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Front Cover Photo - *Ephyriades arcas philemon* Glossy Duskywing (Hesperidae), Puerto Rico, Quebradillas. Photo by Anisha Sapkota and Sajan KC.

Back Cover Photo - *Micandra platyptera* (Lycaenidae), Peru, Junín, Fundo Armorique. Photo by David Geale.

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Additions to the moth (Lepidoptera) fauna of India from the eastern Himalaya and northeastern region: Part 2

Sanjay Sondhi¹, Rachit Pratap Singh², Ujwala Pawar³ and Krushnamegh Kunte³

1. Titli Trust, 49 Rajpur Road Enclave, Dhoran Khas, Dehradun, Uttarakhand 248001, India. 2. Indian Foundation for Butterflies Trust, C-703, Alpine Pyramid Apts, near Canara Bank Layout, Kodigehalli, Bengaluru, Karnataka 560097, India. 3. National Centre for Biological Sciences, Tata Institute of Fundamental Research, Bellary Road, Bengaluru, Karnataka 560097, India.

sanjay.sondhi1@gmail.com (corresponding author); ORCID ID: <https://orcid.org/0000-0002-3970-6858>

rachitsingh98@gmail.com; <https://orcid.org/0000-0001-6158-7659>

ujwalamp@ncbs.res.in; <https://orcid.org/0000-0003-1281-2228>

krushnamegh@ncbs.res.in (corresponding author); <https://orcid.org/0000-0002-3860-6118>

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Abstract: Thirteen moth species, *Pyrinioides oquiho* Owada & Kobayashi, 2020, *Mellea atristrigulalis* (Hampson, 1896) (Thyrididae), *Rotunda rotundapex* (Miyata & Kishida, 1990) (Bombycidae), *Metabraxas pectinella* Yazaki, 2020 and *Psilalcis inoueorum* Sato, 2008 (Geometridae), *Garudinia latana* (Walker, 1863), *Teulisna maculata* Fang, 2000, *Sesapa honbaensis* Dubatolov & Bucsek, 2013, *Ovipennis milani* (Černý, 2009), *Nudina ankistro* Volynkin, Huang, Bolotov & Spitsyn, 2021, *Nudina witti* Spitsyn, Volynkin, Huang & Bolotov, 2021 (Erebidae, Arctiinae), *Lymantria (Beatia) hauensteini hauensteini* Schintlmeister, 2004 (Erebidae, Lymantriinae), and *Hepsidera lignea* Swinhoe, 1902 (Erebidae, Herminiinae) are reported from India for the first time. Of these records, two genera, *Rotunda* Wang, X. & Zolotuhin, 2015 and *Nudina* Staudinger, 1887 are reported from India for the first time.

Key words: Faunal discovery; Himalayan biodiversity; moth diversity; moth taxonomy; range distributions.

INTRODUCTION

The state of Arunachal Pradesh in north-eastern India is situated at the junction of the Oriental and Palearctic biogeographic regions. With 79.33% of its land area under forest cover (India State of Forest Report, 2021), it is home to remarkable biodiversity. As part of the Himalayan (NE Pakistan eastward to Arunachal Pradesh) and Indo-Burma Biodiversity Hotspots (east of the Brahmaputra River), its forests support incredible diversity and many prominent endemic species, making this a globally important biodiversity area.

The Siang River, which originates in Tibet (where it is called the Yarlung Tsangpo), flows south through Arunachal Pradesh. It then flows in a southwesterly direction through Assam, where it is called the Brahmaputra. Mouling National Park is on the Siang River's west bank and is part of Dehang-Dibang Biosphere Reserve. We have been conducting biodiversity assessments in Mouling National Park and its surrounding areas, primarily in Upper and East Siang districts, since 2022. Most of our assessments in the Siang River valley basin have been focussed on community forests on the east and west banks of the Siang River. In addition, we also report on some specimens collected during previous biodiversity assessments in Tale WLS, Lower Subansiri district, Arunachal Pradesh, whose results were published in Sondhi *et al.* (2021) and collections from Eaglenest WLS, West Kameng district, Arunachal Pradesh.

This paper is the second in a series of publications on moths of the Siang landscape. The first publication listed 10 new moth species records for India (Sondhi *et al.*, 2024a). This paper lists another 13 moth species previously not reported from India. For each of these species, we provide information about material (specimens) examined, dissected genitalia, photographs of live individuals, species identification, and distribution.

MATERIALS AND METHODS

The list of survey sites referred to in this paper is provided in Table 1 in Sondhi *et al.* (2024a), where we also describe the survey methods used in this study. We collected moth specimens in Arunachal Pradesh based on collection permits issued by the Principal Chief Conservator of Forests (Wildlife & Biodiversity) and Chief Wildlife Warden, Arunachal Pradesh Forest Department (Letter Nos. CWL/Gen/355/2021/3179 dated 28.ix.2021, CWL/Gen/2018-19/Pt. X/1493-95 dated 31.viii.2022 and CWL/Gen/998/2023/Pt-VIII (B/2775-80 dated 11.i.2024). Two species covered in this paper were collected from previous surveys in Tale WLS, Lower Subansiri district, Arunachal Pradesh and Eaglenest WLS, West Kameng district, Arunachal Pradesh. For collections from Tale, a collection permit for Lepidoptera was obtained from the Office of the Principal Chief Conservator of Forests (Wildlife & Biodiversity), Arunachal Pradesh Forest Department (Letter No. CWL/Gen/173/2018-19/Pt. VII/3993-94 dated 8/3/2019).

For collections from Eaglenest WLS, a collection permit for Lepidoptera was obtained from the Office of the Principal Chief Conservator of Forests (Wildlife & Biodiversity), Arunachal Pradesh Forest Department (Letter no. CWL/G/13(95)/2011-12/Pt-III/2466-70, dated 16/02/2015).

The species are organised in the paper based on the phylogenetic arrangement of superfamilies and families proposed by Nieuwerkerken *et al.* (2011) and Kawahara *et al.* (2019). We follow the terminology used by Scoble (1992), Kristensen (2003) and Kunte *et al.* (2019) for genitalia descriptions and diagnoses. We use the following abbreviations: FWL: Forewing length, WS: Wingspan; NCBS: National Centre for Biological Sciences - TIFR, Bengaluru, India, SS: Sanjay Sondhi, RPS: Rachit Pratap Singh, KK: Krushnamegh Kunte, UP: Ujwala Pawar, YS: Yash Sondhi, TL: type locality, WLS: Wild Life Sanctuary.

RESULTS AND DISCUSSION

Thirteen moth species that are new records for India are reported and their genitalia examined. The species' identities are discussed and they are compared with similar taxa with information provided about their known global distributions.

Family Thyrididae

Subfamily Siculodinae

Pyrinioides oquiho Owada & Kobayashi, 2020 (Figure 1A, Figure 2A, Figure 8A)

Pyrinioides oquiho Owada & Kobayashi, 2020. In: Kishida, Y. (Ed.). 2020. Moths of Laos, Part 1, TINEA Vol. 25, (Supplement 2), pp. 1-224, 94 pls. Pg. 193, Pl. 92: 28 (male); Pl. 93/1 (female); Fig. 63 & 64 (genitalia). TL: Vietnam, Lao Cai, Sa Pa, Deo O Qui Ho, 1,750 m.

Material examined: 1 ♀, Arunachal Pradesh, West Kameng district, Eaglenest WLS, Ramaling, 5.vi.2015, *leg.* YS (IBC-AJ708).

Photographic records: Arunachal Pradesh, West Kameng district, Eaglenest WLS, Bomphu, 22.v.2011.

Diagnosis: Measurements - IBC-AJ708: FWL: 16.5; WS: 31 mm. *Pyrinioides aureus* Butler, 1881, *P. trilineatus* (Zhu & Wang, 1992), *P. oquiho* Owada & Kobayashi, 2020, *P. reticulata* (Moore, 1888) and *P. sinuosus* (Warren, 1896) are the species known from this genus globally. The diagnostic features for *P. oquiho* are: forewing costa slightly concave, with a large crescent patch, apex hooked, ground colour orange-yellow, lines reddish brown, broad oblique line from the centre of the crescent patch to centre of dorsum and connecting with central line of hindwing, and two thin parallel reddish-brown lines from the centre of the crescent patch to the tornus and from the upper end of the crescent patch to the termen. The female genitalia of *P. oquiho* (Owada & Kobayashi, 2020: Fig. 63) has a short papillae anales, ductus bursae short, corpus bursae ovate, with

a large ovate signum.

Distribution: India: Arunachal Pradesh (Ramaling and Bomphu, Eaglenest WLS, West Kameng District; present study). Elsewhere: Vietnam, Laos (Owada & Kobayashi, 2020).

Remarks: So far, the species is known from a photographic record from Eaglenest WLS (Sondhi *et al.*, 2024b). The present study confirm its distribution from India, for the first time, based on voucher specimens.

Tribe Rhodoneurini

Mellea atristrigulalis (Hampson, 1896) (Figure 1B, Figure 2B, Figure 8B)

Rhodoneura atristrigulalis Hampson, 1896, Fauna Br. India (Moths) 4: 480. TL: Bhutan.

References: Gaede (1932: pg. 760, Pl. 92e), Owada & Kobayashi (2020: pg. 189, Pl. 92/8).

Material examined: 1 ♀, India, Arunachal Pradesh: Upper Siang district, Gobuk, 28.viii.2022, *leg.* SS, (IBC-BT018).

Diagnosis: Measurements - IBC-BT018: FWL: 14.5 mm; WS: 28.5 mm. *Mellea atristrigulalis* (Hampson, 1896) can be separated from other congeners based on external morphology: the presence of a cupreous brown patch on the forewing, beyond the cell, which is joined by two bands to the costa, the lower band being broader, an additional two lines from the cupreous brown patch extend to the dorsum. A Y-shaped marking exists below the apex whose lower end extends to the forewing termen. The female genitalia of *M. atristrigulalis* has not been illustrated so far and is described here. Anal papillae convex, setose and separated. Bulla seminalis prominent and globular. Antrum present, indistinct from ductus bursae. Ductus bursae broad and moderately sclerotized. Corpus bursae without signa, elongate and tapered towards apex.

Distribution: India: Arunachal Pradesh (Gobuk, Upper Siang district; present study). Elsewhere: Bhutan (TL), China, Laos (Hampson, 1896; Owada & Kobayashi, 2020).

Remarks: Three species of the *Mellea* Gaede, 1922 are known from India: *Mellea taeniata* Warren, 1908, *M. tetragonata* Walker, (1863) and *M. moorei* (Warren, 1908). There are no published records of this species from India; but having been described from Bhutan, and with records from Laos, to the east, this record fills the distribution gap.

Family Bombycidae

Subfamily Bombycinae

Rotunda rotundapex (Miyata & Kishida, 1990) (Figure 1C, Figure 2C, Figure 8C)

Bombyx rotundapex Miyata & Kishida, 1990. Japan Heterocerists' Journal. 158: 142, figs 1-3. TL: Taiwan, Nantou Hsien, Lushan spa, 1200 m.

References: Wang *et al.* (2015: 20-21, fig. 6A-H); Kishida (2020: 99, Pl. 40/7).

Material examined: India, Arunachal Pradesh, Upper Siang

Figure 1 (p. 3, facing page): Dorsal and ventral views (left to right) of pinned moth specimens. **A.** *Pyrinioides oquiho*, female; **B.** *Mellea atristrigulalis*, female; **C.** *Rotunda rotundapex*, male; **D.** *Triuncina cervina*, male; **E.** *Metabraxas pectinella*, male; **F.** *Psilalcis inoueorum*, male; **G.** *Garudinia latana*, male. **H.** *Teulisna maculata*, male; **I.** *Sesapa honbaensis*, male; **J.** *Sesapa dentifascia*, male; **K.** *Ovipennis milani*, male; **L.** *Nudina ankistro*, female; **M.** *Nudina witti*, male; **N.** *Nudina witti*, female; **O.** *Hepsidera lignea*, male; **P.** *Lymantria hauensteini hauensteini*, male. Millimetres scale bar is shown under every image.

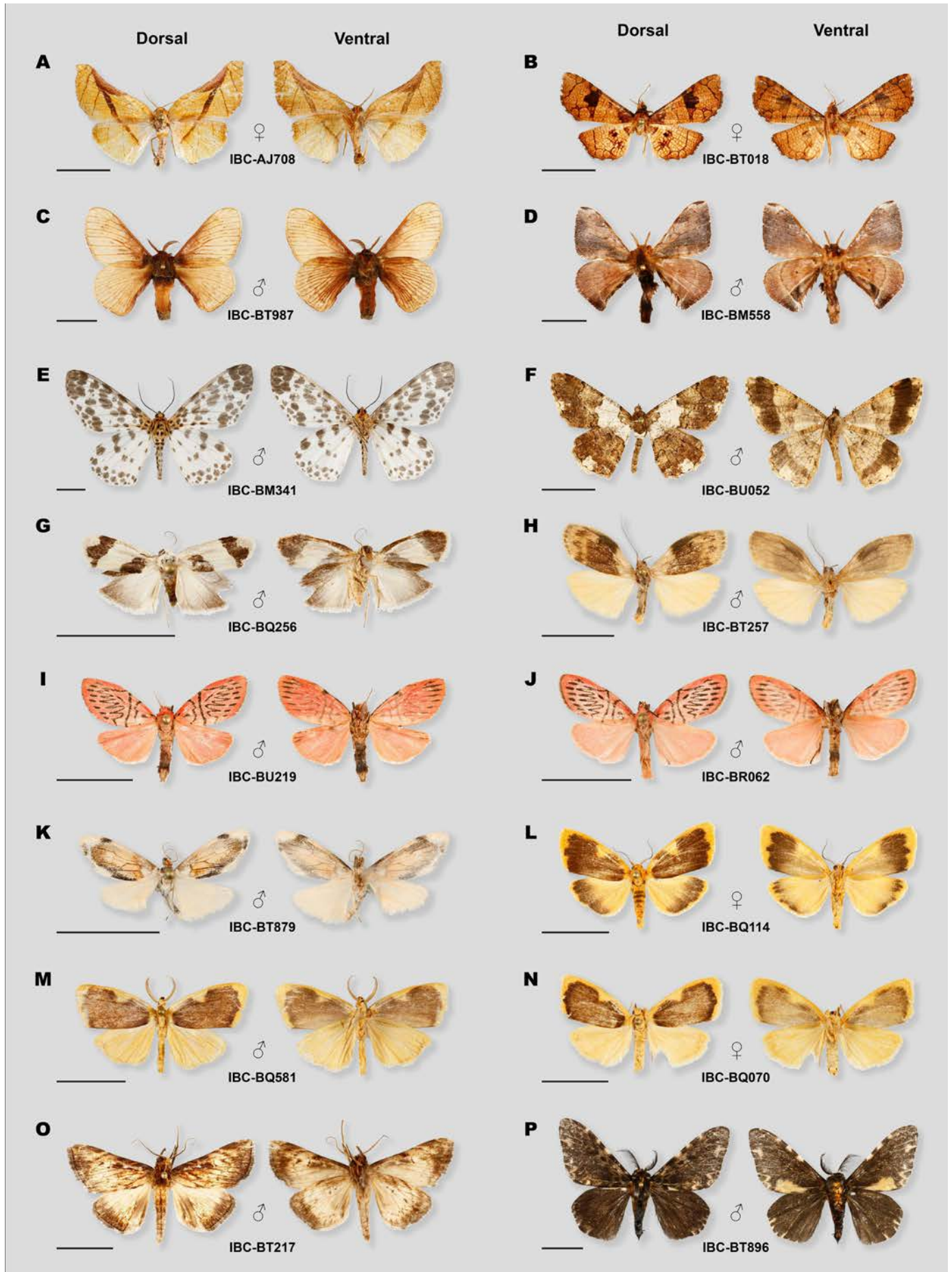




Figure 2: Male and female genitalia of the newly reported moths from northeast India. **A.** *Pyrinioides oquiho* (IBC-AJ708), female; **B.** *Mellea atristrigulalis* (IBC-BT018), female; **C.** *Rotunda rotundapex* (IBC- BT987), male. For each male genitalia figure, top to bottom: genital capsule lateral view, ventral view, dorsal view, 8th sternite, aedeagus. For each panel with female genitalia, top to bottom: dorsal view, ventral view, lateral view.

district: 1 ♂, Ramsing, 21.v.2023, *leg.* SS (IBC-BT987).

Diagnosis: Measurements - IBC-BT987: FWL: 20 mm, WS: 34 mm. Distinct from other bombycids by the following characters: forewing yellow-ochre with rounded apex, veins distinct and basal area blackish-brown mixed with white scales. The male genitalia (Figure 8C) has the uncus long and apex bi-lobed; valva with a long and slender process arising from the costa, extending well beyond uncus; juxta fused with valva; saccus broad, short and rounded; aedeagus slightly curved, with a pair of small caudal processes; caudal margin of the 8th sternite bi-lobed.

Distribution: India: Arunachal Pradesh (Ramsing, Upper Siang district; present study). Elsewhere: Mainland China (Jiangxi-Fujian border, Hubei, Hunan, Guangdong, Guangxi,

Shaanxi, Sichuan) and Taiwan, Korea, Myanmar (Wang *et al.*, 2015; Kishida, 2020).

Remarks: New genus and species record for India. The same individual is figured in the Moths of India website (Sondhi *et al.*, 2024).

***Triuncina cervina* (Walker, 1865)** (Figure 1D, Figure 3A, Figure 8D)

Naprepa cervina Walker, 1865. List Specimens lepid. Insects Colin Br. Mus. 32: 489. TL: "Hindustan".

References: Kishida (1992: 80, Pl. 20:1); Sondhi *et al.* (2021: 18, Image 457).

Material examined: India, Arunachal Pradesh, Lower Subansiri district: 1 ♂, Tale WLS, Pange, 26.viii.2019, *leg.* SS,

(IBC-BM558).

Diagnosis: Measurements - IBC-BM558: FWL: 16 mm, WS: 28 mm. This species was provisionally identified as *Triuncina cervina* (Walker, 1865) in Sondhi *et al.* (2021), but its genitalia were not dissected. Wang *et al.* (2015) provide a list of *Triuncina* Dierl, 1978 species from China, including a generic description of the male genitalia of the genus. Wang *et al.* (2015) state that the male genitalia of the genus has the uncus small and stick-like; socii strongly modified into flattened pyramidal or ovoid processes laterally on the tegumen; valvae short hooked; saccus well-developed; aedeagus slender and long. The genitalia of this individual match the generic characters of the genus. Based on external morphology, this individual matches the original description of *T. cervina* being pale fawn colour with three brown marks on the inner margin of the hindwing. *Triuncina nitida* (Chu & Wang, 1993) has the hindwing tornus edged with yellow (Wang *et al.*, 2015). While the genitalia of *T. cervina* was not available for comparison, the genitalia of this individual are close to *T. nitida*, but differs as following: The uncus in both species is bi-lobed, but is much longer in *T. nitida*. The valvae are similar shaped, but the saccus is much shorter in *T. nitida* and is longer and its tip rounded in this individual. Hence, we conclude that this species is *T. cervina*.

Distribution: India: Arunachal Pradesh (Pange, Tale WLS, Upper Subansiri district) (Sondhi *et al.*, 2021; "Hindustan" (TL); Nepal (Kishida, 1992).

