderone galanthis*	*mexicana*	15-Mar-1982	Mexico	Quintana Roo	Felipe Carrillo Puerto
AIV198	n/a	*Siderone galanthis*	*mexicana*	01-Oct-1991	Mexico	Guerrero	Acapulco de Juaréz
AIV199	n/a	*Siderone galanthis*	*mexicana*	01-Oct-1991	Mexico	Guerrero	Acapulco de Juaréz
AIV200	n/a	*Siderone galanthis*	*mexicana*	01-Sep-1991	Mexico	Guerrero	Acapulco de Juaréz
MAL-04176	L-73641	*Siderone galanthis*	*mexicana*	26-Oct-2004	Mexico	Yucatan	Uman, X-tepen
MAL-04177	L-74032	*Siderone galanthis*	*mexicana*	08-Nov-2004	Mexico	Yucatan	Reserva Cuxtal
MAL-04178	L-85748	*Siderone galanthis*	*mexicana*	14-Sep-2006	Mexico	Yucatan	Panaba, San Juan del Rio
MAL-04179	L-85727	*Siderone galanthis*	*mexicana*	08-Sep-2006	Mexico	Yucatan	Celestun, camino a San Rafael
MAL-04180	L-60777	*Siderone galanthis*	*mexicana*	13-Aug-2003	Mexico	Campeche	Ejido Conhuas
MAL-04181	L-85002	*Siderone galanthis*	*mexicana*	30-Jan-2005	Mexico	Quintana Roo	Ejido X-maben
MAL-04182	L-43574	*Siderone galanthis*	*mexicana*	15-Mar-2004	Mexico	Quintana Roo	Reserva de la Biosfera Sian Kaan
MAL-04183	L-20455	*Siderone galanthis*	*mexicana*	29-Aug-1998	Mexico	Quintana Roo	Bahia de Chetumal
MAL-04184	L-56633	*Siderone galanthis*	*mexicana*	10-Aug-2003	Mexico	Campeche	Calakmul
MAL-04185	L-62195	*Siderone galanthis*	*mexicana*	12-Aug-2003	Mexico	Campeche	Ejido Nuevo Becal
MAL-04186	L-29826	*Siderone galanthis*	*mexicana*	25-Nov-1999	Mexico	Campeche	Calakmul
MAL-04187	L-29825	*Siderone galanthis*	*mexicana*	25-Aug-1999	Mexico	Campeche	Ejido Narciso Mendoza
YB-BCI64429	n/a	*Siderone galanthis*	*mexicana*	n/a	Panama	Panama	n/a



Figs. 9–22. Immature stages of *Zaretis strigosus* (Gmelin, [1790). 9 and 10: First instar, lateral and dorsal. 11 and 12: Second instar, lateral and dorsal. 13 and 14: Third instar, lateral and dorsal. 15 and 16: Fourth instar, lateral and dorsal. 17 and 18: Fifth instar, lateral and dorsal. 19: Fifth instar, head capsule, anterior view. 20–22: Pupa, ventral, dorsal and lateral views. Scale bars = 1 mm.

Barra do Sul (26°27′50″S,48°38′13″W; c.a. 5 m), Santa Catarina, Brazil (*S. galanthis catarina* **comb. nov.** and *Z. strigosus*). Specimens were brought to the Laboratório de Estudos de Lepidoptera Neotropical, Departamento de Zoologia (UFPR), and individually reared in plastic containers with fresh leaves of the host plant in an ambient conditions. Behavioral observations were carried out in the field as well as in the laboratory. Eggs, head capsules and pupal skins were dehydrated and preserved; larvae and pupae were fixed in Kahle-Dietrich solution and preserved in 80% alcohol. Voucher specimens were retained at the Coleção Entomológica Pe. Jesus Santiago Moure, Departamento de Zoologia, Universidade Federal do Paraná, Coleção de Imaturos de Lepidoptera (DZUP-IL), batches 091 (*Z. strigosus*) and 092 (*S. galanthis catarina* **comb. nov.**). The chaetotaxy of the head capsules were observed using an optic microscope equipped with a camera lucida. Measurements and drawings of head capsules were made with the aid of a stereoscopic microscope equipped with micrometric lenses or a camera lucida. Nomenclature follows Scoble (1992) for eggs; Hinton (1946), Peterson (1962), and Stehr (1987) for larval chaetotaxy and morphology, with modifications proposed by Huertas-Dionisio (2006) for the chaetotaxy of the anal legs; and Mosher (1916) for pupal morphology.

To access the taxonomic status of *Siderone galanthis*, 139 specimens deposited at the DZUP and the Olaf Hermann Hendrik Mielke Collection (OM) were studied using standard procedures of dissection. Thirty-seven sequences from samples of specimens of *Siderone* and *Coenophlebia* deposited at the DZUP and the McGuire Center for Lepidoptera & Biodiversity, Florida Museum of Natural History (FLMNH), and sequences of *Siderone* and *Coenophlebia* available at online databases (Benson et al., 2005; Ratnasingham and Hebert, 2007) were used in the molecular study. Extraction, amplification and sequencing of 658 base pairs of the mitochondrial Cytochrome Oxidade, Subunit I (COI), of specimens from DZUP and FLMNH were carried out at the Canadian Center for DNA Barcoding,



Figs. 23–26. Schematics of the first instar of *Zaretis strigosus* (Gmelin, [1790]) and *Siderone galanthis catarina* Dottax and Pierre, 2009 **comb. nov.** 23 and 24: Head capsule, anterior and posterior. 25: Prothoracic plate, dorsal. 26: Thorax and abdomen, lateral.

Biodiversity Institute of Ontario, University of Guelph, Canada, following the protocol described by Hebert et al. (2004). Alignment of the sequences and distance analyses by the Neighbor Joining tree building method (Saitou and Nei, 1987) with Kimura-2-Parameter distance model (Kimura, 1981) were implemented by the Barcode of Life Data Systems console, Version 2.5 (Ratnasingham and Hebert, 2007). Accession numbers to the sequences are given at Table 1, and are available at http://www.boldsystems.com (Ratnasingham and Hebert, 2007).