Remarks: Two *Triuncina* species can be found in the Himalayan region; *T. cervina* (Walker, 1865) with its type locality as "Hindustan", and *T. nitida* from Myanmar. This record confirms the presence of *T. cervina* in Arunachal Pradesh.

Family Geometridae

Subfamily Ennominae

Tribe Unassigned

***Metabraxas pectinella* Yazaki, 2020** (Figure 1E, Figure 3B, Figure 8E)

Metabraxas pectinella Yazaki, 2020. In: Kishida, Y. (Ed.). 2020. Moths of Laos, Part 1, TINEA Vol. 25, (Supplement 2), pp. 1-224, 94 pls. Pg. 37-38, Pl. 9/5, Fig. 20. TL: Laos, Luang Prabang, Phou Khoun, 1360 m.

Material examined: India, Arunachal Pradesh, Lower Subansiri district: 1 ♂, Tale WLS, Pange, 27.viii.2019, leg. SS (IBC-BM341).

Photographic records: India, Arunachal Pradesh, Lower Subansiri district, Tale WLS, Pange, 19.viii.2011.

Diagnosis: Measurements - IBC-BM341: FWL: 33 mm, WS: 58 mm. The male genitalia (Figure 3B) matches that in the original description of *M. pectinella* Yazaki, 2020 (Yazaki, 2020: Fig. 20) with the triangular uncus with a rounded tip, valva slender in distal half, narrowing towards a rounded apex; costa narrowly sclerotized, sacculus gradually broadens and saccus broadly triangular with a rounded apex. The extensive ochreous basal marking and the pattern of grey spots on the forewing separate this species from other congeners.

Distribution: India: Arunachal Pradesh (Pange, Tale WLS, Lower Subansiri district; present study. Elsewhere: Laos, Vietnam (Yazaki, 2020).

Remarks: Three species of *Metabraxas* Butler, 1881 are known from India: *Metabraxas coryneta* (Swinhoe, 1894), *M. regularis* Warren, 1893 and *M. tinctoria* (Hampson, 1895). This species does not resemble any of these. The specimen, IBC-BM341, is a good match to *M. pectinella* Yazaki, 2020, which in turn resembles *M. clerica* Butler, 1881, known from Japan, with differences mentioned in the original description of *M. pectinella*. This species was first photographed in Pange, Tale WLS, Arunachal Pradesh in 2011. In 2019, we collected a specimen, and this was recognized as a species new to science (pers. comm. Dieter Stüning) during the publication of Moths of Tale WLS (Sondhi *et al.*, 2021), but was not published. With the description by Yazaki (2020), the species was finally named. However, Yazaki (2020), mentions its distribution as Laos and Vietnam; hence these records extend its range to India.

Tribe Boarmiini

***Psilalcis inoueorum* Sato, 2008** (Figure 1F, Figure 3C, Figure 8F)

Psilalcis inoueorum Sato, 2008. Two new species of the genus *Psilalcis* (Geometridae, Ennominae) from Myanmar. *Tinea* 20 (4): 209-212. Pg. 209-210; Fig. 1-8. TL: Myanmar, Kachin, Putao, Mt New Zin, 750 m.

References: Kishida (2020: 72, Pl. 25:14).

Material examined: India, Arunachal Pradesh, Upper Siang district: 1 ♂, Ramsing, 20.v. 2023, leg. SS (IBC-BU052), 2 nos. Ramsing, 16.v. 2024, leg. SS (IBC-BW148, IBC-BW159). 1 no., Gobuk, 01.viii.2024, leg. SS (IBC-BX708).

Photographic record: India, Arunachal Pradesh, Upper Siang district, Likor, 19.x.2023.

Diagnosis: Measurements - IBC-BU052: FWL: 17 mm, WS: 32 mm. The facies of *Psilalcis inoueorum* Sato, 2008 is quite distinctive and no other *Psilalcis* Warren, 1893 species has this facies. The male genitalia of this individual matches that shown in the original description (Sato, 200: Fig. 7). Uncus slender and curved; cucullus narrow, with seta; ampulla with small conical projection arising from ovoid-shaped based with many subconical papillae; saccus short, somewhat square-shaped.

Distribution: India: Arunachal Pradesh (Gobuk, Likor and Ramsing, Upper Siang district; present study). Elsewhere: Myanmar, Vietnam, Laos (Sato, 2008; Kishida, 2020).

Remarks: Sato (2008) and Kishida (2020) do not list this species from India. The Moths of India website (Sondhi *et al.*, 2024b) has a live image of the collected specimen as well as the photographic record from Likor. The specimens collected from Gobuk, Likor and Ramsing remain the only records of this species from India, extending its known range to this country.

Family Erebidae

Subfamily Arctiinae

Tribe Lithosiini

Subtribe Cisthenina

***Garudinia latana* (Walker, 1863)** (Figure 1G, Figure 4A, Figure 8G)

Tospitis latana Walker, 1863; *List Spec. Lepid. Insects Colln Br. Mus.* 28: 427; TL: Ceylon.

References: Moore (1882: 59, Pl. 103/2); Hampson, (1900:



Figure 3: Male genitalia of the newly reported moths from northeast India. **A.** *Triuncina cervina* (IBC-BM558), male; **B.** *Metabraxas pectinella* (IBC-BM341), male; **C.** *Psilalcis inoueorum* (IBC-BU052), male. For each male genitalia figure, top to bottom: genital capsule lateral view (right valva removed), dorsal view, distal view, right valva outer view, aedeagus.

262, fig. 178); Holloway, 2001 (Fig. 149 for female genitalia); Kirti & Gill (2009: key); Černý & Pinratana (2009: Pg. 108-109. Pl. 22/215 a,b).

Material examined: India, Arunachal Pradesh, Upper Siang district: 1 ♂, Jengging, 1. iv.2022, *leg.* SS, (IBC-BQ256).

Diagnosis: Measurements - IBC-BQ256: FWL: 7 mm, WS: 15.5 mm. *Garudinia latana* (Walker, 1863) is the type species for this genus, described from Sri Lanka and is separated from all other congeners by the presence of an oblique purplish-fuscous antemedial band, rounded outwardly, an oblique purplish-fuscous postmedial sinuous band on the forewing, which has a creamy-white ground colour. The hindwing is also creamy-white with fuscous suffusion in the terminal area. The hindwing apex is deeply excised. The male genitalia of *Garudinia* Moore, 1882 is characterized by the saccular process apically

narrowed, often curved (Holloway, 2001), which is visible in the dissected genitalia of this individual. External morphology is sufficient to separate this species from other congeners other than the extralimital *G. pseudolatana* Holloway, 2001. The male genitalia of *G. latana* (Figure 4A) differs from that of *G. pseudolatana* in the latter having more evenly curved and slender saccular processes to the valves (Holloway, 2001: Fig. 307).

Distribution: India: Arunachal Pradesh (Jengging, Upper Siang district; present study). Elsewhere: Sri Lanka (type locality), Thailand, Indonesia, Borneo (Černý & Pinratana, 2009).

Remarks: Five species of *Garudinia* Moore, 1882 are known from India: *Garudinia biguttata* Rothschild, 1912, *G. biplagiata* Hampson, 1896, *G. conjuncta* Kirti & Gill,



Figure 4: Male genitalia of the newly reported moths from NE India. **A.** *Garudinia latana* (IBC-BQ256), male; **B.** *Teulisna maculata* (IBC-BT257), male; **C.** *Sesapa honbaensis* (IBC-BU219), male. For each panel here, top to bottom: genital capsule lateral view (right valva removed), dorsal view, distal view, right valva outer view, aedeagus.

2009, *G. pseudosimulana* Kirti & Gill, 2009 and *G. simulana* (Walker, 1863). Singh *et al.* (2021) do not list this species in the catalogue of Indian Arctiinae; hence this represents a new record for India.

Subtribe Lithosiina

Teulisna maculata Fang, 2000 (Figure 1H, Figure 4B, Figure 8H)

Teulisna maculata Fang, 2000, *Fauna sinica* (Ins.) 19: 231, fig. 151, pl. 11:19. TL: China, Yunnan.

References: Černý & Pinratana (2009: Vol. 6: 134-135, pl. 27: 269); Kishida (2020: 128, Pl. 58:3); Kirti, Joshi & Singh (2014: 18 (checklist); Bucsek (2020: 50, Fig. 9-10).

Material examined: India, Arunachal Pradesh, Upper Siang district: 1 ♂, Janbo, 2.ix.2022, leg. SS (IBC-BT257); 1

♂, Bomdo, 3.ix. 2022, leg. SS (IBC-BT365); 1 ♂, Jengging, 22.v.2023, leg. SS (IBC-BU180).

Diagnosis: Measurements - IBC-BT257: FWL: 11.5 mm, WS: 19.5 mm; IBC-BT365: FWL: 11 mm, WS: 21.5 mm; IBC-BU180: FWL: 12.5 mm, WS: 25.5 mm. The dissected male specimen, IBC-BT257, is a good match to the description and the plates in various publications (Černý & Pinratana, 2009; Kishida, 2020; Bucsek, 2020). The pale brown base, dark brown medial band, the sinuous, broken postmedial band, and the darker brown marking in the middle of the costa and the costal fold are diagnostic. While the dissected genitalia of *T. maculata* was not available for comparison, the male genitalia of dissected specimen, matched that of the genus. The genus *Teulisna* Walker, 1865 has the vinculum developed into a squarish frame, indented slightly at the distal margin, that



Figure 5: Male and female genitalia of the newly reported moths from NE India. **A.** *Sesapa dentifascia* (IBC-BR062), male; **B.** *Ovipennis milani* (IBC-BT879), male; **C.** *Nudina ankistro* (IBC-BQ114), female. For each male genitalia figure, top to bottom: genital capsule lateral view (right valva removed), dorsal view, ventral view, right valva outer view, aedeagus. For each panel with female genitalia, top to bottom: dorsal view, ventral view, lateral view.

supports a membrane on which are often diverse setose patches. The saccular process of the valva has a dense, dark mass of setae or spines apically (Holloway, 2001). These are visible in the dissected genitalia.

Distribution: India: Arunachal Pradesh (Bomdo, Janbo, Jengging, Upper Siang district; present study). Elsewhere: Thailand, Laos, China.

Remarks: Bucsek (2020) and Kishida (2020) do not mention any records of this species from India and Singh *et al.* (2021) do not list this species in the catalogue of Indian Arctiinae; hence this represents a new record for India.

Subtribe Nudariina

Sesapa honbaensis Dubatolov & Bucsek, 2013 (Figure 1I, Figure 4C, Figure 8I)

Barsine honbaensis Dubatolov & Bucsek, 2013. New species of lichen-moths from South-East Asia (Lepidoptera, Noctuoidea, Lithosiini). *Tinea*, 22 (4), 279-291. Pg. 286, Fig. 9, 23. TL: Vietnam, Hon Ba, Khanh Hoa Province.

References: Volynkin *et al.* (2019: Fig. 283-287, 295-297, 303).

Material examined: India, Arunachal Pradesh, Upper Siang district: 1 ♂, Damro, 24.v.2023, *leg.* SS, (IBC-BU219) 3 nos., Ramsing, 16.v.2024, *leg.* SS (IBC-BW149, IBC-BW150, IBC-BW160). 1 no., Ramsing, 02.viii.2024, *leg.* SS (IBC-BX768).

Meghalaya, 1 no., Rhi Bhoi District, Nongkhyllem WLS, 14.vi.2024, *leg.* SS, (IBC-BW286).

Diagnosis: Measurements - IBC-BU219: FWL: 11 mm, WS: 21 mm. *Sesapa honbaensis* Dubatolov & Bucsek, 2013 most closely resembles *S. dentifascia* (Hampson, 1894), which

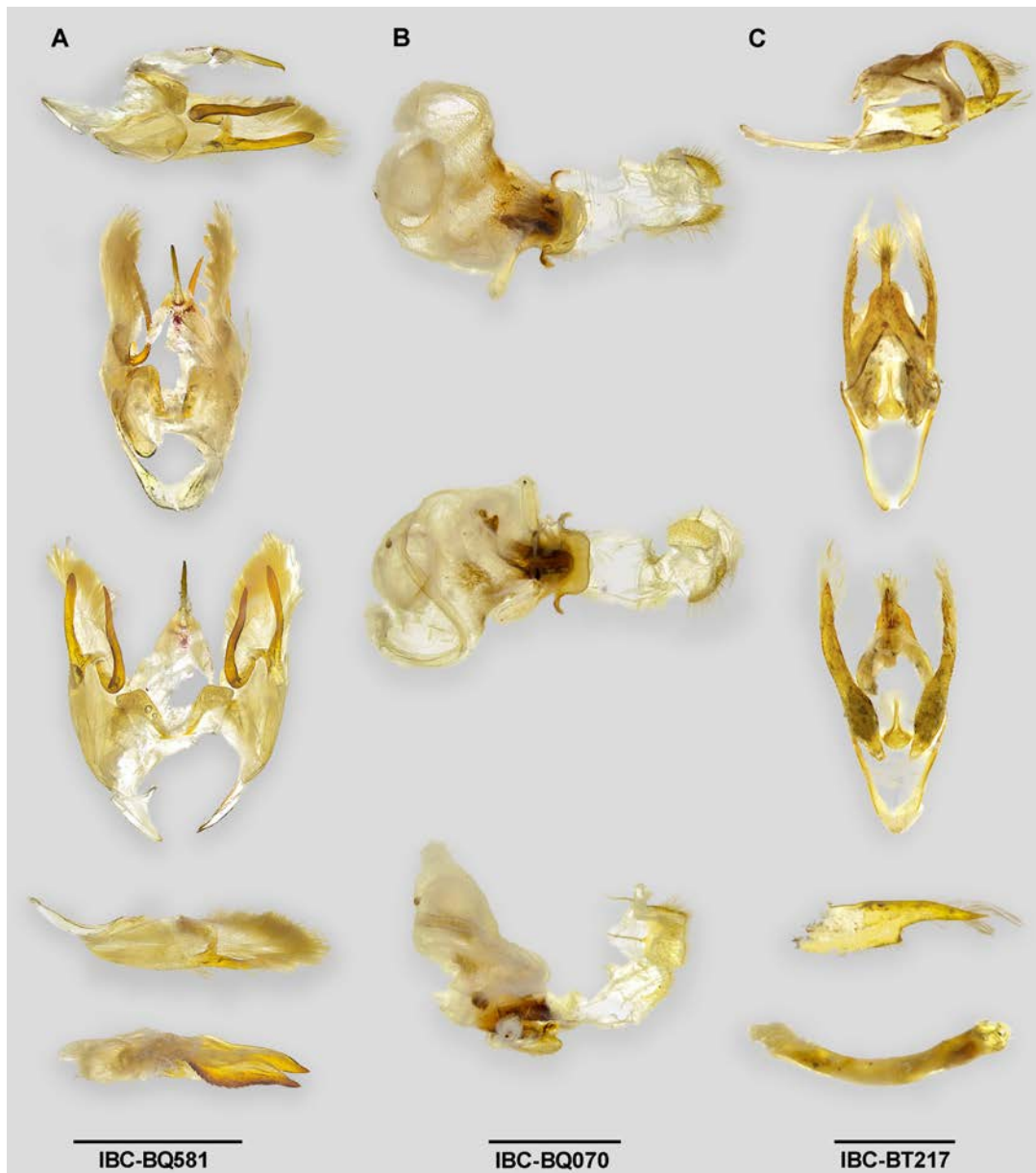


Figure 6: Male and female genitalia of the newly reported moths from NE India. **A.** *Nudina witti* (IBC-BQ581), male; **B.** *Nudina witti* (IBC-BQ070), female; **C.** *Hepsidera lignea* (IBC-BT217), male. For each male genitalia figure, top to bottom: genital capsule lateral view (right valva removed), dorsal view, ventral view, right valva outer view, aedeagus. For each panel with female genitalia, top to bottom: dorsal view, ventral view, lateral view.

is the only member of this genus known from India (Singh *et al.*, 2021). Based on external morphology, *S. honbaensis* can be separated from *S. dentifascia* by the sinuous antemedial line (smoothly concave in *S. dentifascia*), presence of small black markings on the veins near apex of HW, on both upper and underside (maybe obsolescent in some individuals), which are absent in the dissected specimen from Meghalaya (IBC-BR062, Tyrna, East Khasi Hills district, Meghalaya) of *S. dentifascia* (Figure 1J, Figure 8J). The dissected male genitalia matches that in the original description (Dubatolov & Bucsek, 2013:Fig. 23) with a long, narrow uncus, bent downwards, a short apical saccular protrusion, and the valva has a short apical protrusion. *Sesapa dentifascia* (Figure 5A) has a long, curved apical saccular protrusion and the costal apical process of the valva is constricted and slightly rounded, lacking the apical protrusion

of *S. honbaensis*.

Distribution: India: Arunachal Pradesh (Damro and Ramsing, Upper Siang district); Meghalaya (Nongkhylllem WLS, Rhi Bhoi district); present study. Elsewhere: Vietnam, China, Myanmar (Dubatolov & Bucsek, 2013; Volynkin *et al.*, 2019).

Remarks: Singh *et al.* (2021) do not list this species in the catalogue of Indian Arctiinae; hence this represents a new record for India. We encountered numerous individuals of *S. dentifascia* and *S. honbaensis*, across seasons and locations, occurring sympatrically.

***Ovipennis milani* (Černý, 2009)** (Figure 1K, Figure 5B, Figure 8L)

Idopterum milani Černý in Černý & Pinratana 2009. Moths

of Thailand. Volume 6, Arctiidae. Bangkok, Brothers of St Gabriel in Thailand. 283 pp., 56 pls. Pg. 102-103, fig. 203. TL: China, Yunnan.

References: *Nanarsine milani* Černý: Volynkin *et al.* (2019: 78). Zhao *et al.* (2022: 486, Figs 2-5, 12, 13, 19, 20).

Material examined: 1 ♂, India, Arunachal Pradesh: Upper Siang district, Gobuk, 17.v.2023, leg. SS, (IBC-BT879).

Diagnosis: Measurements - IBC-BT879: FWL: 8 mm, WS: 16 mm. *Ovipennis milani* is characterized by the presence of a large golden patch on forewing and a short blackish streak on forewing dorsum (Zhao *et al.*, 2022), which is present in this individual. The rest of the description matches that in the original description and the plates (Zhao *et al.*, 2022:Figs. 2-5). The male genitalia of this individual matches that of *O. milani* (Zhao *et al.*, 2022; Figs. 12, 13) with a long, curved uncus, valvae, broad and ovate, sacculus with a short pointed apical process and saccus rounded at base.

Distribution: India: Arunachal Pradesh (Gobuk, Upper Siang district; present study). Elsewhere: Northern Thailand, Northern Vietnam and Southwestern China.

Remarks: Zhao *et al.* (2022) do not mention any records of this species from India and Singh *et al.* (2021) do not list this species in the catalogue of Indian Arctiinae; hence this represents a new record for India.

Subtribe Unassigned

***Nudina ankistro* Volynkin, Huang, Bolotov & Spitsyn, 2021** (Figure 1L, Figure 5C, Figure 8K)

Nudina ankistro Volynkin, Huang, Bolotov & Spitsyn, 2021. Three new species of the genus *Nudina* Staudinger, 1887 from northern Indochina (Lepidoptera: Erebidae: Arctiinae: Lithosiini). *Zootaxa*, 4970 (3), pp.547-557. Pg. 550, Figs. 3, 4, 9, 10, 19. TL: Myanmar (Burma), 25 km E Putao, env. Nan Sa Bon vill., 800m.