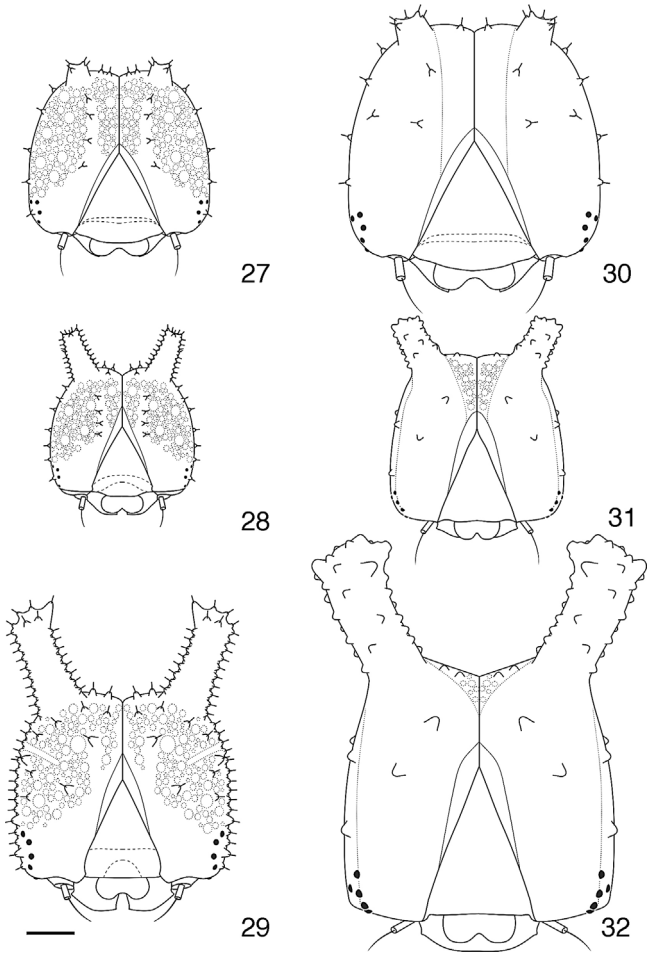
Results and discussion

Zaretis strigosus (Gmelin, [1790])
(Figs. 1–4, 9–22, 27–29, 33–34, 37–39, 43)

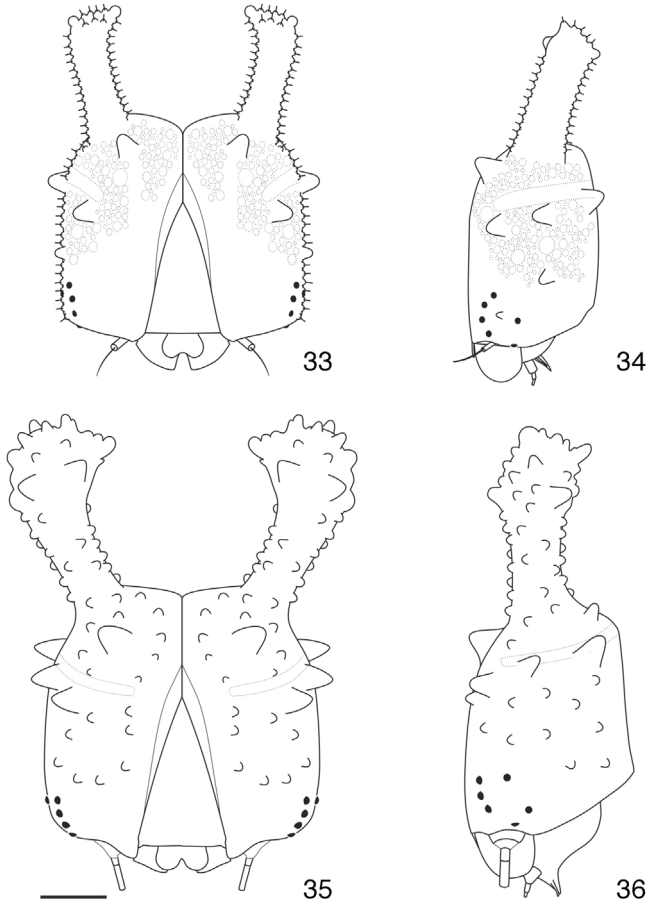
Biology: Eggs are laid singly underneath leaves of *Casearia sylvestris* (Salicaceae) (Fig. 44) in all study sites; all instars feed at night, resting inconspicuously during most of the day; first instar eclodes by chewing a round aperture around the dorsal concave depression of the egg; first and second instars feed initially on the apex of leaves, building and resting on frass chains made out of silk, fecal pellets and parts of the host plant (e.g. Fig. 45), considerably extending the midrib; third to fifth instars rest on twigs or on the midrib of either fresh or partially consumed leaves of the host plant, resembling a piece of rolled-up, dead leaf; third to fifth instars move in a wobbling fashion, resembling a dead leaf being blown by the wind; when close to pupation, the fifth instar stops eating and occasionally leave the host plant to find a suitable place to pupate, then, the larva weaves a thick silk pad underneath a leaf, attaching itself head capsule down by the anal abdominal legs, remaining somewhat coiled until molting; pupae are incapable of movement; at the emergence of the adult, an amount of reddish orange meconium is expelled.

Egg: Pale yellow; nearly spherical, with a dorsal concave depression around the micropyle; chorion smooth; aeropyle as minute bumps around the edge of the dorsal concavity. Egg width: 0.9 mm ($n = 1$). Duration: 6 days.

First instar (Figs. 9–10, 23–26): Head capsule rounded and smooth; mostly dark brown, with whitish anterior and lateral areas and translucent setae; body almost cylindrical, slightly larger at A2 and slightly tapering posteriad, A9 + 10 with a small fleshy projection; body yellowish green, with brown setae with creamy white bases, and a creamy white line along the body on the supraspiracular area, displaced dorsally on A2, A8–A9 + 10 brownish green; prothoracic plate divided at the midline, each part trapezoidal; anal plate rounded, weakly defined; abdominal leg plates semicircular; thoracic legs, prothoracic plate, anal plate, abdominal leg plates and ocrea dark brown. Abdominal legs with 14 and anal legs with 11 crochets, both arranged as a unisserial, uniordinal lateral pennelipse. Head capsule chaetotaxy and stemmata position, and body chaetotaxy, spiracle size and relative position are shown in Figs. 23–26. Head capsule size: 0.67 mm ($n = 1$). Duration: 7 days.



Figs. 27–32. Head capsules of second to fourth instars in anterior view. 27–29: *Zaretis strigosus* (Gmelin, [1790]). 27: Second instar. 28: Third instar. 29: Fourth instar. 30–32: *Siderone galanthis catarina* Dottax and Pierre, 2009 **comb. nov.** 30: Second instar. 31: Third instar. 32: Fourth instar. Scale bar, Figs. 27, 30 = 0.25 mm, Figs. 28, 29, 31 and 32 = 0.5 mm.



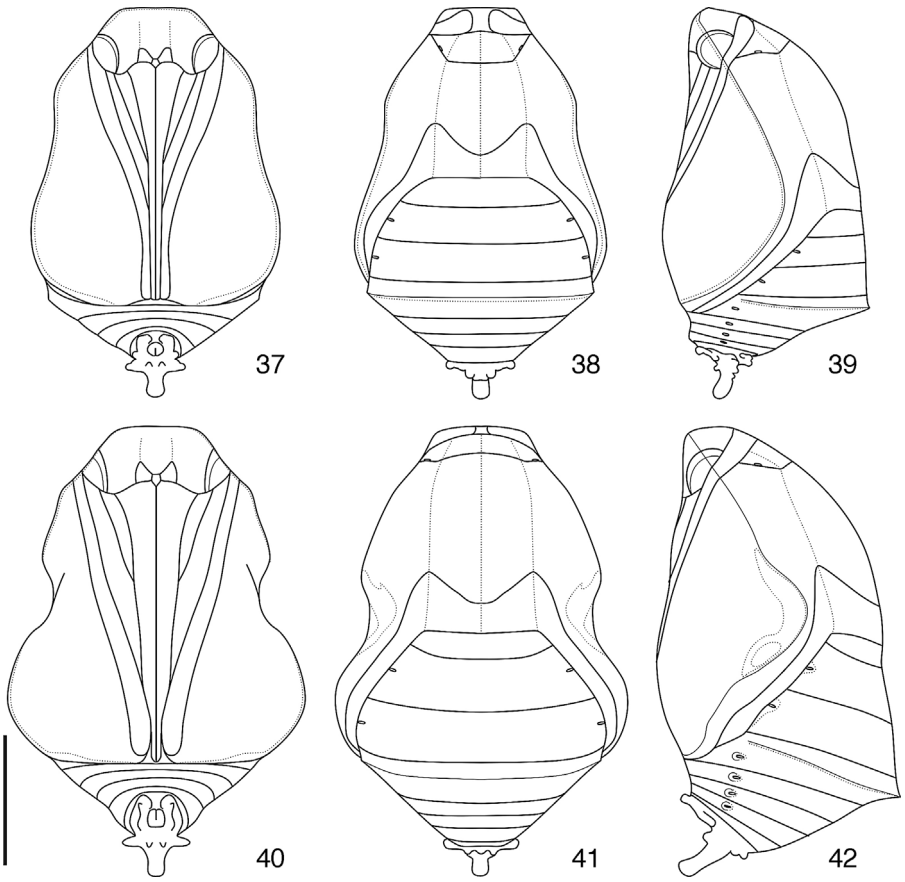
Figs. 33–36. Head capsules of fifth instars in anterior and lateral views. 33 and 34: *Zaretis strigosus* (Gmelin, [1790]). 35 and 36: *Siderone galanthis catarina* Dottax and Pierre, 2009 **comb. nov.** Scale bar = 1 mm.

Second instar (Figs. 11, 12, 27): Head capsule brown, lighter than in previous instar, with scattered creamy yellow tiny knobs and two truncated, dorsal and more or less paralleled projected horns, about one-tenth the height of the head capsule, one on each side of the epicranial suture. Body with T1 about the same size of the head capsule, enlarging posteriorly toward A2, then gradually tapering to A9 + 10; A9 + 10 with a dorsal squared fleshy projection with tips slightly projected; body yellowish green dorsally and laterally, reddish green ventrally; base of the setae creamy yellow, with two supraspiracular creamy yellow lines, one from T1 to half of A1, and another from the dorsal area of A2 to the subdorsal area of the same segment, forming an anterior angle and then running posteriad on the supraspiracular area toward to the end of the A9 + 10 projection. Head capsule size: 0.95 mm (n = 2). Duration: 5–6 days.

Third instar (Figs. 13, 14, 28): Head capsule similar to the previous instar but horns conspicuously larger, about half the height of the head capsule; labrum, anteclypeus, frontoclypeus and the anterior area of the epicranium dark brown, with lighter areas between the horns and along the epicranial suture, lateral and posterior area of the epicranium greenish brown; body shape similar to the previous instar, but thorax conspicuously thicker in A2, with lateral triangular fleshy projections, and dorsal squared fleshy projection in A9 + 10 strongly developed; body mostly greenish brown, speckled with creamy white and yellow on the base of small setae; T1–A1 supraspiracular line creamy white; A2–A9 + 10 supraspiracular line similar to the previous instar, but light yellowish green; A3–A9 + 10 subdorsal areas with a series of oblique creamy white lines forming a trapezoidal and lozenge-shaped pattern; A3 with a small dorsal trapezoidal lighter area; A5 with a dorsal hourglass-shaped lighter area, darker in the adjacent subdorsal areas; A6 with a large dorsal trapezoidal lighter area; A7 similar to A5, but markedly dark brown in the subdorsal area adjacent to the dorsal lighter area; combined dorsal lighter areas of A6–A8 roughly forming a lozenge; A8 and A9 + 10 lighter greenish brown dorsally; A9 + 10 posteriorly reddish green. Head capsule size: 1.5 mm (n = 2). Duration: 6–7 days.