Material examined: India, Arunachal Pradesh, East Siang district: 1 ♀, Yingku, 29.iii.2022, leg. SS, (IBC-BQ114), Upper Siang district: 3 ♀, Ramsing, 2.viii.2024, leg. SS (IBC-BX742, IBC-BX745, IBC-BX789).

Diagnosis: Measurements - IBC-BQ114: FWL:12 mm, WS: 21 mm. The specimen collected in Arunachal Pradesh, IBC-BQ114, matched the female of *N. ankistro*, having brown antennae and a brown marginal border on the hindwing. The only variance shown in external morphology of this individual compared with the female in the original description, is the presence of abdominal bands and a broader hindwing marginal border. This is attributed to individual variation, as the female genitalia are a good match to that shown in Volynkin *et al.* (2021: Fig. 19) with the antevaginal plate being narrower and rounded, the ductus bursae having an elongate sclerotized plate ventrally and the ductus bursae having a rectangular shaped sclerotized plate, which are diagnostic when compared with other congeners.

Distribution: India: Arunachal Pradesh (Yingku, East Siang district and Ramsing, Upper Siang district; present study). Elsewhere: Myanmar (Volynkin *et al.* 2021).

Remarks: The genus *Nudina* Staudinger, 1877 was considered as monotypic, *N. artaxidia* (Butler, 1881) as the only known species, widely distributed in south-eastern



Figure 7: Male genitalia of the newly reported moths from NE India. **A.** *Lymantria hauensteini hauensteini* (IBC-BT896), male. For the panel here, top to bottom, genital capsule lateral view (right valva removed), dorsal view, distal view, right valva outer view, aedeagus.

Palearctic Region. Volynkin *et al.* (2021) described three new species, *N. ankistro* Volynkin, Huang, Bolotov & Spitsyn, 2021, *N. witti* Spitsyn, Volynkin, Huang & Bolotov, 2021 and *N. harpago* Volynkin & Huang, 2021 from Vietnam and Myanmar. Volynkin *et al.* (2021) do not mention any records of this species from India and Singh *et al.* (2021) do not list this species in the catalogue of Indian Arctiinae; hence these records represent a new genus and species record for India.

***Nudina witti* Spitsyn, Volynkin, Huang & Bolotov, 2021** (Figure 1M, 1N, Figure 6A, 6B)

Nudina witti Spitsyn, Volynkin, Huang & Bolotov, 2021.

Three new species of the genus *Nudina* Staudinger, 1887 from northern Indochina (Lepidoptera: Erebidae: Arctiinae: Lithosiini). *Zootaxa*, 4970(3), pp.547-557. Pg. 551, Figs. 7, 8, 13, 14. TL: N-Vietnam, 1600m, Mt. Fan-si-pan (Nord), Cha-pa, Primärurwald [primary forest].

Material examined: India, Arunachal Pradesh, Upper Siang district: 1 ♂, Ramsing, 22.v.2022, leg. SS (IBC-BQ581). 1 ♀, Boleng, 28.iii.2022, leg. SS, (IBC-BQ070). 1 ♀ and 1 ♂, Ramsing, 2.viii.2024, leg. SS (IBC-BX744 & IBC-BX799).

Diagnosis: Measurements IBC-BQ581: FWL: 12 mm, WS: 23 mm; IBC-BQ070: FWL: 12.5 mm, WS: 23 mm. *Nudina witti* is similar to *N. harpago* externally, but the former has a submarginal brown suffused band on the upperside and underside of the hindwing, which the latter lacks. These bands, though somewhat obsolescent, are visible in both the specimens presented here. The male genitalia are a good match to original descriptions in Volynkin *et al.* (2021: Fig. 13, 14) with the rounded vinculum, long and narrow harpe and the stick-like ventro-distal process of valva that are sufficient to separate this species from other congeners. We also recorded a female *Nudina* at a different location, Boleng, from the male, which was recorded at Ramsing.

Both the females of *N. witti* and *N. harpago* are unknown (Volynkin *et al.* 2021). Based on the external morphology, this female specimen is a really good match to the *N. witti* male having the submarginal brown suffused band on the upperside and underside of the hindwing, which is absent in *N. harpago*. Hence, the male and female of *N. witti* are very similar based on external morphology. The female genitalia of *N. witti* are quite different from the known females of *N. artaxidia* and *N. ankistro* in the papillae anales having two separate rounded plates, the antevaginal plate being rounded, ending in a hooked structure on either side and the ductus bursae has a sclerotized plate (similar to *N. artaxidia* and *N. ankistro*, but smaller).

Distribution: India: Arunachal Pradesh (Boleng, East Siang district and Ramsing, Upper Siang district; present study). Elsewhere: Vietnam, Myanmar (Volynkin *et al.* 2021).

Remarks: Volynkin *et al.* (2021) do not mention any records of this species from India and Singh *et al.* (2021) do not list this species in the catalogue of Indian Arctiinae; hence this represents a new genus and species record for India.

Subfamily Herminiinae

Tribe Unassigned

Hepsidera lignea Swinhoe, 1902 (Figure 10, Figure 6C, Figure 8M)

Hepsidera lignea Swinhoe, 1902; *Ann. Mag. nat. Hist.* (7) 9 (51): 176; TL: Malaysia, Perak, Goping.

References: Holloway (2008: 61, fig. 35, 148, pl. 2:31); Kononenko & Pinratana (2013: 20, Pl. 1/22).

Material examined: India, Arunachal Pradesh, Upper Siang district: 1 ♂, Ramsing, 1.ix.2022, leg. SS (IBC-BT217). Jengging, 21.viii.2023, leg. SS (IBC-BU754).

Diagnosis: Measurements - IBC-BT217: FWL: 16 mm, WS: 33 mm; IBC-BU754: FWL: 15.5 mm, WS: 29 mm. *Hepsidera lignea* differs from *H. deletaria* and *H. ferruginea* in having straw-coloured wings, streaked with dark brown, mostly on the wings (Holloway, 2008). The genitalia generally

matches that of *H. lignea* as shown in Holloway (2008). The male genitalia of this specimen has a narrow club-like shaped uncus with numerous setae on its apical end (broader club-shaped uncus with rounded apical end in *H. ferruginea*). The valvae are long and apically pointed and lack a sub-basal angle on the costa (present in *H. ferruginea*). The base of the valvae are heavily sclerotized. The saccus is shorter and more rounded when compared to that of *H. ferruginea*.

Distribution: India: Arunachal Pradesh (Jengging, Ramsing, Upper Siang district; present study). Elsewhere: Thailand, Malaysia, Indonesia (Kononenko & Pinratana, 2013).

Remarks: Three species of *Hepsidera* Swinhoe, 1902 are known globally; *Hepsidera deletaria* (Hampson, 1895), *H. ferruginea* Holloway, 2008 and *H. lignea* Swinhoe, 1902. *Hepsidera deletaria* is the only species of this genus known so far from India, with its type locality being Sikkim in the eastern Himalaya. There are no published records of *H. lignea* from India; hence this represents a new moth record for the country.

Subfamily Lymantriinae

Tribe Lymantriini

Lymantria (Beatia) hauensteini hauensteini Schintlmeister, 2004 (Figure 1P, Figure 7A, Figure 8N)

Lymantria (Beatia) hauensteini hauensteini Schintlmeister, A. 2004. The taxonomy of the genus *Lymantria* Hübner, [1819] (Lepidoptera: Lymantriidae) *Quadrifina* 7 : 1-248. Pg. 118, figs. 473, 519, 524, 487-489, 492. TL: North Thailand, Prov. Mae Hong Son, 1250m, between Pa Pae and Khun Sa,

Material examined: India, Arunachal Pradesh, Upper Siang district, Gobuk: 1 ♂, 17.v.2023, leg. SS (IBC-BT896). 17.v.2023, leg. SS (IBC-BT921), wet only. 1 ♂, 19.v.2023, leg. SS (IBC-BU065).

Diagnosis: Measurements - IBC-BT896: FWL: 23.5 mm, WS: 40 mm; IBC-BU065: FWL: 22 mm, WS: 36 mm. Schintlmeister (2004) described this species from N. Thailand and Myanmar and it most closely resembles *L. (Beatia) marginata* Walker, 1855. Males differs from *L. marginata* in the larger size of *hauensteini* (FWL: 22-26 mm), white forehead (brown in *L. marginata*) and the ground colour of the males is more blackish than brownish, the pattern much more contrasting than in *L. marginata* Schintlmeister (2004). Comparing the male genitalia with that displayed by Schintlmeister (2004: Fig. 518 & 519), the juxta is straight in *hauensteini* (concave in *marginata*), dorsal arm of the bifid valvae has no second processes (fold) as in *marginata* and the apical part of the valvae are more acute in *hauensteini* (more rounded in *marginata*).

Distribution: India: Arunachal Pradesh (Gobuk, Upper Siang district; present study). Elsewhere: N. Thailand and Myanmar (Schintlmeister, 2004).

Remarks: Schintlmeister (2004) does not include India in the range of this species; hence this is a new record for India.

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Figure 8: Images of the reported moth species photographed live in the field. **A.** *Pyriniooides oquiho*, female; **B.** *Mellea atristrigulalis*, female; **C.** *Rotunda rotundapex*, male; **D.** *Triuncina cervina*, male; **E.** *Metabraxas pectinella*, male; **F.** *Psilalcis inoueorum*, male; **G.** *Garudinia latana*, male; **H.** *Teulisna maculata*, male; **I.** *Sesapa honbaensis*, male; **J.** *Sesapa dentifascia*, male; **K.** *Nudina ankistro*, female; **L.** *Ovipennis milani*, male; **M.** *Hepsidera lignea*, male; **N.** *Lymantria (Beatria) hauensteini hauensteini*, male.

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Author contributions

SS and KK conceived the project, obtained permits for specimen collection, and conducted the field surveys. SS collected and identified moth specimens, and wrote the manuscript. RPS assisted in moth surveys, specimen collection, pinned the specimens, dissected the genitalia, prepared the plates and contributed to writing the manuscript. UP assisted in specimen collection, pinning, curation, genitalia dissections and preparing the plates. KK guided moth collections in the field and museum work at NCBS, and edited the manuscript.

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Observations on the species richness, abundance, and behavior of butterflies (Lepidoptera: Papilionoidea) in Puerto Rico during a two-week survey

Sajan K.C. and Anisha Sapkota

McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, Gainesville, Florida, USA;
E-mail: sajanck143@gmail.com; E-mail: anishasapkota363@gmail.com

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Abstract: The butterfly fauna of Puerto Rico remains understudied, despite the island's unique biodiversity and its susceptibility to anthropogenic pressures, climate change, and natural disasters. To investigate patterns of species richness, abundance, and behavior of butterflies in Puerto Rico, we conducted non-invasive, opportunistic surveys at eight locations from 18 February to 1 March 2024. During this period, we recorded 64 species and 1,796 individuals across all Papilionoidea families, excluding Riodinidae and Hedyliidae, which are not present on the island. Nymphalidae was the most species-rich and abundant family, while *Hemiargus hanno* (Stoll) (Lycaenidae) was the most widespread and abundant species. Bosque Estatal de Cambalache exhibited the highest single-day species diversity followed by El Yunque National Forest. Rarefaction and extrapolation analyses were conducted to control for differences in sampling duration and permit comparisons among sites. We found the endemic species *Calisto nubila* Lathy to be common and widespread ($n = 162$), whereas *Pyrisitia portoricensis* (Dewitz) ($n = 4$), *Choranthus borincona* (F. Watson) ($n = 6$), and *Atlantea tulita* (Dewitz) ($n = 2$) were rare. The survey also revealed a low abundance of the non-native *Papilio demoleus* Linnaeus ($n = 2$). Significant records include *Allosmaitia fiden*a (Hewitson) ($n = 1$), last observed in 2006, and *Rhinthon cubana* (Herrich-Schäffer) ($n = 4$), with scarce previous records. This article provides a concise account of the species richness, abundance, and behavior of adult butterfly species we observed in Puerto Rico during our survey period.

Key words: conservation, endemism, island ecology, species richness.

Resumen: La diversidad de mariposas en Puerto Rico sigue siendo insuficientemente estudiada, a pesar de la biodiversidad única de la isla y su susceptibilidad a las presiones antropogénicas, el cambio climático y los desastres naturales. Para investigar la riqueza de especies, la abundancia y las historias naturales de las mariposas en Puerto Rico, realizamos encuestas no invasivas y oportunistas en ocho ubicaciones desde el 18 de febrero hasta el 1 de marzo de 2024. Durante este período, registramos 64 especies y 1,796 individuos de todas las familias de Papilionoidea, excluyendo a Riodinidae y Hedyliidae, que no están presentes en la isla. Nymphalidae fue la familia más rica en especies y abundante, mientras que *Hemiargus hanno* (Stoll) (Lycaenidae) fue la especie más extendida y abundante. El Bosque Estatal de Cambalache mostró la mayor diversidad de especies en un solo día, seguido por el Bosque Nacional El Yunque, que presentó una diversidad más baja de lo esperado. Se realizaron análisis de rarefacción y extrapolación para controlar las diferencias en la duración de las muestras y estandarizar los datos. Encontramos que la especie endémica *Calisto nubila* Lathy fue común y extendida ($n = 162$), mientras que *Pyrisitia portoricensis* (Dewitz) ($n = 4$), *Choranthus borincona* (F. Watson) ($n = 6$) y *Atlantea tulita* (Dewitz) ($n = 2$) fueron raras. La encuesta también reveló una sorprendentemente baja abundancia de la no nativa *Papilio demoleus* Linnaeus, con solo dos individuos registrados. Los registros significativos incluyen *Allosmaitia fiden*a (Hewitson) ($n = 1$), observada por última vez en 2006, y *Rhinthon cubana* (Herrich-Schäffer) ($n = 4$), con registros previos escasos. Este artículo ofrece un resumen conciso de la riqueza de especies, la abundancia y las historias naturales de las especies de mariposas adultas observadas en Puerto Rico durante nuestro período de encuesta.

Palabras clave: conservación, endemismo, ecología insular, riqueza de especies.

INTRODUCTION

Puerto Rico, a US territory in the northeast Caribbean, is the smallest and easternmost island of the Greater Antilles, with a terrestrial area of about 8,870 km² (Anadón-Irizarry *et al.*, 2012; Ramirez-Reyes *et al.*, 2023). The island's isolated location has fostered a unique and diverse array of endemic

flora and fauna; however, the island's butterfly fauna, as well as many other arthropod groups, remains poorly documented (Barahona-Segovia & Zúñiga-Reinoso, 2021; Ramirez-Reyes *et al.*, 2023). With its diverse habitats and ecosystems, the island is experiencing constant environmental changes owing to socio-economic factors, including agricultural practices, the introduction of non-native species, developmental activities,

and natural disasters such as tropical storms and hurricanes, which significantly alter forest structures (Gould *et al.*, 2008; Anadón-Irizarry *et al.*, 2012; Duvat *et al.*, 2017; Terry *et al.*, 2023). Notably, Puerto Rico experiences one of the highest frequencies of hurricanes in the North Atlantic basin (Neumann & McAdie, 1997). Research suggests that climate change is contributing to an increase in both the intensity and frequency of tropical storms in certain regions globally, including Puerto Rico (Sugi *et al.*, 2016; Seneviratne *et al.*, 2021). Another consequence of tropical storms is the introduction of non-native species from neighboring islands, also discussed by Torres (1988). While total forest cover in Puerto Rico reached approximately 52% in 2019, human activities had reduced the island's native forest cover to just 6% in the late 1940s (Birdsey & Weaver, 1987; Marcano-Vega, 2023). Given its high level of endemism and threats, Puerto Rico is considered a priority area for biodiversity conservation (Myers *et al.*, 2000; Anadón-Irizarry *et al.*, 2012).

Butterflies, as ecological indicators, offer valuable insights into environmental changes (Parmesan, 1996, 2003). Their well-studied life cycles, specific habitat requirements, and short lifespans make them ideal for monitoring ecosystem health (Brown, 1991, 1997; Hill *et al.*, 2021). Documenting butterfly populations is therefore essential for establishing baseline data. Comstock (1944) listed 110 butterfly species and subspecies from both Puerto Rico and the Virgin Islands, along with several butterfly taxa that may possibly occur on the islands. Later studies have reported 98 (Ramos, 1996) and 102 (Pérez-Asso *et al.*, 2009) species of butterflies in Puerto Rico, including four endemic species (*Atlantea tulita* (Dewitz), *Calisto nubila* Lathy, *Choranthus borincona* (F. Watson), and *Pyrisitia portoricensis* (Dewitz)), with *Atlantea tulita* recently (January 2023) listed as threatened under the Endangered Species Act (Department of the Interior, 2022; Terry *et al.*, 2023). The island is also home to Caribbean endemic subspecies of mainland species (Comstock, 1944; Núñez *et al.*, 2023), whose narrow ecological niches, small population sizes, and limited distributional ranges potentially make them more susceptible to the impacts of anthropogenic climate change and subsequent natural disasters than their mainland counterparts (Moser *et al.*, 2018; Trew & Maclean, 2021). Núñez *et al.* (2023) revised the taxonomic status of many of these taxa, revealing a much richer endemism in the Greater Antilles than previously thought. While earlier studies have noted a decline in Lepidoptera abundance following tropical storms (Schowalter & Ganio, 1999; Barberena-Arias & Aide, 2002), a recent study revealed more complex dynamics, finding no straightforward link between butterfly diversity and abundance as the forest recovered from Hurricane Maria, instead highlighting seasonal fluctuations (see Aparicio-Jiménez *et al.*, 2024). In contrast, certain species of insects, including butterflies, might become more abundant after major tropical storms (Askew & Stafford, 2008; Novais *et al.*, 2018; Steele Cabrera *et al.*, 2025).

Owing to constant environmental changes, there remains a need for updated assessments of Puerto Rico's butterfly fauna to monitor current species composition, detect emerging trends, and evaluate the population status of endemic and non-native species. Our survey aimed to provide a brief overview of the

current status of butterflies in Puerto Rico and contribute to the understanding of their ecology and conservation. The objectives for this trip were to document the species richness, abundance, and behavior of Puerto Rico's butterfly fauna, while recording the current rarity status of the endemic species and documenting the distribution and abundance of the non-native *Papilio demoleus malayanus* Wallace across the selected survey locations. Although a two-week period is insufficient to provide a comprehensive understanding of the butterfly populations' status, it offers a preliminary insight into their species composition, richness, abundance, and behavior.

MATERIALS AND METHODS

Survey Locations

We conducted surveys across eight locations in Puerto Rico (Fig. 1), focusing on three key areas owing to their diverse environmental conditions (Miller & Lugo, 2009): El Yunque National Forest, Guánica Dry Forest, and Bosque Estatal de Cambalache. Daytime temperatures ranged from 26°C to 32°C during the survey; moderate to heavy rainfall was observed at El Yunque National Forest, Coco Beach, and Jardín Botánico de la UPR, while the other locations remained sunny and received no precipitation during the survey.