Fourth instar (Figs. 15, 16, and 29): Head capsule shape similar to the previous instar, but larger and dark brown, with a lateral whitish line ventral to the head horns, more or less continuous with the T1–A1 supraspiracular line; horns about two-thirds the height of the head capsule; body shape and color similar to the previous instar but larger, with color pattern darker and more noticeable; fleshy projections of A2 larger. Head capsule size: 2.25 mm (n = 3). Duration: 8–9 days.

Fifth instar (Figs. 17–19, 33–34): Head capsule shape and color similar to the previous instar, but larger (Fig. 19); body shape similar to the previous instar, but thorax even thicker and humped at A2, with enlarged lateral triangular fleshy projections; thoracic legs red; body color mostly dark greenish brown, similar to the previous instar, but color pattern posterior to the dorsal line in A2 and dorsal to the A2–A9 + 10 supraspiracular line formed by poorly defined whitish oblique markings; A7 similar to the previous instar, with dark brown and greenish brown subdorsal and posterior greenish brown dorsal areas; A8 with a dorsal trapezoidal greenish brown area; A9 + 10 dorsally greenish brown; abdominal legs crochets



Figs. 37–42. Pupae in ventral, dorsal and lateral views. 37–39: *Zaretis strigosus* (Gmelin, [1790]). 40–42: *Siderone galanthis catarina* Dottax and Pierre, 2009 **comb. nov.** Scale bar = 0.5 cm.

arranged as a unisserial, triordinal interrupted mesoseries and anal legs arranged as a unisserial, triordinal mesal pennelipse. Head capsule size: 3.66 mm (n = 3). Duration: 12–14 days.

Pupa (Figs. 20–22, 37–39): Mostly uniformly light green, creamy yellow around the cremaster. Head and prothorax narrower than the rest of the thorax and abdomen, abdomen wider than thorax, the latter medially narrower in dorsal and ventral view; pupa with two sets of strongly developed creamy white carinae: one lateral, runs continuously from the vertex posteriorly to the edge of the mesothoracic wing cases, and another across A4; abdomen strongly compressed, somewhat conical; scape and pedicel dorsal, the former larger than the latter; antennae flagellum extending ventrally and posteriorly between the mesothoracic wing cases; eye cases lateral and divided into one rough and other smooth area; frons and clypeus weakly separated from genae, anterior tentorial fovea visible between these areas; mandible trapezoidal and wide; labium somewhat lozenge-shaped, between the mandibles; galae slightly wider than mandibles basally, extending and tapering between the mesothoracic legs. Prothorax trapezoidal; mesothoracic spiracle between prothorax and mesothorax; mesothorax dorsally bulged; mesothoracic wing cases ventral, wing shape and venation visible; prothoracic and mesothoracic legs between the galae and the mesothoracic wing cases, the former approximately two-thirds the size of the latter; metathorax 'M' shaped; metathoracic wing cases extending posteriad and ventrally between the abdomen and the mesothoracic wing cases. A1–A4 partially covered by the meso end metathoracic wing cases ventrally; first spiracle not visible; spiracles on A2 and A3 dorsal, close to the metathoracic wing cases, and the others lateral; A5–A6 conical and compressed; genital scars slits on A9 in males and A8 and A9 in females; cremaster mostly black, directed ventrally and surrounded by creamy yellow set of tubercules: one set anterior and lateral to the yellowish green anal scar, one on each side of the shaft of the cremaster, and one dorsal to the shaft of the cremaster. Shaft slightly curved ventrally, with several tiny hooks at the tip. Length: 1.033 cm; height: 1.5 cm; cremaster height: 1.75 mm (n = 3). Duration: 12–14 days.

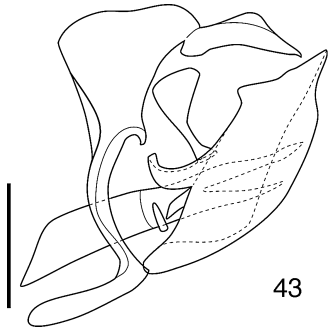


Fig. 43. Male genitalia of *Zaretis strigosus* (Gmelin, [1790]), lateral. Scale bar = 0.5 mm.

Discussion: The immature stages of *Z. strigosus* were illustrated by Sepp [1829] and Rydon (1971), and described by Müller (1886). Müller's (1886) description is based on *S. galanthis catarina* **comb. nov.** (misidentified as *S. ide* Hübner, [1823]), highlighting only the differential characters between these two species. There is no noticeable difference between the immature stages described by Müller (1886) and the description given here. Biezanko et al. (1966, 1974) and Brown (1992) reported *Casearia sylvestris* (Salicaceae) as preferred host plant; Zikán and Zikán (1968) and (Silva et al., 1968) report the use of species of *Colubrina* (Rhamnaceae) as the host

Figs. 44–57. Host plant and immature stages of *Siderone galanthis catarina* Dottax and Pierre, 2009 **comb. nov.** 44: Host plant, *Casearia sylvestris* (Salicaceae). 45: Egg, lateral. 46: Second instar resting in frass chain. 47: Second instar, dorsal. 48 and 49: Third instar, lateral and dorsal. 50 and 51: Fourth instar, lateral and dorsal. 52 and 53: Fifth instar, lateral and dorsal. 54: Fifth instar, head capsule in anterior view. 55 and 56: Pupa, ventral, dorsal and lateral views. Scale bars = 1 mm.

plant of *Z. strigosus*, but those unusual records needs confirmation. Nevertheless, there are a number of other host plant records in the literature (Beccaloni et al., 2008) that cannot be ascertained to a specific species of *Zaretis*, given the confused taxonomy of the genus. These records are all in the Salicaceae, of species of *Casearia*, *Laetia*, *Xylosma*, *Zuelania* and *Ryania*; DeVries (1986) reports an unusual record in the Piperaceae. Janzen and Hallwachs (2015) illustrate fourth and fifth instar and pupae of species of Central American *Zaretis*, with host plant records, and reports of parasitism by Tachinidae flies and Braconidae wasps. Other species of *Zaretis* with detailed description are *Z. ellops* and *Z. callidryas*, described by Muyshondt (1973, 1976) (the former identified as *Anaea* (*Zaretis*) *itys* (Cramer, [1777])), both reported to feed on *C. sylvestris* and *C. nitida*. Although similar, the larvae of *Z. callidryas* can be easily distinguished by the smoother head capsule, longer and posteriorly curved head horns, and much lighter dorsal color posterior to the A2 hump; on the other hand, *Z. ellops* and *Z. strigosus* are almost identical, varying only in the coloration of the dorsal area posterior to the A2 hump. *Zaretis ellops* and *Z. strigosus* are likely sister species; they are similar not only in the morphology of the immature stages, but also in the morphology of the adults. Nevertheless, while *Z. ellops* only occurs in west of the Andes and Central America, *Z. strigosus* is restricted to South America east of the Andes.

Taxonomic comments: *Zaretis strigosus* is frequently misidentified as *Z. itylus* (Westwood, 1850) and *Z. isidora* (Cramer, [1779]); indeed the name *strigosus* was synonymized with *isidora* by Willmott and Hall (2004), but the name was later resurrected by a number of authors in faunistic studies (e.g. Francini et al., 2011; Morais et al., 2012; Bellaver et al., 2012). Due to the intrinsic intraspecific variation and sexual dimorphism found in most species of the genus, there is no consensus among authors about the number of species of *Zaretis* and the correct name to apply to each phenotype. Nevertheless, morphologic and molecular evidence support the validity of *Z. strigosus* and a number of cryptic

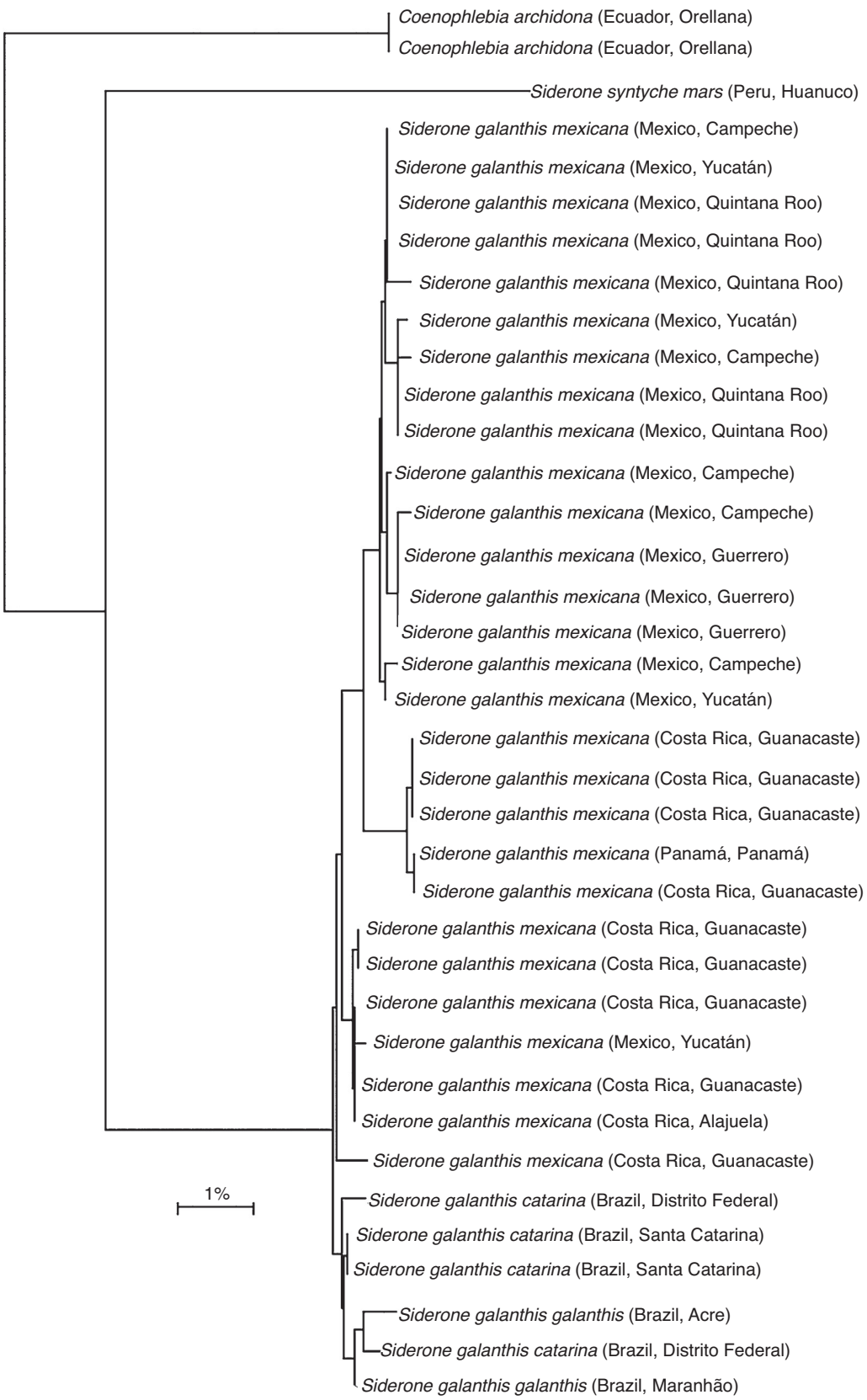


Fig. 58. Neighbor joining tree using Kimura-2-Parameter distance model of 37 sequences of species of *Siderone* Hübner [1823] and *Coenophlebia* C. Felder and R. Felder, 1862, with 658 base pairs of the mitochondrial gene cytochrome oxidase, Subunit I. Scale bar = 1% of distance.