1. El Yunque National Forest (18°19'00.0"N, 65°47'00.0"W, 60-1070 m) was surveyed on 18-21, 27, and 29 February 2024 (Figs. 2A-B). The area encompasses a variety of life zones, including subtropical rain forests, lower montane rain forests, lower montane wet forests, and subtropical wet forests (Gould *et al.*, 2008). It is characterized by a diverse array of vegetation, including *Heliconia rostrata* Ruiz & Pav., *Cecropia schreberiana* Miq., *Prestoea montana* (Graham) G.Nicholson, *Cyrtia racemiflora* L., *Manilkara bidentata* (A.DC.) A.Chev., *Cyathea arborea* (L.) Sm., *Didymopanax morototoni* (Aubl.) Decne. & Planch., *Buchenavia tetraphylla* (Aubl.) R.A.Howard, *Guarea guidonia* (L.) Sleumer, *Calypttranthes krugii* Kiaersk., and *Ocotea spathulate* Mez, among others (Weaver, 2012; iNaturalist, 2024). While El Yunque National Forest is a protected area, its outskirts have undergone urbanization (Martinuzzi *et al.*, 2007).

2. Coco Beach (18°24'59"N, 65°47'46"W, 0-30 m) was surveyed on 22 and 26 February 2024 (Fig. 2C). The beach's vegetation is primarily composed of *Lantana* L., *Bidens* L., *Cyanthillium cinereum* (L.) H.Rob., and other shrubs and herbs. As a popular public beach, this area is heavily urbanized and hosts various recreational activities.

3. Guánica (17°57'00.0"N, 66°54'00.0"W, 0-162 m) was surveyed on 23 and 24 February 2024 (Figs. 2D-E). The area's subtropical dry forest (Gould *et al.*, 2008) is characterized by diverse vegetation, including evergreen and semideciduous trees, along with scrubby vegetation. Although the core area remains protected, the surrounding public lands have experienced urbanization (Martinuzzi *et al.*, 2007).

4. Bosque Estatal de Maricao (18°09'00.0"N, 66°59'00.0"W, 732-747 m) was briefly surveyed from 10:00-12:00 hours on 24 February 2024. The subtropical submontane wet forest ecosystem is marked by a blend of evergreen and semideciduous trees (Gould *et al.*, 2008). As a protected area,

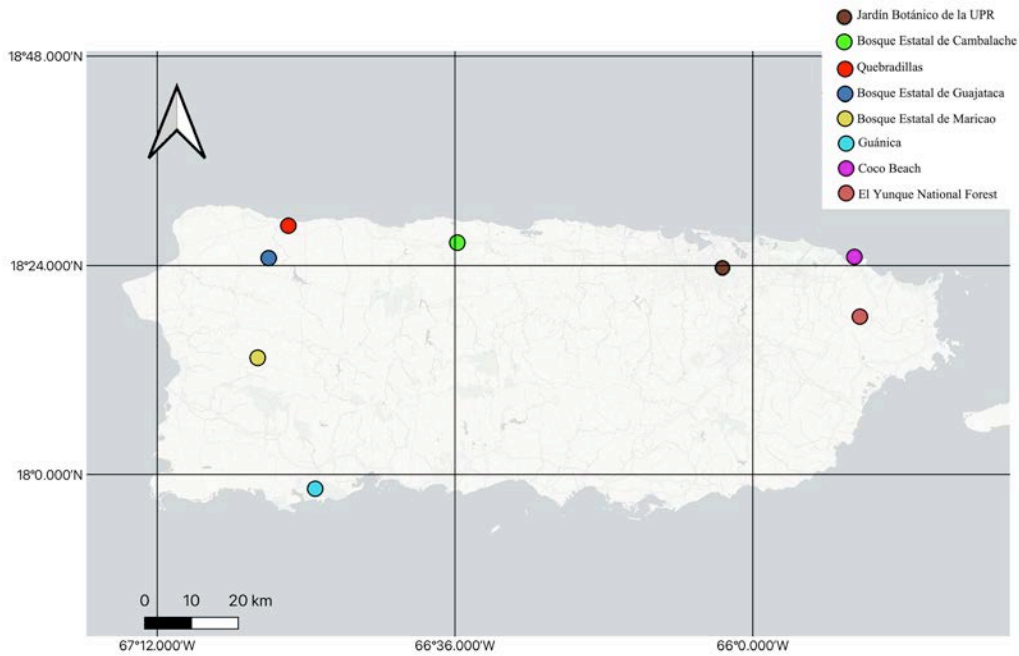


Figure 1. Study area map. A map of the study area showing the locations of the survey sites.



Figure 2. Habitat images. (A) El Yunque National Forest bottom (300 m); (B) El Yunque National Forest top (1067 m); (C) Coco Beach (6 m); (D) Guánica by the Caribbean Sea (76 m); (E) Guánica Dry Forest (162 m); (F) Bosque Estatal de Guajataca (290 m).

Maricao's interior remains largely intact, though its periphery ranges from sparsely to densely populated (Martinuzzi *et al.*, 2007). This forest is also a critical habitat for the threatened *Atlantea tulita* (Department of the Interior, 2022).

5. Bosque Estatal de Guajataca (18°25'00.0"N, 66°57'00.0"W, 232-290 m) was surveyed on 24 February 2024 (Fig. 2F). The lowland moist ecosystem of the forest

is characterized by a mix of evergreen and semideciduous vegetation (Gould *et al.*, 2008). While Guajataca's interior remains protected, its outskirts range from sparsely to densely populated (Martinuzzi *et al.*, 2007). This area also serves as a critical habitat for *Atlantea tulita* (Department of the Interior, 2022).



Figure 3. Habitat images. (A) Bosque Estatal de Cambalache (61 m); (B) Jardín Botánico de la UPR (24 m).

6. Quebradillas (18°29'00.0"N, 66°57'00.0"W, 30-52 m), a lowland moist forest area (Gould *et al.*, 2008) along the Atlantic Ocean, was surveyed on 25 February 2024. Its vegetation comprises a mix of evergreen and semideciduous species. With increasing urban developments (Martinuzzi *et al.*, 2007), the area also includes public beaches and parks. Importantly, it serves as a critical habitat for *Atlantea tulita* (Department of the Interior, 2022), underscoring the need for conservation efforts.

7. Bosque Estatal de Cambalache (18°26'00.0"N, 66°35'00.0"W, 24-79 m) was surveyed on 25 and 28 February 2024 (Fig. 3A). This protected area includes lowland moist forests with some dry regions, characterized by a mix of evergreen and semideciduous vegetation (Gould *et al.*, 2008). While the interior remains protected, urbanization beyond the boundaries is evident (Martinuzzi *et al.*, 2007) and appears to have increased in recent years.

8. Jardín Botánico de la UPR (18°23'31"N, 66°03'20"W, 15-30 m), a public botanical garden within the University of Puerto Rico (UPR), was surveyed on 1 March 2024 (Fig. 3B). The garden features ornamental vegetation and various wildflowers, including *Lantana* and *Bidens*. Located in the middle of San Juan, this area, along with the contiguous Bosque Estatal del Nuevo Milenio, is surrounded by extensive urban development and experiences high foot traffic due to its heavily urbanized outskirts.

Data Collection and Analysis

We conducted the survey from 18 February 2024 to 1 March 2024 (a hurricane-safe and relatively warm time of year), with varying observation periods: 14:00-18:00 hours on February 18, 11:00-15:00 hours on March 1, and 8:00-17:00 hours on the remaining days. Our surveys involved stopping at designated locations, exploring surrounding microhabitats (grasslands, woods, flowers, clearings, forest streams, and hilltops), and photographing adult butterflies using Canon 7D Mark II cameras with EF-S 18-135 mm f/3.5-5.6 IS USM and EF 100 mm f/2.8L Macro IS USM lenses. The locality data, time, and elevations were stored in the image metadata. Our sampling approach was opportunistic, involving non-invasive observations without fixed transect lines, ensuring minimal disturbance to the butterfly population. A mixture in the ratio

of 1 ripe banana, 4 g sugar, 50 mL beer, and 100 mL water, fermented in a Ziploc bag for 2-3 consecutive days in the sun, was initially tested as a bait, but it proved ineffective and was discontinued. The number of species and individuals observed was recorded, but for species seen in substantial numbers (tens or hundreds) in the same location we made best estimates, and, where necessary, to ensure consistency and precision, estimates were rounded to the nearest 50, particularly for abundant species such as *Calisto nubila* and *Hemiargus hanno* (Stoll). The study areas were mapped (Fig. 1) using QGIS version 3.32.3 'Lima' (2024). To account for the bias of uneven sampling days, we performed rarefaction and extrapolation using the online tool iNEXT (Chao *et al.*, 2014, 2016; <https://chao.shinyapps.io/iNEXTOnline/>) at $q = 0$ (diversity order = species richness), using the default endpoint, 50 bootstraps, and a 95% confidence interval (Fig. 4). This method enabled us to standardize the data and make meaningful comparisons between sites. The Butterflies of America (Warren *et al.*, 2024) website was used for recent taxonomic references.

RESULTS

A total of 64 butterfly species and 1,796 individuals were recorded during the study, representing all families of Papilionoidea except Riodinidae and Hedyliidae. The most species-rich family was Nymphalidae, comprising 20 species, followed by Hesperidae with 19 species, Pieridae with 12 species, and Lycaenidae with 10 species. In terms of abundance, Nymphalidae was also the dominant family, with 556 individuals, followed by Hesperidae with 490 individuals, Lycaenidae with 439 individuals, and Pieridae with 306 individuals. Papilionidae was the least represented family, with only three species and five individuals recorded. A visual representation of the relative species richness and abundance of butterfly families, expressed as percentages, is provided in Figure 5. *Hemiargus hanno* (Fig. 12C) (Lycaenidae) was the most abundant and most widespread species during our survey, with 223 individuals recorded across almost all survey sites. With the exception of four species (*Heraclides androgeus* (Cramer), *H. pelaus* (Fabricius), *Ministrymon azia* (Hewitson), and *Papilio demoleus* Linnaeus), all recorded species were photographed and are presented in the accompanying plates (Figs. 6-16).

Bosque Estatal de Cambalache exhibited the highest single-day species diversity, with 30 species and 216 individuals recorded on February 28. In comparison, El Yunque National Forest peaked at 21 species and 130 individuals on February 19, with a cumulative total of 33 species recorded over six days. Regarding abundance, Guánica recorded the highest single-day total with 322 individuals, followed by Bosque Estatal de Cambalache and El Yunque National Forest.

Rarefaction analysis (Fig. 4) indicated that El Yunque National Forest had the highest overall diversity (species richness), followed by Bosque Estatal de Cambalache, Coco Beach, Guánica, Jardín Botánico de la UPR, Quebradillas, Bosque Estatal de Guajataca, and Maricao. While Bosque Estatal de Cambalache ranked highest in the extrapolation analysis, it showed no significant difference in diversity

compared to El Yunque National Forest in both rarefaction and extrapolation analyses. Furthermore, the extrapolation analysis suggested that with increased sampling, Guánica's diversity would also show no significant difference compared to that of El Yunque National Forest.

Our survey yielded only two sightings of the non-native *Papilio demoleus*, in the southwest (Guánica) and northern central (Bosque Estatal de Cambalache) regions. Among the endemic species, *Choranthus borincona* (Fig. 7E) and *Pyrisitia portoricensis* (Fig. 11B) were rare/uncommon, with six and four individuals each, respectively, while *Atlantea tulita* (Fig. 13E) was local and rare, with only two individuals recorded; *Calisto nubila* (Fig. 15F) was the commonest and most widespread endemic butterfly species, with 162 individuals recorded. We did not record any previously undocumented butterfly species in Puerto Rico, with the most significant records being *Rhinthon cubana* (Herrich-Schäffer) (Fig. 9B) ($n = 4$) and *Allosmaitia fidena* (Hewitson) (Fig. 11C) ($n = 1$). *Rhinthon cubana*, with only a few records from Puerto Rico, has, for example, only a single record on iNaturalist (2024); Ramos (1996) listed it as occurring rarely in Puerto Rico and questioned whether it is a resident species. *Allosmaitia fidena*, last reported from Puerto Rico in 2006 (inferred from Warren *et al.*, 2024), has no records on iNaturalist (2024); previous studies by Smith *et al.* (1994) and Ramos (1996) suggested its occurrence as rare in Puerto Rico. The list of all species, with the numbers of individuals recorded and geo-location data, is provided in Table 1.

DISCUSSION

Although El Yunque National Forest ranked highest in species richness in the rarefaction analysis, we observed a notable scarcity of butterflies compared to our expectations. These expectations were based on iNaturalist (2024) records and the fact that this site is the only tropical national forest in the U.S. (McGinley, 2017). Despite favorable weather conditions, the trails appeared substantially empty, and despite conducting

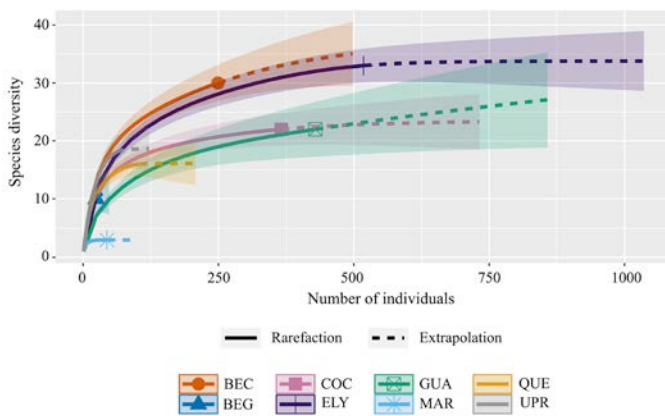


Figure 4. Rarefaction and extrapolation of species diversity in the survey areas using iNEXT (<https://chao.shinyapps.io/iNEXTOnline/>) (Chao *et al.* 2014, 2016) at $q = 0$ (species richness). Locality codes are provided with a three-letter code as follows: El Yunque National Forest (ELY); Coco Beach (COC); Guánica (GUA); Maricao (MAR); Bosque Estatal de Guajataca (BEG); Quebradillas (QUE); Bosque Estatal de Cambalache (BEC); Jardín Botánico de la UPR (UPR).

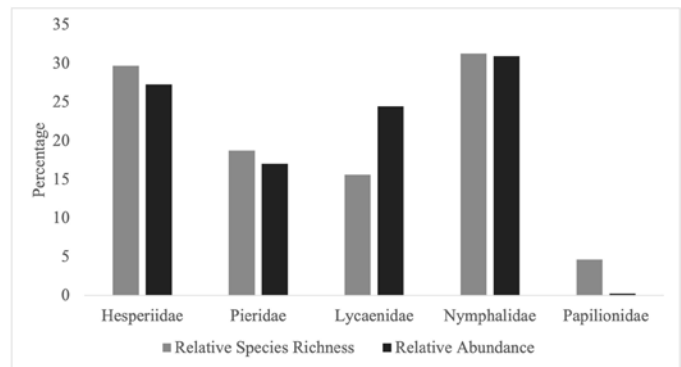


Figure 5. Familywise relative species abundance and richness. A comparison of the relative species abundance and richness of each butterfly family observed during the study expressed in percentage.

an extensive survey for six days, we did not encounter species such as *Dismorphia spio* (Godart) and *Euphyes singularis* (Herrich-Schäffer), which have been previously reported from here (Bain, 2010; iNaturalist, 2024). Relatively low species richness and abundance in El Yunque National Forest during our visit was expected to some extent due to seasonal fluctuations, as tropical regions typically experience reduced butterfly populations and diversity during dry months (Castro & Espinosa, 2015; Checa *et al.*, 2019), a pattern also observed by Aparicio-Jiménez *et al.* (2024) in other Puerto Rican forests. However, the butterfly community there may also have been impacted by urbanization and agriculture, and perhaps Hurricane Maria in 2017, which severely affected natural habitats in this area and potentially decimated certain butterfly populations such as those of *Euphyes singularis*. A similar experience as ours regarding low numbers of butterflies in El Yunque was also reported in December 2022 (Jack McDonough, pers. comm. 2024). Additional surveys, particularly long-term ones, are crucial for a better understanding of butterfly diversity in El Yunque National Forest, for which this study will perhaps serve as a baseline reference for this time period. In contrast, despite a brief survey period, Bosque Estatal de Cambalache exhibited one of the highest species diversities during our study (highest in extrapolation analysis). Although we did not observe species such as *Archaeoprepona demophoon* (Hübner) and *Historis odius* (Fabricius) in Bosque Estatal de Cambalache, they have been recently observed from here (Glassberg, 2024; iNaturalist, 2024). The site with the lowest species diversity was Maricao in the central western part of the island, despite minimal urbanization. Jack McDonough observed several notable species there in December 2022, including *Siderone galanthis* (Cramer), and reported (pers. comm.) a relatively high overall butterfly diversity, including *Atlantea tulita* and *Historis odius*. However, despite clear weather conditions, our survey yielded only three species, common and widespread, with no observations of the rarer nymphalids observed by McDonough, perhaps as a result of seasonal changes in abundance. In our study, Nymphalidae was the best represented family in terms of species richness and abundance, likely owing to its overall high species richness on the island compared to other butterfly families (Ramos, 1996; Pérez-Asso *et al.*, 2009), in part likely influenced by the adaptability and dispersal capacity of many

Table 1. Butterfly Survey Results. Checklist of butterflies of Puerto Rico observed during a two-week survey from 18 February to 1 March 2024, along with their distributions and natural histories. Species are listed alphabetically and grouped in their respective families and subfamilies. Locality codes are provided with a three-letter code as follows: El Yunque National Forest (**ELY**); Coco Beach (**COC**); Guánica (**GUA**); Maricao (**MAR**); Bosque Estatal de Guajataca (**BEG**); Quebradillas (**QUE**); Bosque Estatal de Cambalache (**BEC**); Jardín Botánico de la UPR (**UPR**). Dates of observations are given in the format of months written in Roman numerals followed by days in Arabic numerals.