Table 2
Systematic checklist of the genus *Siderone* Hübner [1823]. PA = Pará, Brazil; AM = Amazonas, Brazil; SC = Santa Catarina, Brazil.

Genus	Species	Subspecies	Synonyms	Original combination	Author	Type locality	Notes
Siderone			–	Hübner, [1823]	–		
			Siderone	–	Boisduval, 1836	–	preocc. (Hübner [1823])
			Phyllophasis	–	Blanchard, 1840	–	
			Phlllophasis	–	Blanchard, 1840	–	Incorrect orig. spelling
			Sideronidia	–	Bryk, 1939	–	Unavail., ICZN Art. 13.1
	galanthis		–	–	–		
		galanthis		*Papilio*	Cramer, 1775	Surinam	Type of *Phyllophasis*
			marthesia	*Papilio*	Cramer, 1777	Surinam	
			marthesia f. leonora	*Siderone*	Krüger, 1933	Brazil (PA)	preocc. (Bargmann 1928)
			marthesia f. sincera	*Siderone*	Krüger, 1933	Brazil (PA)	
			marthesia f. salmonea	*Siderone*	Biedermann, 1933	Brazil (PA)	repl. name
			marthesia f. cancellariae	*Siderone*	Hall, 1935	Trinidad	
			thebais	*Siderone*	Hewitson, [1854]	Colombia	syn. nov.
			nemesis var. confluens	*Siderone*	Staudinger, 1887	Brazil (AM)	syn. nov.
			nemesis f. leonora	*Siderone*	Bargmann, 1928	Colombia	syn. nov.
			thebais f. exacta	*Siderone*	Bargmann, 1929	Colombia	syn. nov.
		nemesis		*Papilio*	Illiger, 1801	Domincan Rep	
			ide	*Siderone*	Hübner, [1823]	Cuba	type of *Siderone*
			rogerii	*Nymphalis*	Godart, [1824]	Cuba	
		mexicana		*Siderone*	Dottax and Pierre, 2009	Mexico	**comb. nov.**
		catarina		*Siderone*	Dottax and Pierre, 2009	Brazil (SC)	**comb. nov.**
	syntyche			–	–	–	
		syntyche		*Siderone*	Hewitson, [1854]	Mexico	
			polymela	*Siderone*	Godman and Salvin, 1884	Panama	
		angustifascia		*Siderone*	Hall, 1917	W. Ecuador	
		mars		*Siderone*	Bates, 1860	Brazil (AM)	

species (Dias et al., 2012; Dias et al., unpublished data). No different from most species of *Zaretis*, *Z. strigosus* is highly intraspecific variable, and specimens from different locations are widely different in appearance. However, this species can be easily distinguished from other South American species east of the Andes of *Zaretis* by the shape of the uncus, thick and strongly keeled (Fig. 43, C. Mielke et al., 2004). Specimens of *Z. strigosus* from south and southeastern Brazil also can be distinguished by the coloration of the male wings upper side (Fig. 1), light orange with dull and faint brown or reddish brown markings, and of the female, uniformly light yellow, with dull and faint brown or dark brown markings (Fig. 3), and the forewing underside of the female, more or less uniformly light yellow (i.e. without a clear two-color pattern), speckled with brown and dark brown (Fig. 4). Although some species of *Zaretis* are similarly widespread and sympatric with *Z. strigosus* in other areas, *Z. strigosus* appears to be the only species of the genus occurring in southern Brazil in the coastal Ombrophilous Dense Forest and interior Ombrophilous Mixed Forest of Paraná, Santa Catarina and Rio Grande do Sul states.

Siderone galanthis catarina Dottax and Pierre, 2009 ***comb. nov.*** *(Figs. 5–8, 30–32, 35–36, 40–42, 44–57, 61)*

Biology: similar to *Z. strigosus*.

Egg (Fig. 45): similar to *Z. strigosus* in shape and color, but larger. Egg width: 1.2 mm ($n = 1$).

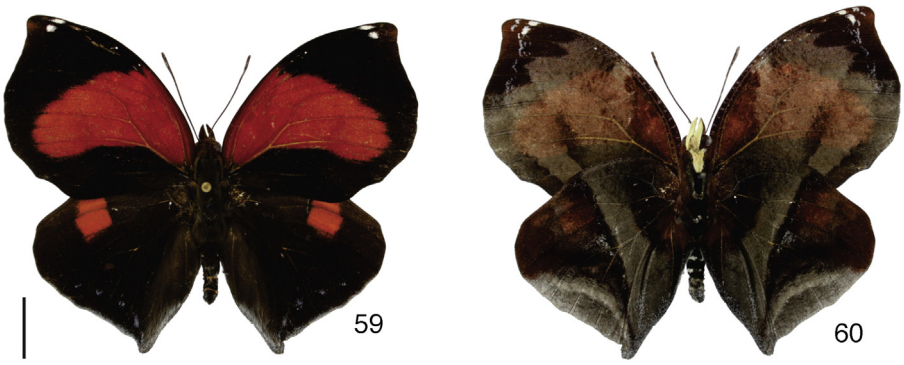
First instar: similar to *Z. strigosus* in shape and color, but larger. Head capsule chaetotaxy and stemmata position, and body chaetotaxy, spiracle size and relative position similar to *Z. strigosus* (Figs. 23–26). Head capsule size: 0.91 mm ($n = 1$). Duration: 6 days.

Second instar (Figs. 30 and 47): Head capsule similar to *Z. strigosus* but labrum, anteclypeus, frontoclypeus and the anterior area of the epicranium dark brown, lateral and posterior area of the epicranium light brown, including the posterior area of the horns; head horns similar to *Z. strigosus* but projecting dorsally at a wider angle; body color and shape similar to *Z. strigosus*. Head capsule size: 1.31 mm ($n = 2$). Duration: 6–7 days.