S.No.	Scientific Name (Based on Warren <i>et al.</i> (2024)) with Fig. references	English Name	Locality	Date (2024)	Elevation (m)	No. of individuals	Natural History/Habitat
Family: HesperIIDae							
Subfamily: Eudaminae							
1.	<i>Cecropterus dorantes cramptoni</i> (W. Comstock, 1944) (Fig. 6A)	Dorantes Longtail	BEG, BEC	ii.24, 28	58-235 m	2	Nectaring <i>Bidens</i> , mud-puddling
2.	<i>Epagyreus zestos zestos</i> (Geyer, 1832) (Fig. 6B)	Zestos Skipper	ELY	ii.20, 21, 27, 29	274-305 m	8	Patrolling on treetops next to a water source
3.	<i>Proteides mercurius pedro</i> (Dewitz, 1877) (Fig. 6C)	Mercurial Skipper	BEC	ii.28	64 m	1	Woods (resting under a tree leaf)
4.	<i>Telegonus anausis anausis</i> Godman & Salvin, 1896 (Fig. 6D)	Yellow-tipped Flasher	ELY	ii.19, 20	274-305 m	2	Ovipositing on tree vines
5.	<i>Urbanus proteus domingo</i> (Scudder, 1872) (Fig. 6E)	Longtail Skipper	ELY, COC, BEC, UPR	ii.20, 26, 28; iii.1	24-329 m	6	Ovipositing on legumes
Subfamily: Pyrginae							
6.	<i>Burnsius oileus</i> (Linnaeus, 1767) (Fig. 7C)	Tropical Checkered Skipper	All but MAR	ii.19-29; iii.1	24-314 m	122	Nectaring <i>Bidens</i> , low flight on clearings, meadows
7.	<i>Eantis minor</i> W. Comstock, 1944 (Fig. 6F)	Lesser Sickling	ELY, BEC	ii.19, 20, 27, 28	55-396 m	13	Mud-puddling, nectaring flowers, basking on leaves, patrolling from broad-leaves
8.	<i>Ephyriades arcas philemon</i> (Fabricius, 1775) (Figs. 7A-B)	Glossy Duskywing	All but COC and MAR	ii.23, 24, 25, 27, 28; iii.1	24-411 m	22	Woods, nectaring, resting on twigs esp. during evening
Subfamily: HesperIIDae							
9.	<i>Atalopedes mesogramma apa</i> W. Comstock, 1944 (Fig. 7D)	Mesogramma Skipper	UPR	iii.1	24 m	3	Nectaring skittishly on <i>Lantana</i> and legumes, basking
10.	<i>Choranthus borincona</i> (F. Watson, 1937) (Fig. 7E)	Puertorican Skipper	ELY, BEC, UPR	ii. 20, 24; iii. 1	24-305 m	6	Nectaring, basking
11.	<i>Choranthus vitellius</i> (Fabricius, 1793) (Fig. 7F)	V-mark Skipper	All but GUA and MAR	ii. 18-22, 25-29; iii.1	3-427 m	119	Nectaring, basking
12.	<i>Cymaenes tripunctus</i> (Herrich-Schäffer, 1865) (Fig. 8A)	Three-spotted Skipper	All but MAR and BEG	ii.19, 20, 22, 23, 25, 26, 27, 29; iii.1	3-396 m	50	Nectaring, basking, patrolling in shady places
13.	<i>Hylephila phyleus phyleus</i> (Drury, 1773) (Fig. 8B)	Fiery Skipper	COC, UPR	ii. 22, 26; iii. 1	6-24 m	6	Nectaring <i>Bidens</i> , basking
14.	<i>Nyctelius nyctelius nyctelius</i> (Latreille, [1824]) (Fig. 8C)	Violet-banded Skipper	ELY, UPR	ii. 20; iii. 1	24-396 m	6	Nectaring, basking, patrolling
15.	<i>Panoquina lucas lucas</i> (Fabricius, 1793) (Fig. 8D)	Purple-washed Skipper	All but GUA, MAR, and QUE	ii. 19, 20, 22, 24-28; iii. 1	3-421 m	33	Nectaring, basking, patrolling, ovipositing on grass-blade tips
16.	<i>Panoquina nero</i> (Fabricius, 1798) (Fig. 8E)	Nero Skipper	ELY, BEC, UPR	ii. 19, 20, 27, 28; iii. 1	24-411 m	23	Nectaring, basking, patrolling, ovipositing on grass-blade tips
17.	<i>Panoquina panoquinoides</i> (Skinner, 1891) (Fig. 8F)	Obscure Skipper	COC	ii. 22	3-15 m	10	Nectaring on <i>Bidens</i>
18.	<i>Polites drury</i> (Latreille, [1824]) (Fig. 9A)	Drury's Broken-dash	All but GUA, BEG, and BEC	ii. 19-22, 24-27; iii. 1	3-1067 m	54	Nectaring, basking, perching on grasses
19.	<i>Rhinthon cubana</i> (Herrich-Schäffer, 1865) (Fig. 9B)	Cuban Skipper	ELY	ii. 19, 20	427-457 m	4	Nectaring on <i>Bidens</i> , perching on grasses, around <i>Heliconia caribaea</i> Lam. clumps
Family: Pieridae							
Subfamily: Pierinae							
20.	<i>Ascia monuste eubotea</i> (Godart, 1819) (Fig. 9C)	Great Southern White	COC, GUA, QUA	ii. 22, 23, 25, 26	3-46 m	22	Nectaring
21.	<i>Glutophrissa drusilla boydi</i> (W. Comstock, 1943) (Fig. 9D)	Florida White	GUA, QUA, BEC	ii. 23, 25, 28	46-67 m	21	Nectaring, basking, mud-puddling

Table 1, continued. Butterfly Survey Results.

S.No.	Scientific Name (Based on Warren <i>et al.</i> (2024)) with Fig. references	English Name	Locality	Date (2024)	Elevation (m)	No. of individuals	Natural History/Habitat
Subfamily: Coliadinae							
22.	<i>Aphrissa statira hispaniolae</i> (Munroe, 1947) (Fig. 9E)	Statira Sulphur	ELY, COC, UPR	ii. 18, 22; iii. 1	6-65 m	3	Nectaring (perhaps more common, mixed with the abundant <i>Phoebis trite</i>)
23.	<i>Eurema daira palmira</i> (Poey, [1852]) (Fig. 9F)	Barred Yellow	ELY, COC	ii. 18-22, 26, 27, 29	3-67 m	22	Nectaring, constant flight on open meadows, roadsides
24.	<i>Kricogonia lyside</i> (Godart, 1819) (Fig. 10A)	Lyside Sulphur	GUA	ii. 23, 24	70-91 m	60	Nectaring, basking
25.	<i>Phoebis agarithe antillia</i> F. Brown, 1929 (Fig. 10B)	Large Orange Sulphur	GUA, UPR	ii. 23; iii. 1	24-158 m	8	Nectaring on <i>Bidens</i>
26.	<i>Phoebis argante martini</i> W. Comstock, 1944 (Fig. 10C)	Apricot Sulphur	ELY	ii. 29	274 m	1	Ovipositing on an unidentified non-legume (Fig. 10C)
27.	<i>Phoebis sennae sennae</i> (Linnaeus, 1758) (Fig. 10D)	Cloudless Sulphur	COC, GUA, QUA, BEC	ii. 22, 23, 25, 26, 28	15-91 m	12	Nectaring skittishly
28.	<i>Phoebis trite watsoni</i> F. Brown, 1929 (Fig. 10E)	Straight-lined Sulphur	ELY	ii. 18-21, 27-29	274-427 m	78	Flying among trees, barely stopping to nectar, perching under leaves
29.	<i>Pyrisitia leuce antillarum</i> (A. Hall, 1936) (Fig. 10F)	Leuce Yellow	BEC	ii. 28	27-49 m	4	Nectaring very skittishly
30.	<i>Pyrisitia lisa euterpe</i> (Ménétriés, 1832) (Fig. 11A)	Little Yellow	GUA, COC	ii. 22, 23, 26	6-46 m	71	Nectaring, constant flight on open meadows, roadsides, ovipositing on <i>Mimosa</i>
31.	<i>Pyrisitia portoricensis</i> (Dewitz, 1877) (Fig. 11B)	Puertorican Yellow	ELY, UPR	ii. 20, 29; iii. 1	24-411 m	4	Nectaring on <i>Bidens</i>
Family: Lycaenidae							
Subfamily: Theclinae							
32.	<i>Allosmaitia fidena</i> (Hewitson, 1867) (Fig. 11C)	Fidena Hairstreak	BEC	ii. 28	79 m	1	Ovipositing
33.	<i>Chlorostrymon maesites</i> (Herrich-Schäffer, 1865) (Fig. 11D)	Amethyst Hairstreak	GUA	ii. 23	70 m	1	Nectaring on treetop flowers
34.	<i>Electrostrymon angelia boyeri</i> (W. Comstock & Huntington, 1943) (Fig. 11E)	Fulvous Hairstreak	COC, GUA, BEG, QUA	ii. 23, 24, 25, 26	15-152 m	8	Nectaring, patrolling on treetops
35.	<i>Ministrymon azia</i> (Hewitson, 1873)	Gray Ministreak	GUA	ii. 23	70 m	1	Nectaring on treetop flowers (no publishable picture)
36.	<i>Nesiostrymon celida aibonito</i> (W. Comstock & Huntington, 1943) (Fig. 11F)	Caribbean Hairstreak	ELY	ii. 19, 21	283-1067 m	6	Treetops, patrolling
37.	<i>Strymon acis mars</i> (Fabricius, 1776) (Fig. 12A)	Caribbean Scrub-hairstreak	GUA	ii. 23, 24	3-70 m	3	Nectaring, patrolling around <i>Croton</i> bushes
38.	<i>Strymon bubastus ponce</i> (W. Comstock & Huntington, 1943) (Fig. 12B)	Cramer's Scrub-hairstreak	COC, BEC	ii. 22, 28	3-76 m	2	Nectaring, perching on leaves
Subfamily: Polyommatainae							
39.	<i>Hemiargus hanno watsoni</i> W. Comstock & Huntington, 1943 (Fig. 12C)	Hanno Blue	All but MAR	All days but ii. 29	3-235 m	223	Nectaring, flying low on meadows and clearings, scrubby bushes
40.	<i>Leptotes cassius theonus</i> (Lucas, 1857) (Fig. 12D)	Cassius Blue	All but MAR and GUA	All days but ii. 21	6-457 m	54	Nectaring
41.	<i>Pseudochrysops bornoi escobioi</i> A. Schwartz, 1987 (Fig. 12E)	Antillean Blue	GUA	ii. 23, 24	15-91 m	140	Nectaring, ovipositing on an unidentified tree legume species
Family: Nymphalidae							
Subfamily: Heliconiinae							
42.	<i>Dione vanillae</i> (Linnaeus, 1758) (Fig. 12F)	Gulf Fritillary	All but BEG and MAR	All but ii. 20, 21, 29	3-61 m	58	Nectaring, rapid flight
43.	<i>Dryas iulia iulia</i> (Fabricius, 1775) (Fig. 13A)	Julia	ELY, MAR, BEG, BEC	ii. 19, 20, 24, 27, 28	15-396 m	44	Nectaring, basking
44.	<i>Heliconius charithonia charithonia</i> (Linnaeus, 1767) (Fig. 13B)	Zebra Heliconian	ELY, QUA, BEC, UPR	ii. 19, 20, 25, 28; iii. 1	24-457 m	73	Nectaring, roosting in group
Subfamily: Nymphalinae							
45.	<i>Anartia jatrophae semifusca</i> Munroe, 1942 (Fig. 13C)	White Peacock	COC	ii. 22, 26	3-21 m	70	Nectaring, basking, patrolling on ground
46.	<i>Antillea pelops pelops</i> (Drury, 1773) (Fig. 13D)	Antillean Crescent	ELY, BEC	ii. 21, 28	46-1067 m	14	Nectaring, basking

Table 1, continued. Butterfly Survey Results.

S.No.	Scientific Name (Based on Warren <i>et al.</i> (2024)) with Fig. references	English Name	Locality	Date (2024)	Elevation (m)	No. of individuals	Natural History/Habitat
47.	<i>Atlantea tulita</i> (Dewitz, 1877) (Fig. 13E)	Puerto Rican Harlequin	QUA	ii. 25	46 m	2	Patrolling on treetops
48.	<i>Colobura dirce wolcottii</i> W. Comstock, 1942 (Fig. 13F)	Dirce Beauty	ELY, BEG	ii. 19, 20, 24, 27, 29	265-396 m	19	Rapid flight, patrolling while perching upside down on tree trunks esp. during evening
49.	<i>Hypanartia paullus</i> (Fabricius, 1793) (Fig. 14A)	Antillean Mapwing	ELY	ii. 19, 21	366-415 m	6	Mud-puddling, nectaring, patrolling
50.	<i>Junonia neildi</i> Brévignon, 2004 (Fig. 14C)	Mangrove Buckeye	COC, GUA	ii. 22, 24, 26	3-30 m	26	Patrolling on ground, nectaring
51.	<i>Junonia zonalis michaelisi</i> Fruhstorfer, 1907 (Fig. 14B)	Tropical Buckeye	COC	ii. 22, 26	3-30 m	6	Patrolling on ground, nectaring
52.	<i>Siproeta stelenes stelenes</i> (Linnaeus, 1758) (Fig. 14D)	Malachite	BEG	ii. 24	232 m	1	Perched on treetop
Subfamily: Biblidinae							
53.	<i>Biblis hyperia hyperia</i> (Cramer, 1779) (Fig. 14E)	Southern Red Rim	BEC	ii. 28	15-91 m	30	Perched on tree leaves, basking
54.	<i>Eunica monima</i> (Stoll, 1782) (Fig. 14F)	Dingy Purplewing	BEC	ii. 28	27-61 m	2	Perched on/under tree leaves
55.	<i>Eunica tatila tatilista</i> Kaye, 1926 (Fig. 15A)	Florida Purplewing	GUA, BEC	ii. 23, 28	70-162 m	7	Rotting fruits, perched on twigs, tree trunks, undersides of leaves
56.	<i>Hamadryas februa ferox</i> (Staudinger, 1886) (Fig. 15B)	Caribbean Cracker	GUA, BEC	ii. 23, 28	30-162 m	11	Gray tree trunks
Subfamily: Limenitidinae							
57.	<i>Adelpha gelania arecosa</i> (Hewitson, 1847) (Fig. 15C)	Antillean Sister	ELY, BEC	ii. 27-29	61-305 m	3	Near water sources, treetops
Subfamily: Cyrestinae							
58.	<i>Marpesia petreus damicorum</i> Brévignon, 2001 (Fig. 15D)	Ruddy Daggerwing	ELY	ii. 19	457 m	1	Nectaring
Subfamily: Charaxinae							
59.	<i>Anaea troglodyta borinquensis</i> F. Johnson & W. Comstock, 1941 (Fig. 15E)	Puerto Rican Leafwing	GUA, BEC	ii. 23, 28	21-162 m	14	Rotting fruits, dry twigs, trailsides
Subfamily: Satyrinae							
60.	<i>Calisto nubila</i> Lathy, 1899 (Fig. 15F)	Puerto Rican Calisto	ELY, MAR, BEG, BEC	ii. 19, 20, 21, 24, 28	27-1067 m	162	Roadsides, trailsides, woods, clearings, nectaring
Subfamily: Danainae							
61.	<i>Danaus plexippus portoricensis</i> A. Clark, 1941 (Fig. 16)	Monarch	ELY, COC, QUA, BEC	ii. 19, 25, 26, 28	9-396 m	7	Nectaring
Family: Papilionidae							
Subfamily: Papilioninae							
62.	<i>Papilio demoleus malayanus</i> Wallace, 1865	Lime Swallowtail	GUA, BEC	ii. 23, 28	27-158 m	2	Seen in flight
63.	<i>Heraclides androgeus epidaurus</i> (Godman & Salvin, 1890)	Androgeus Swallowtail	GUA	ii. 23	55 m	1	Seen in flight
64.	<i>Heraclides pelaus puertoricensis</i> Möhn, 1999	Caribbean Swallowtail	ELY	ii. 29	283 m	2	Seen twice in flight near the same water source (could have been the same individual)

of these butterflies (Vandewoestijne *et al.*, 2004; Suchan *et al.*, 2024). In contrast, Papilionidae was the least represented family, which agrees with its low overall species richness on the island (Ramos, 1996); the low abundance we observed was also likely due to it being too early in the year for many species, such as *Battus polydamas* (Linnaeus), *Heraclides androgeus*, *H. aristodemus* (Esper), and *H. pelaus* (iNaturalist, 2024; BAMONA, 2025). *Hemiargus hanno* was the most abundant species encountered; this is a species capable of utilizing various Fabaceae species as larval host plants (Fernández-Hernández, 2007; Askew & Stafford, 2008; Pérez-Asso *et al.*, 2009), which are widespread throughout the island (iNaturalist, 2024), much like the butterfly itself. Our observation of only two individuals of *Papilio demoleus* aligns with Jeff Glassberg's observation of only a single individual during a late February 2024 visit

(pers. comm., 2024), indicating that this non-native species is perhaps currently not abundant, and potentially localized in Puerto Rico. Data from iNaturalist (2024) revealed 42 records of *P. demoleus* over more than a decade, averaging fewer than four sightings per year, further substantiating our conclusion regarding the rarity of this species on the island; however, regular population monitoring is essential.

The endemic *Calisto nubila*, the only Satyrinae species on the island, appears to be abundant, presumably owing to abundant larval host plants (multiple Poaceae species) (Comstock, 1944; Sourakov, 1999; Pérez-Asso *et al.*, 2009; Andrei Sourakov, pers. comm. 2025) and potentially low predation pressure; nevertheless, the numbers fluctuate yearly because of change in humidity, temperature, and wind speeds (Bain, 2010). By contrast, the scarcity of *Atlantea tulita*, an ESA-

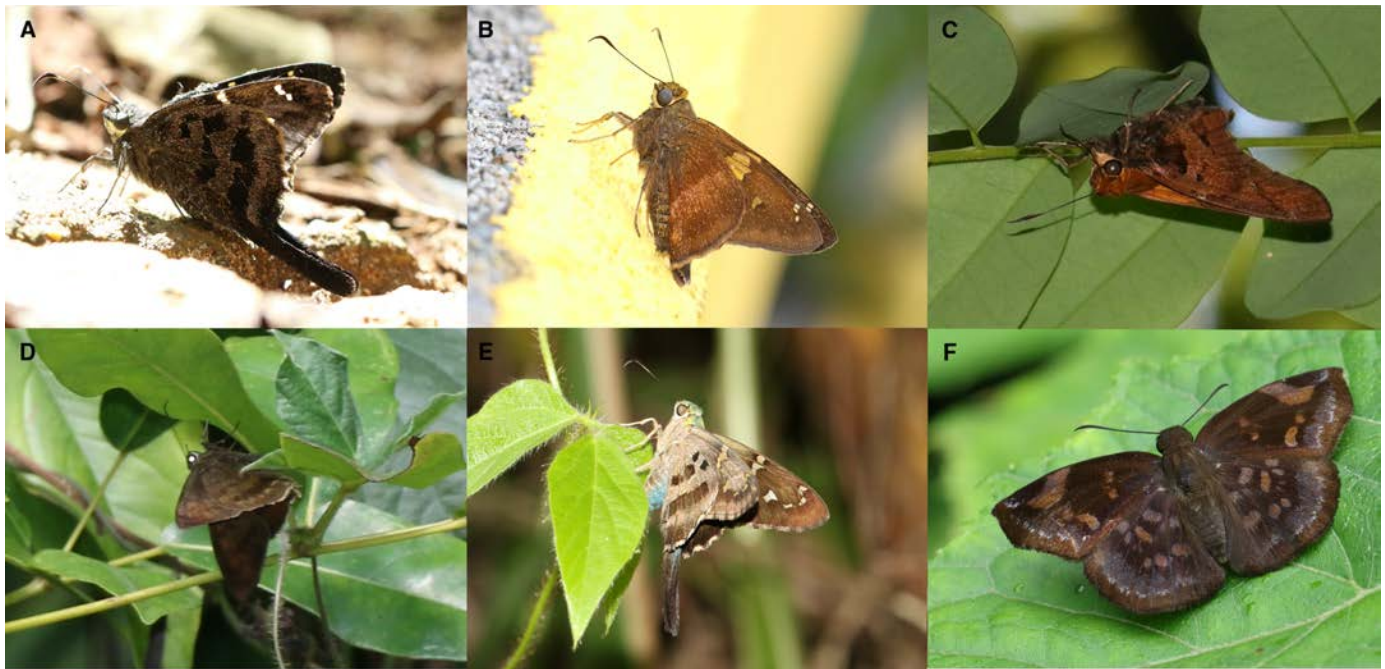


Figure 6. Live adults of Hesperiiidae. (A) *Cecropterus dorantes cramptoni* (W. Comstock, 1944); (B) *Epagyreus zestos zestos* (Geyer, 1832); (C) *Proteides mercurius pedro* (Dewitz, 1877); (D) *Telegonus anausis anausis* Godman & Salvin, 1896; (E) *Urbanus proteus domingo* (Scudder, 1872); (F) *Eantis minor* W. Comstock, 1944.

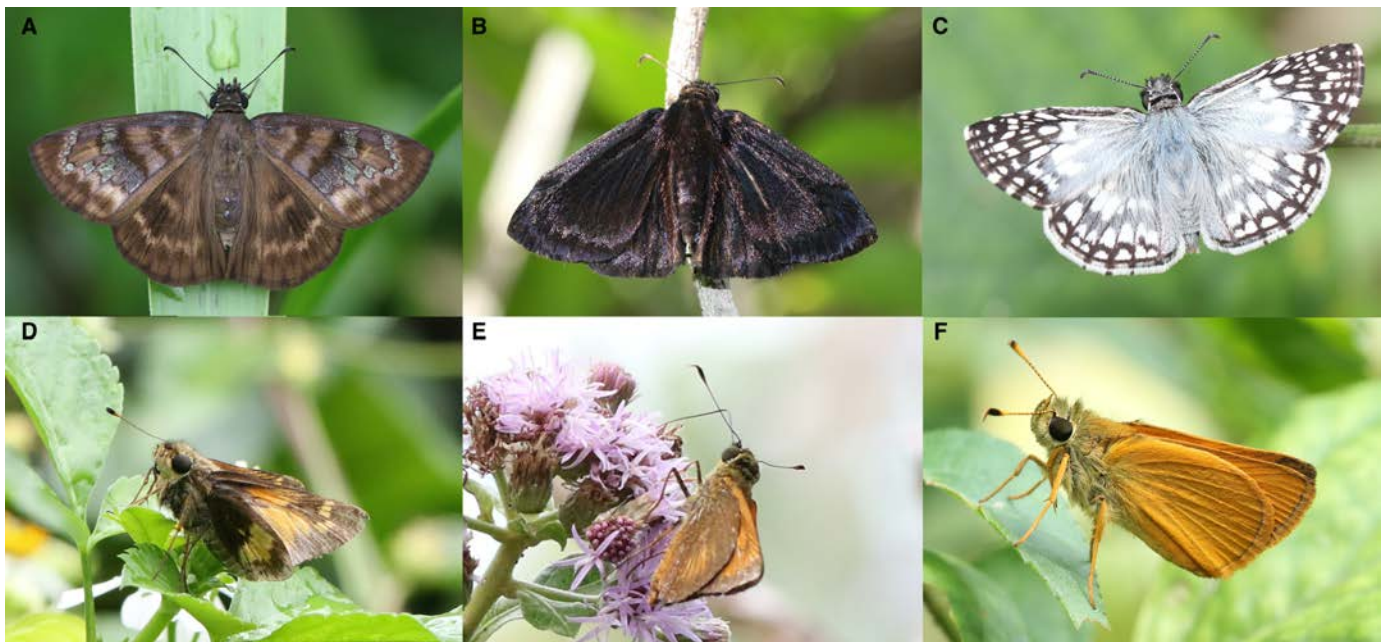


Figure 7. Live adults of Hesperiiidae. (A) *Ephyriades arcas philemon* (Fabricius, 1775) female; (B) *Ephyriades arcas philemon* (Fabricius, 1775) male; (C) *Burnsius oileus* (Linnaeus, 1767); (D) *Atalopedes mesogramma apa* W. Comstock, 1944; (E) *Choranthus borincona* (F. Watson, 1937); (F) *Choranthus vitellius* (Fabricius, 1793).

listed threatened endemic species, can appear puzzling given the abundance of its larval host plant, *Oplonia spinosa* (Jacq.) Raf. (Prickly Bush) (Carrión-Cabrera, 2003), in Quebradillas. Obviously, numerous factors other than larval host plant availability influence abundance, such as pathogens, predators, and environmental stressors. Moreover, Puerto Rico's frequent tropical storms could be a significant hindrance to population recovery in the fragmented habitats now remaining on the island, as the recurring disturbances may not allow sufficient

time for certain species' populations to rebound. It is also important to note that our surveys were primarily conducted in natural and/or protected areas (except for Coco Beach), and the diversity observed in these areas may not represent the diversity in the adjacent urban areas. Extrapolating our findings—for example, overall abundance—to urban environments would be inappropriate, as the ecological conditions and species distributions are almost certainly distinct, a topic which is discussed by Forister *et al.* (2023).



Figure 8. Live adults of Hesperiiidae. (A) *Cymaenes tripunctus tripunctus* (Herrich-Schäffer, 1865); (B) *Hylephila phyleus phyleus* (Drury, 1773); (C) *Nyctelius nyctelius nyctelius* (Latreille, [1824]); (D) *Panoquina lucas lucas* (Fabricius, 1793); (E) *Panoquina nero* (Fabricius, 1798); (F) *Panoquina panoquinoides* (Skinner, 1891).



Figure 9. Live adults of Hesperiiidae and Pieridae. (A) *Polites drury* (Latreille, [1824]); (B) *Rhinthon cubana* (Herrich-Schäffer, 1865); (C) *Ascia monuste eubotea* (Godart, 1819); (D) *Glutophrissa drusilla boydi* (W. Comstock, 1943); (E) *Aphrissa statira hispaniolae* (Munroe, 1947); (F) *Eurema दौरा palmira* (Poey, [1852]).

CONCLUSION

This study provides a concise snapshot of the butterfly species composition and abundance observed in Puerto Rico during a two-week period, highlighting their natural histories and providing records of species rarely documented from the island, such as *Allosmaitia fidena* and *Rhinthon cubana*. Puerto Rico's butterfly fauna faces ongoing challenges of habitat loss and threats from climate change, with relatively few recent peer-reviewed publications. Long-term studies are clearly vital to reach broader conclusions, but short surveys such as this

can also provide valuable information, particularly for poorly documented species.

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Figure 10. Live adults of Pieridae. (A) *Kricogonia lyside* (Godart, 1819); (B) *Phoebis agarithe antillia* F. Brown, 1929; (C) *Phoebis argante martini* W. Comstock, 1944; (D) *Phoebis sennae sennae* (Linnaeus, 1758); (E) *Phoebis trite watsoni* F. Brown, 1929; (F) *Pyrisitia leuce antillarum* (A. Hall, 1936).



Figure 11. Live adults of Pieridae and Lycaenidae. (A) *Pyrisitia lisa euterpe* (Ménétriés, 1832); (B) *Pyrisitia portoricensis* (Dewitz, 1877); (C) *Allosmaitia fidena* (Hewitson, 1867); (D) *Chlorostrymon maesites* (Herrich-Schäffer, 1865); (E) *Electrostrymon angelia boyeri* (W. Comstock & Huntington, 1943); (F) *Nesiostrymon celida aibonito* (W. Comstock & Huntington, 1943).

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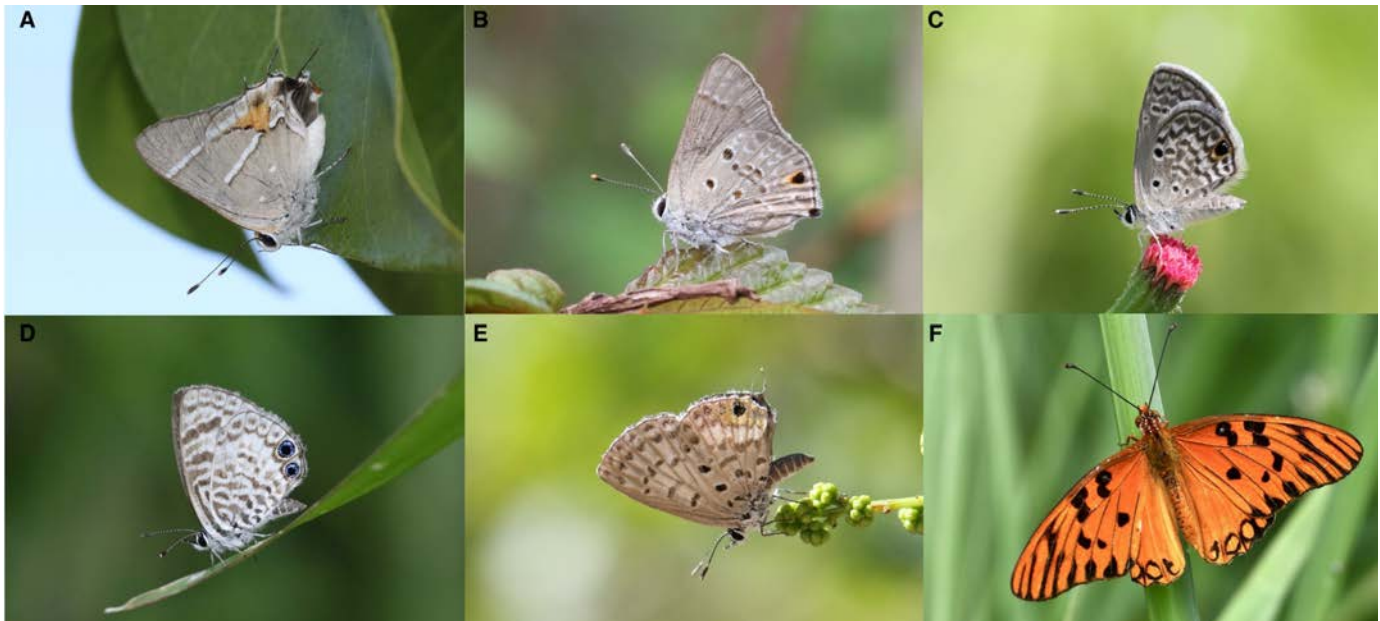


Figure 12. Live adults of Lycaenidae and Nymphalidae. (A) *Strymon acis mars* (Fabricius, 1776); (B) *Strymon bubastus ponce* (W. Comstock & Huntington, 1943); (C) *Hemiargus hanno watsoni* W. Comstock & Huntington, 1943; (D) *Leptotes cassius theonus* (Lucas, 1857); (E) *Pseudochrysops bornoi escobioi* A. Schwartz, 1987; (F) *Dione vanillae* (Linnaeus, 1758).



Figure 13. Live adults of Nymphalidae. (A) *Dryas iulia iulia* (Fabricius, 1775); (B) *Heliconius charithonia charithonia* (Linnaeus, 1767); (C) *Anartia jatrophae semifusca* Munroe, 1942; (D) *Antillea pelops pelops* (Drury, 1773); (E) *Atlantea tulita* (Dewitz, 1877); (F) *Colobura dirce wolcottii* W. Comstock, 1942.

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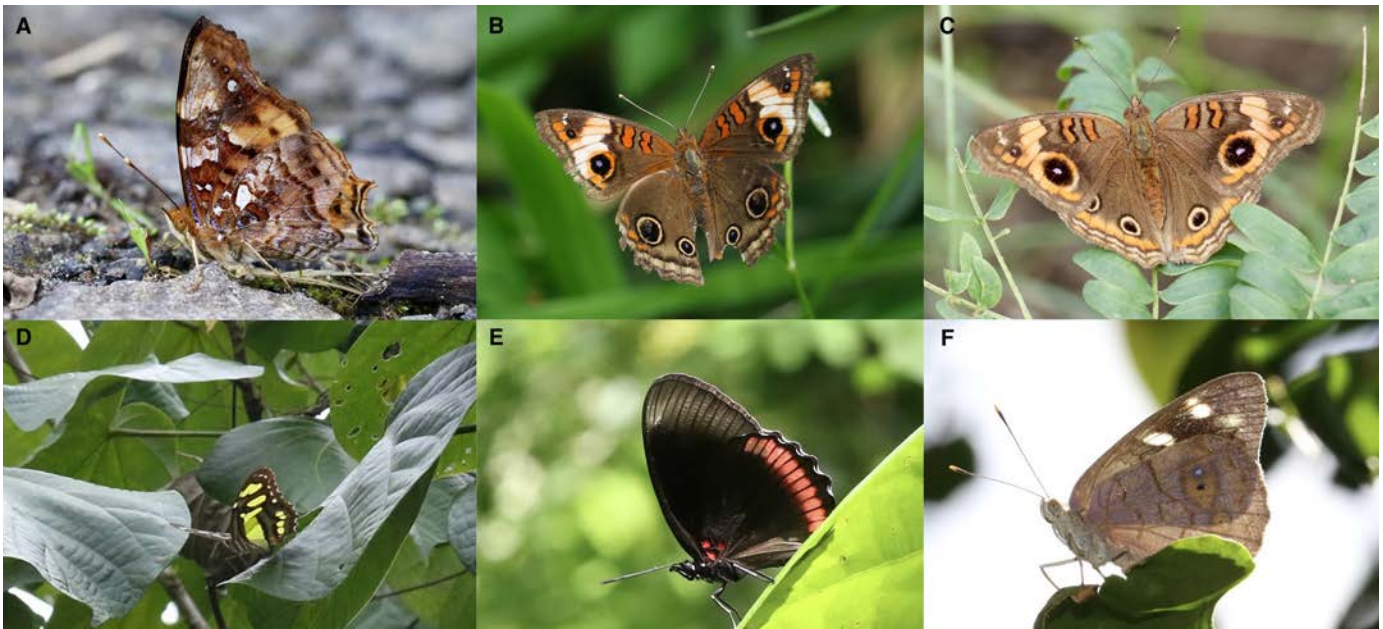


Figure 14. Live adults of Nymphalidae. (A) *Hypanartia paullus* (Fabricius, 1793); (B) *Junonia zonalis michaelisi* Fruhstorfer, 1907; (C) *Junonia neildi* Brévignon, 2004; (D) *Siproeta stelenes stelenes* (Linnaeus, 1758); (E) *Biblis hyperia hyperia* (Cramer, 1779); (F) *Eunice monima* (Stoll, 1782).



Figure 15. Live adults of Nymphalidae. (A) *Eunice tatila tatilista* Kaye, 1926; (B) *Hamadryas februa ferox* (Staudinger, 1886); (C) *Adelpha gelania arecosa* (Hewitson, 1847); (D) *Marpesia petreus damicorum* Brévignon, 2001; (E) *Anaea troglodyta borinquenalis* F. Johnson & W. Comstock, 1941; (F) *Calisto nubila* Lathy, 1899.

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Figure 16. Live adults of Nymphalidae. *Danaus plexippus portoricensis* A. Clark, 1941.

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Scientific Note: The first confirmed record of the genus *Scoliozona* Kallies & Arita, 1998 (Lepidoptera: Sesiidae: Sesiinae) from India

Sanjay Sondhi^{1,2}, Axel Kallies⁴, Rachit Pratap Singh², Arjan Basu Roy^{2,5} and Krushnamegh Kunte³

1. Titli Trust, 49 Rajpur Road Enclave, Dhoran Khas, Dehradun, Uttarakhand 248001, India. 2. Indian Foundation for Butterflies Trust. C-703, Alpine Pyramid Apts., near Canara Bank Layout, Kodigehalli, Bengaluru, Karnataka 560097, India. 3. National Centre for Biological Sciences, Tata Institute of Fundamental Research, Bellary Road, Bengaluru, Karnataka 560097, India. 4. The University of Melbourne, 792 Elizabeth Street, Melbourne, Victoria 3000, Australia. 5. Nature Mates - Nature Club, 5/5 Bijoygarh, Kolkata, West Bengal 700092, India.
 sanjay.sondhi1@gmail.com (corresponding author); ORCID ID: <https://orcid.org/0000-0002-3970-6858>
 axel.kallies@unimelb.edu.au; <https://orcid.org/0000-0002-6312-6968>
 rachitsingh98@gmail.com; <https://orcid.org/0000-0001-6158-7659>
 basuroyarjan@gmail.com; <https://orcid.org/0000-0001-9872-3562>
 krushnamegh@ncbs.res.in; <https://orcid.org/0000-0002-3860-6118>

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Abstract: The clearwing moth species *Scoliozona kalliesi* Arita & Riefenstahl, 2004 is recorded from the Jayanti region of Buxa Tiger Reserve, West Bengal, India. This is the first confirmed record of this genus and species from India, substantially extending the known range of the genus to the west.

Key words: clearwing moth, diversity, faunal discovery, taxonomy, West Bengal.

INTRODUCTION

The clearwing moth genus *Scoliozona* Kallies & Arita, 1998 was erected by Kallies & Arita (1998) with *Sura tetrapora* Diakonoff, 1968 from the Philippines as the type species. The genus belongs to tribe Paranthrenini and is represented currently by fifteen species distributed primarily in South East Asia, with records from Indonesia, Myanmar, Malaysia, Philippines, South China and Vietnam (Kallies & Arita, 1998; Kallies *et al.*, 2014; Gorbunov, 2021; Pühringer & Kallies, 2024). In this paper, we record *Scoliozona kalliesi* Arita & Riefenstahl, 2004 from West Bengal, India, substantially extending the known range of this genus westwards.

MATERIAL AND METHODS

The specimen of *S. kalliesi* was recorded during Lepidoptera surveys in Jayanti, a region within the expansive Buxa Tiger Reserve, West Bengal, India. Buxa Tiger Reserve covers an area of 760 km² in Jayanti, situated in the Alipurduar district of West Bengal. The area provides a diverse environment for numerous invertebrate species, many of which have not been fully studied or recorded.

The collection locality, Gue Nallah (26.70458; 89.60949, altitude 100 m), is situated in close proximity to civilization. However, it is renowned for its abundant diversity of lepidopteran species. The Gue Nallah is a stream that has a length of around 2.2 km and flows parallel to the main Jayanti

river. The area has an extensive canopy with certain sections of the stream passing through dense forest.

Photographs during the field survey were taken with a Canon EOS R6 with a Canon RF 100-500mm F4.5-7.1 L IS USM Lens. The sesiid was collected using a butterfly net. The pinned specimen is deposited in the Biodiversity Lab Research Collections (<http://biodiversitycollections.in>) at the National Centre for Biological Sciences, Tata Institute of Fundamental Research, Bengaluru, India. We photographed the pinned specimen using a Canon 1200D DSLR camera body with 60 mm Canon Macro lens.

The male genitalia were dissected after dissolving extraneous abdominal tissue with 10% KOH (w/v) at 80°C in a dry bath incubator. The dissected genitalia were preserved in a 0.5 ml vial containing anhydrous Glycerol, and stored in a laboratory refrigerator at 4°C. The genitalia were photographed using a Leica digital camera (DFC425) mounted on a Leica M250 C stereomicroscope (Leica Microsystems GmbH, Germany). Multiple images were taken for each view of the genitalia and stacked to improve depth of field and sharpness using the Leica application suite (LASX) software.

We follow the terminology used by Scoble (1992), Kristensen (2003) and Kunte *et al.* (2019) for the genitalia descriptions and diagnosis. Abbreviations used are as follows: FWL: Forewing length, NCBS: National Centre for Biological Sciences - TIFR, Bengaluru, India, NP: National Park, SS: Sanjay Sondhi, ABR: Arjan Basu Roy, WS: wingspan.