Third instar (Figs. 31, 48 and 49): Head capsule similar to the previous instar but somewhat rectangular in anterior view, with a different aspect ratio than *Z. strigosus*; head horns about one-third the height of the head capsule; anterior area of the head capsule dark brown, and posterior area of the epicranium lighter, matching the color of the body; body mostly brown, speckled with light brown; T1–A1 supraspiracular line light brown; A2–A9 + 10 dorsal and supraspiracular line similar to *Z. strigosus*, but subtler and dorsally "V"-shaped in A2, while trapezoidal in *Z. strigosus*; dorsal area of A2 anterior to the dorsal line and ventral to the supraspiracular line from A2–A4 black; A2 enlarged with a pair of large lateral fleshy projections; A2–A7 dorsal and subdorsal areas with oblique brown lines forming five lighter colored lozenges; each lozenge is formed by the posterior oblique line of one segment and the anterior oblique line of the next segment; lines from the posterior half of A7–A8 straight and continuing obliquely to the subdorsal area in A9 + 10; dorsally, A9 + 10 dark brown at the squared fleshy projection. Head capsule size: 1.83 mm ($n = 4$). Duration: 6–8 days.

Fourth instar (Figs. 32, 50 and 51): Head capsule shape and color similar to the previous instar, but larger and much larger than fourth instar of *Z. strigosus*; posterior area of the epicranium lighter, matching the color of the body, and horns about half the height of the head capsule; body shape and color similar to the previous instar, but larger and with the color pattern more noticeable, in a lighter beige and light brown tinge; fleshy projections of A2 larger. Head capsule size: 2.79 mm ($n = 4$). Duration: 6–8 days.

Fifth instar (Figs. 35, 36, 52–54): Head capsule similar to the previous instar but rougher, with large anterior, lateral and posterior knobs; horns knobby at the tip and about two-thirds the height of the head capsule; mostly dark brown with light brown areas and a conspicuous whitish lateral line continuous with the supraspiracular line of the thorax (Fig. 54); body shape similar to the previous instar, but fleshy projections of A2 greatly enlarged



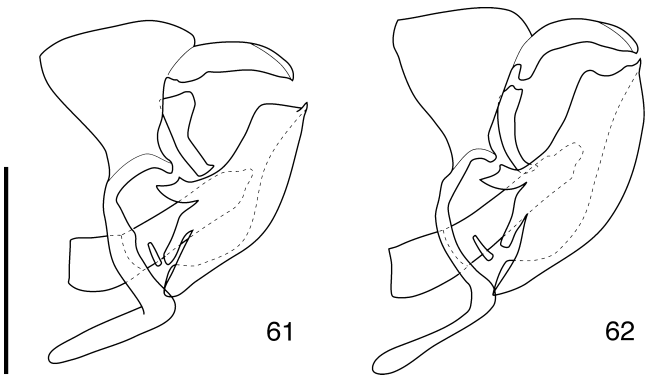
Figs. 59–60. Male specimen of *Siderone syntyche mars* Bates, 1860, dorsal and ventral (Huanuco, Peru). Scale bar = 1 cm.

and anteriorly projected; body mostly dark brown; thoracic legs red; T1–A1 with a conspicuous whitish supraspiracular line; dorsal area of A2 anterior to the dorsal line black; A2–A7 dorsal and subdorsal areas with oblique brown lines forming five lozenges, the first, third, fourth and fifth are lighter brown, while the second is darker than the ground dorsal color; A7 anteriorly with black oblique subdorsal lines; dorsal area from the posterior half of A7–A8, and obliquely to the subdorsal area in A9 + 10 black; posterior end of the squared fleshy projection of A9 + 10 reddish; abdominal legs crochets arranged as a unisserial, triordinal interrupted mesoseries and anal legs arranged as a unisserial, triordinal mesal pennelipse. Head capsule size: 4.91 mm (n = 3). Duration: 13–22 days.

Pupa (Figs. 40–42, 55–57): Similar to *Z. strigosus*, but with a strong concave indentation with reddish brown markings in the middle of the thorax, conspicuous in ventral and dorsal views; lateral carinae strongly developed, with extensive yellowish green coloration along the mesothoracic wing cases; prothoracic spiracle reddish brown; meso and metathorax with paired dorsal yellowish green areas; metathoracic wing cases yellowish green. Abdomen similarly conical, but less compressed and wider than *Z. strigosus* in ventral and dorsal views; spiracles on yellowish green areas, surrounded by reddish brown irregular markings and over a small protuberance in A4–A7; cremaster similar in shape to *Z. strigosus*, but entirely brown, anal scar light brown. Length: 1.13 cm; height: 1.65 cm; cremaster height: 2.83 mm (n = 3). Duration: 14–22 days.