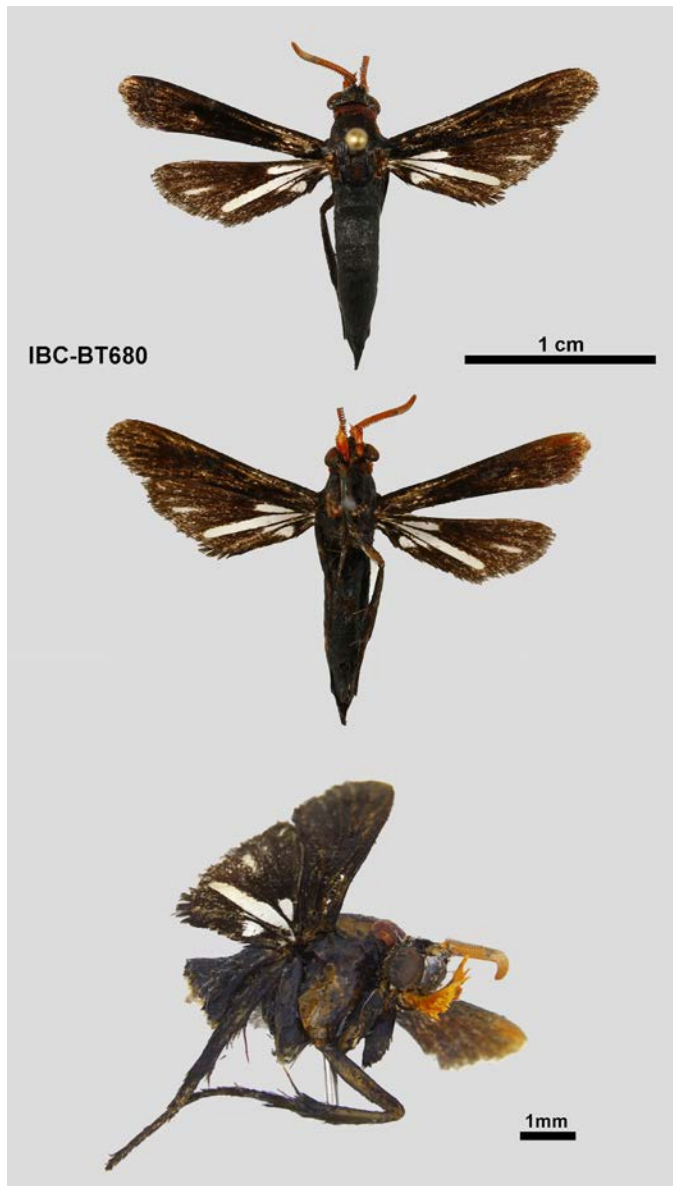


Figure 1. *Scoliokona kalliesi*. Male, IBC-BT680, (top to bottom), upperside, underside and lateral view of head close up.

Family **Sesiidae**
Subfamily **Sesiinae**
Tribe **Paranthrenini**

Genus *Scoliokona* Kallies & Arita, 1998

Type species: *Sura tetrapora* Diakonoff, 1968

Diagnosis: The genus *Scoliokona* is closely related to *Nokona* Matsumura 1931, *Adixoa* Hampson 1893 and *Pramila* Moore 1879. All four genera are characterized by the distinctive hand-shaped setae on the inner surface of the valvae. *Scoliokona* differs from the other genera by its general appearance with long and slender abdomen, often somewhat constricted in the middle and usually partially opaque hindwings (abdomen simple and hindwings transparent in genera compared), the venation (cross vein and M3 in hindwing forming an acute angle (forming a right angle in genera compared), the lateral scale tufts on abdominal segments 6 and 7 (absent in genera compared), the

long scale tufts of the labial palps (short in genera compared) and details of the male genitalia with a distinct medial row of hand-shaped setae (absent in genera compared).

***Scoliokona kalliesi* Arita & Riefenstahl, 2004**

Scoliokona kalliesi Arita & Riefenstahl, 2004; Arita & Riefenstahl, 2004: 116. TL: Myanmar, Kachin, Putao, Mt. New Zin.

Material examined: (Figs 1, 2): 1 ♂, India, West Bengal, Alipurduar district, Buxa Tiger Reserve, Jayanti, leg. SS/ABR, 29.iii.2023 (IBC-BT680). FWL: 11.5 mm. WS: 24 mm.

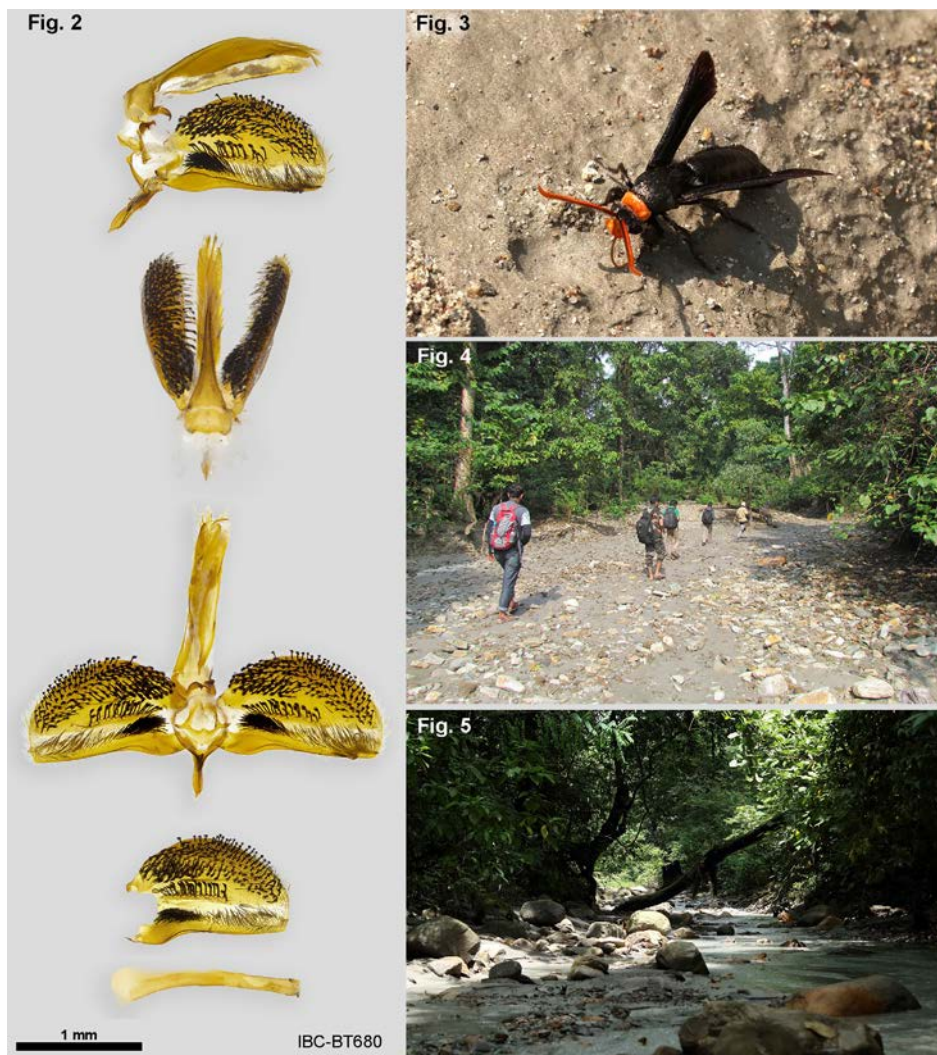
Diagnosis: *Scoliokona kalliesi* differs from other *Scoliokona* species by a number of characters, particularly the orange antennae, vertex of the head, labial palps and patagia. The only species with orange body parts is *S. balinensis* Gorbunov 2021. However, this species has black antennae and more extensive transparent areas in the hindwings (transparent areas between veins M1 and M2 and CuP and 1A of the hindwing, opaque in *S. kalliesi*) and a different structure of the male genitalia, especially the shape of the gnathos and valva. The male genitalia of this specimen match that of *S. kalliesi* (Arita & Riefenstahl, 2004; Yu *et al.*, 2019).

Remarks: A single individual was first spotted at 0945 hrs. The sesiid was initially mistaken for a wasp, but closer inspection through binoculars revealed that it was a moth (Figure 3). The specimen was mud-puddling on moist soil next to a small stream (Figure 4, 5). It flew away initially, only to re-appear 15 minutes later, at which point it was netted and collected. Nothing is known about the natural history and life cycle of this species. The genus is diurnal and in other parts of its range artificial attractants have often been used to attract and capture specimens.

Distribution: The genus *Scoliokona* is distributed throughout the Oriental region with records from Indonesia, Myanmar, Malaysia, Philippines, South China and Vietnam (Kallies & Arita 1998; Kallies *et al.* 2014, Yu *et al.* 2019; Gorbunov 2021, Pühringer & Kallies 2024). Yu *et al.* (2019) report the distribution of *S. kalliesi* as Myanmar, Thailand, Vietnam and China (Yunnan). Joshi *et al.* (2021) do not list this genus from northeast India. Hence, this represents the first record of this genus and species from India, extending the known range of this genus westwards.

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The moth was collected based on a collection permit from the Principal Chief Conservator of Forests (Wildlife & Biodiversity) and Chief Wildlife Warden, West Bengal Forest Department (permit no. 1107/WL|2W-705/2018 dated 7 May 2018, letter no. C-28011/07/2020 dated 14 August 2020 and letter no. 1523/WL/4R-7/2021 dated 9 August 2021), issued to Nature Mates-Nature Club, Kolkata, West Bengal. We thank Debal Roy, Principal Chief Conservator of Forest and Chief



Figures 2-5. **Figure 2.** Genitalia of *Scoliokona kalliesi*, male, IBC-BT680, (top to bottom) genital capsule lateral view, genital capsule dorsal view, genital capsule ventral view, valva and aedeagus. **Figure 3.** Image of live individual of *Scoliokona kalliesi*. **Figures 4, 5.** Habitat of *Scoliokona kalliesi*.

Wildlife Warden, Dept. of Environment and Forests, Govt. of West Bengal, for issuing the research and collection permits to Nature Mates-Nature Club. ABR would like to acknowledge the support provided by Sarika Baidya in obtaining research permits from the West Bengal Forest Department. SS would also like to acknowledge the support of Nandita Hazarika and Goutam Narayan at EcoSystems-India for providing local support in Guwahati. Museum work was supported by a research grant from NCBS to KK. We also thank the reviewers for their comments on the manuscript.

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Scientific Note: First record of Sematuridae (Lepidoptera: Geometroidea) moths in the Atlantic Forest of Brazil, north of the São Francisco river, and description of the male genitalia of *Coronidia orithea* (Cramer, [1780])

Eduardo Vasconcelos Tavares^{1*}, Saulo Dal Bó^{1,3} and Alessandre Pereira-Colavite^{1,2,4}

1. Laboratório de Entomologia, Departamento de Sistemática e Ecologia, CCEN, Universidade Federal da Paraíba, João Pessoa, PB, Brazil. 2. Programa de Pós-Graduação em Ecologia e Monitoramento Ambiental, CCAE, Universidade Federal da Paraíba, Rio Tinto, PB, Brazil. 3. ORCID: <https://orcid.org/0009-0006-3680-6702>. 4. ORCID: <https://orcid.org/0000-0002-7660-8384>. *Corresponding author: eduvastava@gmail.com; <https://orcid.org/0009-0003-7430-0727>.

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Abstract: Known as corkscrew moths, the family Sematuridae is a small group of lepidopterans within the superfamily Geometroidea, predominantly distributed in the Neotropical region and comprising about 40 species across six genera, with seven species from three genera known to occur in Brazil. They are moderate to large in size, visually similar to the Uraniidae family, which has historically led to taxonomic confusion. Despite their distinctive appearance, little is known about their biology, especially in northeastern Brazil. This study presents the first documented collection of *Coronidia orithea* (Cramer, [1780]) in Alagoas and the Northeastern Atlantic Forest, making it the first collection of that family in Brazil, north of São Francisco River. Significantly, this work includes the first description and illustration of the male genitalia of *Coronidia*, advancing anatomical knowledge of the group.

Keywords: Biodiversity, biogeography, Brazilian moths, morphology.

INTRODUCTION

Sematuridae is a family of moths belonging to the superfamily Geometroidea (Minet & Scoble 1998), with a disjunct distribution that includes an African species, a genus in the Nearctic region, and the majority being predominantly Neotropical (Carneiro *et al.* 2024). Globally, there are approximately six genera with 40 species (Nieukerken *et al.* 2011), and in Brazil, seven species from three genera are recognized by Moraes *et al.* (2024). Adults are predominantly active during the night, displaying a moderate to large size, with a wingspan that can reach up to 80 mm (Carneiro *et al.* 2024). Visually, their appearance resembles moths from the Uraniidae family, which historically led to their inclusion within this taxonomic group.

Knowledge of sematurid moths in Brazil is very limited due to the lack of inventories and studies focused on these moths, particularly in the region known as the Pernambuco Center of Endemism, a unique area of the northeastern Atlantic Forest with distinctive configurational characteristics (Santos *et al.* 2007). Until this work, dissections and descriptions of Sematuridae genitalia were almost non-existent, with Cock (2016) being one of the few exceptions, and no prior studies had focused on the genitalia of the genus *Coronidia*. This lack of anatomical detail makes the present study particularly important, as it includes the first description and illustration of the male genitalia of *C. orithea* (Cramer, [1780]), which significantly advances our comprehension of the group as a whole.

Coronidia orithea, like other family members, has a distribution and habits that are not well-known, although it is known that the *Coronidia* genus is endemic to the Neotropics (Carneiro *et al.*, 2024). *Coronidia orithea* differs from other species in the genus by having a round metallic blue area on the hind wings, as well as a straight pale line on the forewing that extends its full width (Carlos & Beutelspacher 1987).

The other species in the same genus found in Brazil, *Coronidia erecthea* Westwood, 1879 is very similar to *C. orithea* but can be distinguished by the shape of the blue band on the hind wings: in *C. orithea*, the band is more rounded and has a thin white line directed toward the anal angle, while in *C. erecthea*, the blue band is distinctly triangular, and the white line is reduced (Westwood 1879).

RESULTS AND DISCUSSION

Coronidia Westwood, 1879

Coronidia orithea (Cramer, [1780]) (Figs 1, 2)

= *Phalaena orithea* Cramer, [1780]

= *Coronidia hysudrus* Hopffer, 1856 (in parts, figures). Synonymized by Strand (1911).

= *Coronidia boreada* Westwood, 1879. Synonymized by Strand (1911).

Material examined (Fig. 1A, B): 1♂ “BR, AL, Quebrangulo/REBIO Pedra Talhada/ 26.XI-03.XII.2023/ APC, SDB, JPN cols.” [DSEC0004503LP]. The material is deposited in the Coleção Entomológica of the Departamento de Sistemática e

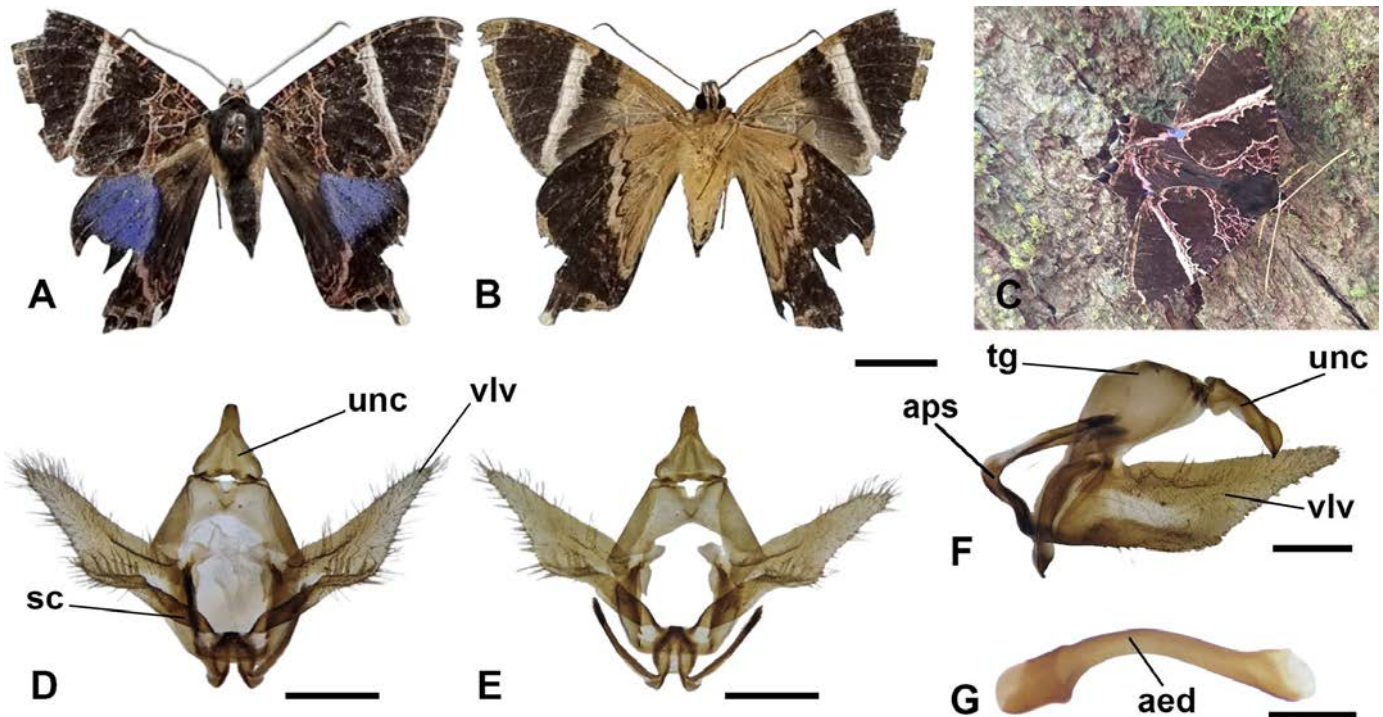


Figure 1. *Coronidia oritheia* (Cramer, [1780]), Alagoas specimen. A, Dorsal view; B, Ventral view; C, live specimen; D, Male genital capsule, ventral view; E, dorsal view; F, lateral view; G, aedeagus, lateral view. Key: aed, aedeagus; aps, anterior projection of saccus; sc, saccus; tg, tegumen; unc, uncus; vlv, valva. Scales: A,B: 1cm; D - F: 1mm; G: 0.5mm.

Ecologia (DSEC) of the Universidade Federal da Paraíba, João Pessoa, Paraíba, Brazil.

Male Genitalia (Fig. 1D-G): Ventral view: subtriangular valva with fine, long setae along its length, tapering to a pointed apex. Uncus narrows to a slightly rectangular-shaped tip. Lateral view: valva three times longer than wide, extending beyond the uncus, with setae on both outer and inner surfaces. Uncus slightly curved downward, ending in a fine tip; tegumen trapezoidal in shape. Anterior projection of the saccus prominent, curved towards the anterior portion, followed by a curve towards the posterior portion, reaching the level of the tegumen. Aedeagus cylindrical, with a dorsal opening for the ejaculatory duct, curved, shorter than the valva, with its anterior and posterior portion slightly expanded.