Discussion: The immature stages of *S. galanthis catarina* **comb. nov.** were described by Müller (1886) as *S. ide* (synonym with *S. galanthis nemesis*, Table 2). Müller (1886) did not note the indentation in the middle of the thorax of the pupa, and thus Muyshondt (1976) argued that the species described by Müller was another related species, probably of the genus *Zaretis*. Nevertheless, no other species of *Siderone* or *Zaretis* occurs at the location Müller reared *S. galanthis catarina* **comb. nov.**, additionally, the descriptions and Fig. 26a and b, plate XIII, undoubtedly identifies the species as *S. galanthis catarina* **comb. nov.** Rydon (1971) illustrates the fifth instar and pupa of *S. galanthis galanthis* and *S. galanthis nemesis* (identified as *S. marthesia* and *S. nemesis*, respectively); the illustrations by Miss M. E. Fountaine do not bring up any significant difference between the two taxa. Rydon (1971), based mainly on immature stages, erected a new taxa, "Zaretidinae" to set apart *Zaretis*, *Siderone* and *Coenophlebia* from others Anaeini. To some extent, this arrangement follows Röber (1892), who considered *Zaretis* and *Siderone* as "intermediate" between Preponini and Anaeini. The immature stages of *S. galanthis mexicana* **comb. nov.** were described by Muyshondt (1976) as *S. marthesia* (which is in fact synonym with *S. galanthis galanthis*, Table 2), describing the fleshy squared projection of A9 + 10 as rounded, a claim that is not supported by his own figures (Muyshondt, 1976: 162, Figs. 13–15), which clearly depicts the structure as described and illustrated here. Morais et al. (1996) illustrate the fifth instar and pupa of *S. galanthis catarina* **comb. nov.**, identified as *S. marthesia nemesis*. The density of *S. galanthis catarina* **comb. nov.** in Distrito Federal, Brazil, appears to be low: larvae were found only in a little more than 2% of all *Casearia sylvestris* plants examined. Larvae are reported to feed on mature leaves and to behave in a similar fashion to the behavior described here. Parasitism by Chalcidoidea wasps was reported by DeVries (1987) and Morais et al. (1996). Teshirogi (2004) illustrates a fifth instar of *Siderone* from Peru, claiming it is *S. galanthis*; however, the adult specimen used to illustrate the species is a male of *S. syntyche mars* Bates, 1860 (Figs. 59 and 60); one year after, Teshirogi (2005) describes and illustrates again the immature stages of *S. galanthis* from Peru, but using the same male specimen of *S. syntyche mars*, a male of *S. galanthis galanthis* and a female of *S. galanthis mexicana* **comb. nov.** to illustrate the species reared. Given that *S. galanthis* is much more common than *S. syntyche* Hewitson, [1854] in the Neotropics and the larvae illustrated by Teshirogi (2004, 2005) are identical to the larvae described here, the identity of the species reared by him probably is *S. galanthis galanthis*. To the best of our knowledge, the immature stages of *S. syntyche* are still unknown. Janzen and Hallwachs (2015) illustrate the fourth and fifth instar and pupae of *S. galanthis mexicana* **comb. nov.**, identified simply as *S. galanthis*. The species are illustrated by numerous photographs and a number of host plant records are provided, all in the Salicaceae; several cases of parasitism by Tachinidae flies and Braconidae wasps are reported. The majority of the host plant records belongs to *Casearia* (Beccaloni et al., 2008), although there are records for species of *Xylosma* (Janzen and Hallwachs, 2015) and *Zuelania* (DeVries, 1986; Janzen and Hallwachs, 2015); *C. sylvestris* is the species more frequently cited as host plant for all subspecies of *S. galanthis*. The fact that there are no significant morphologic differences between immature stages of specimens from El Salvador, Costa Rica, Cuba, Trinidad, Peru, central and southern Brazil supports the claim that *S. galanthis* is a single, widespread species.

Taxonomic comments: *Siderone galanthis catarina* **comb. nov.** was described by Dottax and Pierre (2009) as a subspecies of *S. nemesis*, however, molecular evidence indicate that this taxon is conspecific with *S. galanthis* and that *S. galanthis* is a widespread, geographic and intraspecifically variable species (Fig. 58): the mean distance of the COI fragment of 34 specimens of *S. galanthis* from Mexico, Costa Rica, Panamá, and from the east and west Amazon basin, the Cerrado and southern Brazil (Table 1) is 1.014% (standard error = 0.028) (Fig. 58). Dottax and Pierre (2009) recognized *S. galanthis* and its subspecies as distinct from *S. nemesis* and its subspecies, on the basis of the coloration of the upperside of the wings: *S. galanthis*, with a large red patch on the hindwing, often reaching the outer margin near the tornus, and females with a single and enlarged red or yellowish patch, while in *S. nemesis*, the hindwing patch is reduced; and the forewing coloration of the females are similar



Figs. 61–62. Male genitalia of species of *Siderone* Hübner, [1823] in lateral view. 61: *Siderone galanthis catarina* Dottax and Pierre, 2009 **comb. nov.** (Santa Catarina, Brazil). 62: *Siderone syntyche mars* Bates, 1860 (Huánuco, Peru). Scale bar = 1 mm.

to that of the males, with two patches. However, both characters are subject to intraspecific variation, particularly the development of the hindwing patch, which is highly variable all through the range of the species. The patch of the forewing as a single patch varies from yellowish to red and in development, with transitional specimens to the two-patch phenotype in places such as southern Amazonas (Colombia), Rondônia and northern Mato Grosso states (Brazil), where two patches are discernible, connected by scattered red scales or red patches similar to the type of *S. nemesis* var. *confluens* Staudinger, 1887. Most specimens from the Amazonian basin and the Guyanas correspond to the phenotype with large hindwing patch and single forewing patch in the female. There is no marked sexual dimorphism of the forewing upperside patches in specimens from the Antilles, South America west of the Andes and central, eastern and southern Brazil, but the genitalia of different phenotypes throughout the entire range of *S. galanthis* are alike (Fig. 61). Therefore, the morphology and distribution data support the recognition of four subspecies (Table 2): *S. galanthis galanthis*, as recognized by Lamas (2004) but including *S. thebais* C. Felder and R. Felder 1862, *S. nemesis* var. *confluens*, *S. nemesis* f. *leonora* Bargmann, 1928 and *S. nemesis* f. *exacta* Bargmann, 1929 as synonyms; *S. galanthis nemesis*, as recognized by Lamas (2004); *S. galanthis mexicana* **comb. nov.** and *S. galanthis catarina* **comb. nov.**, the latter two as diagnosed by Dottax and Pierre (2009) and here combined with *S. galanthis*. Nevertheless, since no specimens from the Antilles were included in the molecular analysis, further studies including Antillean specimens may indicate *S. galanthis nemesis* as a valid species. The molecular and morphologic analyses also indicate *S. galanthis* as clearly distinct from *S. syntyche* (Figs. 58–62, Table 2). *Siderone syntyche* (Figs. 59–60) also can be morphologically distinguished from *S. galanthis* by the shape of the outer margin of the forewing, strongly convex; the red patch of the forewing upperside, as a single patch in both sexes, but usually absent or greatly reduced in the base of space CuA_2–2A; the brown patches near the base of the hindwing underside, reduced and lighter in color; and the valva, generally wider, with a developed lobe in the ampulla (Fig. 62).

Conflicts of interest

The authors declare no conflicts of interest.

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