Remarks: In Brazil, Sematuridae collections have been documented primarily in the states of Rio Grande do Sul, Rio de Janeiro, São Paulo, Santa Catarina, Sergipe (Strand 1911), and Espírito Santo (Westwood 1879). For *C. oritheia*, Cramer ([1780]) specified Suriname as the type locality. Its distribution spans a broad range, from Mexico and Honduras to Bolivia, Paraguay, Argentina, and Brazil (Strand 1911; Westwood 1879, Carlos & Beutelspacher 1987). The location recorded by Strand (1911), likely near the present-day municipality of Santa Leopoldina, Espírito Santo, is the closest known locality to the collection site of the specimen discussed in this study, at an approximate distance of 1,600 km. The nearest record for another *Coronidia* species is in Sergipe (Strand 1911), approximately 300 km from the collection site referenced here. While this Sergipe locality is in Northeast Brazil, it has distinct features, such as botanical diversity, temperature and precipitation (Iserhard *et al.* 2017), due to its position south of the São Francisco River, and the species recorded there likely corresponds to *C. erecthea*.

This recent record of *C. oritheia* expands our knowledge of the distribution range for both the species and its family,

allowing for a more accurate mapping of its geographic occurrence. However, considering this extensive range, we cannot rule out the possibility of undetected cryptic species (Núñez & Ezequiel 2017). It is noteworthy that this species has frequently been collected at high-altitude sites, with elevations ranging from 450 to 1200 meters above sea level; this pattern was also observed in the collection referenced in this study, which took place at an altitude of 750 meters. This trend may suggest a preference for higher-altitude habitats, though further data is required to confirm this hypothesis.

In the past decade, some studies have reported new records for *C. oritheia* in Argentina (Núñez & Ezequiel 2017), contributing to a better understanding of the distribution patterns of the species and family in the Neotropics. These studies are essential as they provide foundational data for other research, including systematic and biogeographic analyses.

Additionally, the citizen science platform iNaturalist, which enables individuals outside academia to share observations of life forms with detailed records such as date and time, offers valuable insights into the distribution of this species. It is worth noting that while many images undoubtedly belong to the genus *Coronidia*, they may not specifically depict *Coronidia oritheia*, as accurate identification often relies on observing the hindwings, which are frequently covered by the forewings. On the platform, the records are concentrated in Central America, northern South America, and southeastern Brazil. However, for Brazil's northeastern region, there is only a single record on the platform, from the city of Itacaré, Bahia, highlighting the importance of this work in documenting and expanding knowledge about the species' distribution in this area, particularly in the northeastern portion north of the São Francisco River, which lacks any records.



Figure 2. Historical illustrations of *Coronidia orithea* (Cramer, [1780]), extracted from BHL. A, *Phalaena orithea* by Cramer (1780), dorsal view, plate CCLXII, fig. C; B, ventral view, plate CCLXII, fig. D; C, *C. orithea* by Westwood (1879), plate LXXXVII fig. 3.

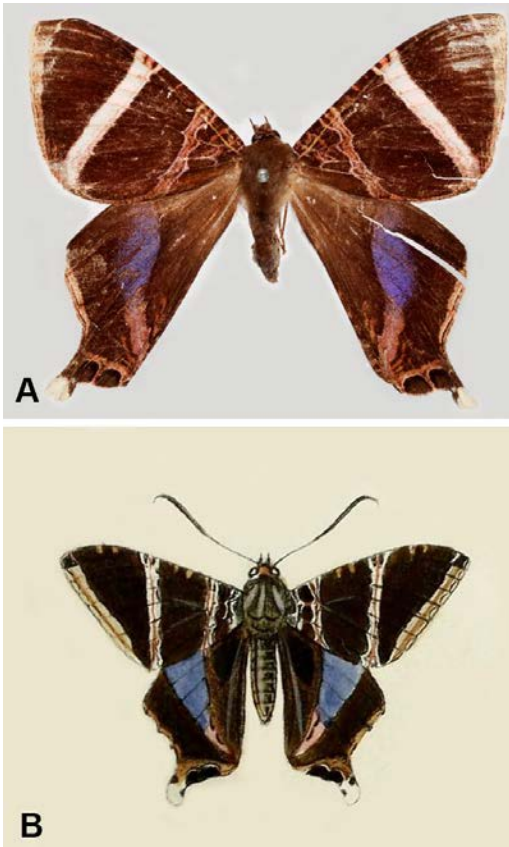


Figure 3: Illustrations of *Coronidia erecthea* Westwood, 1879. A, *C. erecthea* following Call (2020); B, *C. erecthea* by Westwood (1879), extracted from BHL, plate LXXXVII fig. 4.

iNaturalist observations: *Coronidia orithea* (Cramer, [1780]). (https://www.inaturalist.org/observations?taxon_id=465544)

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A new *Chavarriella* species from Costa Rica with first larval biology insights for the genus (Geometridae, Geometrinae)

Tanner A. Matson¹, Winnie Hallwachs² and Daniel H. Janzen²

1. Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560-0127, USA. 2. Department of Biology, University of Pennsylvania, Philadelphia, PA 19104, USA. Corresponding Author: Tanner A. Matson, matsonT@si.edu

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Abstract: The three known *Chavarriella* species of Central America are illustrated to facilitate the diagnosis and description of a fourth species, *Chavarriella lindapitkiniae* Matson, n. sp., from Costa Rica. Additionally, the first larval illustrations for the genus are presented, and the first food records are reported from Lauraceae for both *C. lindapitkiniae* n. sp. and *C. porcius* (Schaus).

Key words: Área de Conservación Guanacaste (ACG), DNA barcoding, rainforest, emerald moth, Lauraceae, Neotropical, Supraocotea.

INTRODUCTION

The Neotropical genus *Chavarriella* was described by Pitkin (1993) and currently includes 14 recognized species (Rajaei *et al.*, 2022). Pitkin identified a single, slightly raised brown tuft of scales on the second pale abdominal spot as the defining apomorphy of the genus. This character distinguishes *Chavarriella* from *Oospila* Warren, a genus it closely resembles among the emerald moths in adult wing pattern but that differs by having several pronounced tufts of scales on the abdomen and more elaborate genitalia. In contrast, the genitalia of *Chavarriella* are notably simple and exhibit limited variation across species, making it challenging to assess morphological diversity using traditional character systems alone. Consequently, Pitkin adopted a conservative approach in her treatment of Neotropical species. However, with the advent of widespread DNA barcoding (Hebert *et al.*, 2003), morphological variation can now be evaluated in conjunction with this additional character system. In the case of the new species described here, DNA barcodes reveal that a distinct form, previously included within Pitkin's concept of *Chavarriella fallax* (Warren) and provisionally referred to as the "narrow blotched form," is both unique and undescribed. The other three species of *Chavarriella* recognized from Central America include *C. fallax*, *C. porcius* (Schaus), and *C. semiornata* (Warren).

Pitkin (1993) and subsequent literature provide no information on the food plants of *Chavarriella*. However, DHJ and WH and the team of Área de Conservación Guanacaste (ACG) parataxonomists (Janzen & Hallwachs, 2011) have reared individuals of this genus numerous times, particularly for the new species described herein. As a result, the first larval images and food plants for the genus are recorded.

MATERIALS AND METHODS

Chavarriella holdings (including primary types) were examined from the following institutions: American Museum of Natural History (AMNH), New York City, New York, USA; Natural History Museum (NHMUK), London, United Kingdom; and National Museum of Natural History (USNM), Washington DC, USA.

Genitalic preparations were made following methods described by Lafontaine (2004). Preparations were stained with Chlorazol Black and slide-mounted in Euparal. Morphological terms follow Pitkin (1993). Images were taken using a Visionary Digital imaging system and manipulated (background removed) with Adobe Photoshop (Adobe Systems, Mountain View, CA). ACG specimen vouchers are given as yy-SRNP-nnnnn.

A brief section titled 'Molecular data' draws from information available in the 'BIN Details' of BOLD's public data portal BIN (Barcode Index Number) page (BOLD Systems, 2024). These statistics are based only on sequences with a minimum length of 500 base pairs and < 1% ambiguous bases, and they almost invariably change with the addition of new sequence data (but the BIN voucher code for a correctly identified array of specimens generally does not), which is an ongoing process.

SPECIES DESCRIPTION

Chavarriella lindapitkiniae Matson, new species

(Figs. 1, 3, 4A, 4B)

urn:lsid:zoobank.org:act:DF715935-E9B0-4124-BC0D-AFC386B06FBD

Diagnosis: The wing pattern and color in *C. lindapitkiniae* are diagnostic; however, the genitalia offer limited distinguishing

features. In Central America, the stark white with red-outlined wing margins differentiates *C. lindapitkinae* from *C. porcius* and *C. semiornata*. While *C. fallax* may appear similar, its apex and wing margins are off-white to light tan rather than stark white. Additionally, in the forewing tornal area, *C. lindapitkinae* displays two red-outlined “cells,” whereas *C. fallax* shows only one. Furthermore, the posterior band of red scales on the vertex of *C. lindapitkinae* are diagnostic, as all other Central American *Chavarriella* have green scales in this area.

A specimen from a population from Esmeraldas, Ecuador, currently shares a BIN with *C. lindapitkinae* but is regarded here as likely to be an undescribed entity. In this Ecuadorian population, the chain of white outer margin “cells” extends continuously through the medial wing area, whereas in *C. lindapitkinae* from Costa Rica these white “cells” are broken and discontinuous in the medial areas.

Description: Adult. *Head:* Antenna bipectinate with rami gradually reducing in length distally to appear filiform in distal third; filiform in female. Vertex

(interantennal fillet) mostly white, but with small patch of anterior green scales and posterior band of red scales. Frons mostly blackish gray. Labial palpus blackish gray, 1.5x diameter of eye, with long and skinny apical segment. Proboscis well-developed. *Thorax:* Mostly green, posterior dorsum with some white and red scales whose pattern continues across abdomen. Legs cream to ochreous; tibial spur formula 0–2–4; scales around epiphysis blackish. *Forewing:* Forewing length, male: 12–14 mm; female: 13–15 mm. Ground color green. Costa white, paralleled below by rusty red pinstripe. Apical and tornal areas with distinct white blotches divided into segments or cells by brownish red lines. Fringe checkered with red and ochreous scales. Underside pale, unremarkable. *Hindwing:* Like forewing, but costal area green. *Abdomen:* Brownish red above with large white spots, brownish red tuft on second white abdominal spot; laterally green; pale below. *Male genitalia:* See Figs. 3A, 3B. Uncus long and slender with bulbous apex. Gnathos with sharp distal tooth. Valve slender. Juxta plate-like. Phallus slender, cornuti absent. *Female genitalia:* see Fig. 3C. Anterior apophysis almost half as long as posterior apophysis. Ductus bursae short; without additional sclerotization. Corpus bursae with bulbous anterior end, signum absent. **Larva.** see Figs. 4A, 4B. Final instar predominantly green with fine surface excrescences. Head brown. Anterior dorsum of prothorax elevated, dark brown. Dorsum flattened in anterior half of body; lateral constrictions between A1–A2 and A2–A3. Pronounced dark brown lateral processes on anterior A2; lighter brown to orange on A3; spiracles positioned on these processes, visible from above. Posterior segments laterally warty, brown. Paraprocts pronounced. Spiracles surrounded by brown halo.

Types: HOLOTYPE ♀: COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Mismo, (10.98758°, -85.41967°), el. 680 m, On *Ocotea atirrensis*, 16-XII-2019, ecl. 10-I-2020, Freddy Quesada, 19-SRNP-31941, USNM 01942696, [USNM].

PARATYPES (25♂, 26♀): 1♂, COSTA RICA: Alajuela, ACG, Rincon Rain Forest, Albergue Oscar, Tunel, (10.8835°, -85.32711°), el. 708 m, 12-II-2010, @ Light Trap, S. Rios & F. Quesada, 10-SRNP-105101, USNM 01942676, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, Rincon Rain Forest, Albergue Oscar, Termales, (10.86390°, -85.32429°), el. 694 m, 12-I-2010, @ Light Trap, F. Quesada, 10-SRNP-101146, USNM 01942677, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Mismo, (10.98758°, -85.41967°), el. 680 m, On *Ocotea atirrensis*, 06-IX-2018, ecl. 03-X-2018, Calixto Moraga, 18-SRNP-31756, USNM 01942678, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Mismo, (10.98758°, -85.41967°), el. 680 m, On *Ocotea atirrensis*, 11-X-2018, ecl. 24-XI-2018, Manuel Rios, 18-SRNP-31979, USNM 01942679, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, San Cristobal, Rio Blanco Abajo, (10.90037°,



Figure 1. *Chavarriella lindapitkinae* Matson, n. sp. holotype, 19-SRNP-31941 (USNM 01942696). Forewing length = 14 mm.

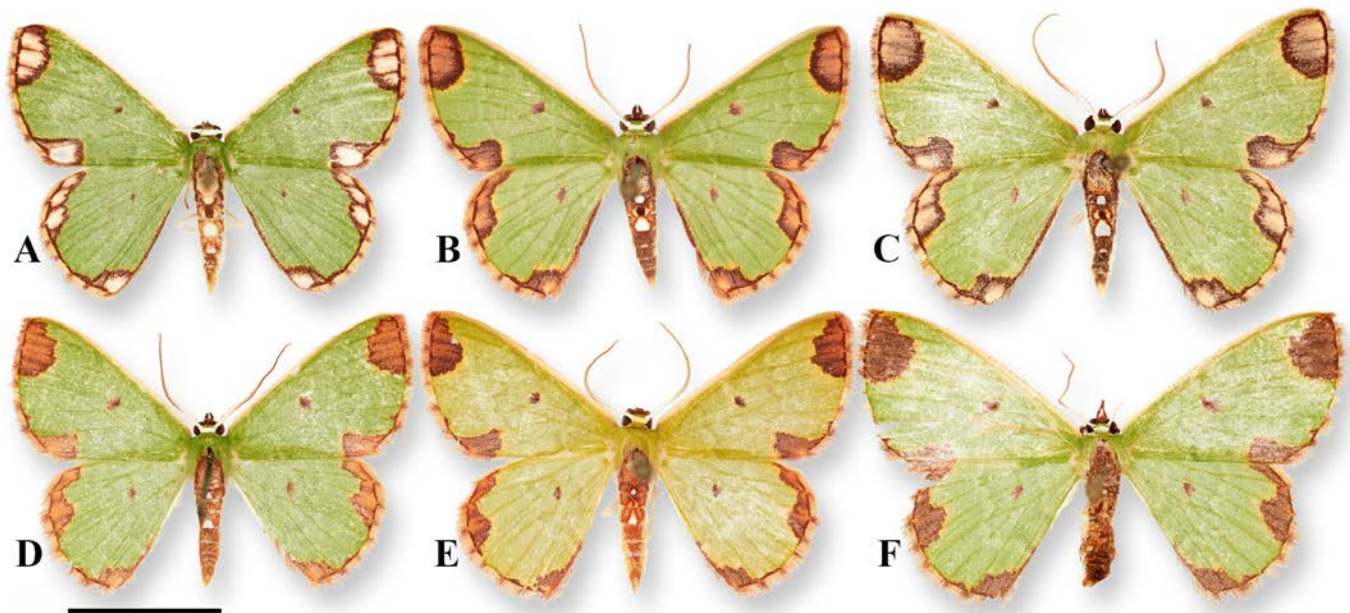


Figure 2. Other Costa Rican *Chavarriella*. **A,** *C. fallax*, 09-SRNP-103716 (USNM 01943243). **B,** *C. porcius*, 17-SRNP-104037 (USNM 01942607). **C,** *C. porcius*, 18-SRNP-101999 (USNM 01942644). **D,** *C. semiornata*, (USNM 01920520). **E,** *C. semiornata*, 17-SRNP-105049 (USNM 01942598). **F,** *C. semiornata*, (USNM 01920521). Scale bar = 1 cm.

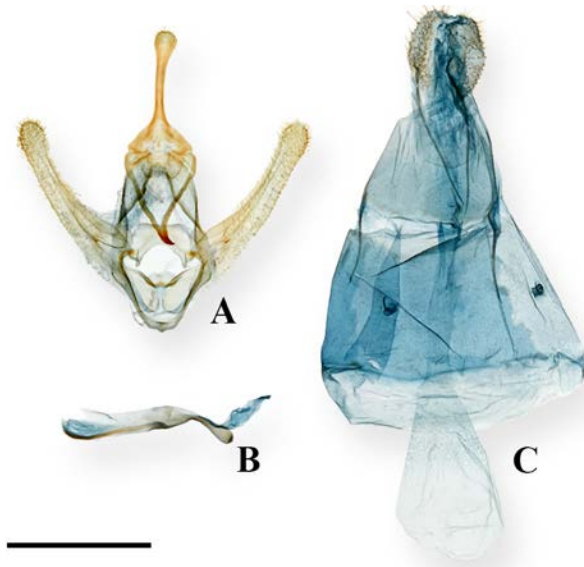


Figure 3. *Chavariella lindapitkinae* Matson, n. sp. genitalia. **A**, male genital capsule and **B**, phallus, genitalia slide: TAM-2024-527 (USNMI57126), 11-SRNP-33261 (USNMENT 01942694). **C**, female genitalia, genitalia slide: TAM-2024-528 (USNMI57127), 18-SRNP-31955 (USNMENT 01942687). Scale bar = 1 mm.

-85.37254°), el. 500 m, On *Ocotea atirrensis*, 19-VII-2018, ecl. 24-VIII-2018, Carolina Cano, 18-SRNP-1584, USNMENT 01942680, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, San Cristobal, Rio Blanco Abajo, (10.90037°, -85.37254°), el. 500 m, On *Ocotea atirrensis*, 19-VII-2018, ecl. 12-VIII-2018, Elda Araya, 18-SRNP-1583, USNMENT 01942681, [USNM] • 1♂, COSTA RICA: Guanacaste, ACG, Pitilla, Estacion Pitilla, (10.98931°, -85.42581°), el. 675 m, 28-II-2006, @ Light Trap, S. Rios & H. Cambronero, 06-SRNP-101245, USNMENT 01942682, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Laguna, (10.98880°, -85.42336°), el. 680 m, On *Ocotea atirrensis*, 31-III-2018, ecl. 06-V-2018, Manuel Rios, 18-SRNP-30350, USNMENT 01942683, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Laguna, (10.98880°, -85.42336°), el. 680 m, On *Ocotea atirrensis*, 08-XII-2004, ecl. 07-II-2005, Calixto Moraga, 04-SRNP-56742, USNMENT 01942684, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, Rincon Rain Forest, Albergue Oscar, Casa, (10.86627°, -85.32605°), el. 725 m, 11-II-2010, @ Light Trap, S. Rios & F. Quesada, 10-SRNP-104893, USNMENT 01942685, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, San Cristobal, Sendero Huerta, (10.93050°, -85.37223°), el. 527 m, On *Ocotea atirrensis*, 19-XI-2012, ecl. 03-I-2013, Elda Araya, 12-SRNP-5016, USNMENT 01942686, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Mismo, (10.98758°, -85.41967°), el. 680 m, On *Ocotea atirrensis*, 08-X-2018, ecl. 06-XI-2018, Petrona Rios, Genitalia slide: TAM-2024-528 (USNMI57127), 18-SRNP-31955, USNMENT 01942687, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, Rincon Rain Forest, Sendero Rincon, (10.89620°, -85.27769°), el. 430 m, On *Ocotea atirrensis*, 19-VIII-2014, ecl. 08-IX-2014, Anabelle Cordoba, 14-SRNP-43693, USNMENT 01942688, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Mismo, (10.98758°, -85.41967°), el. 680 m, On *Ocotea atirrensis*, 11-X-2018, ecl. 18-XI-2018, Manuel Rios, 18-SRNP-31980, USNMENT 01942689, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Mismo, (10.98758°, -85.41967°), el. 680 m, On *Ocotea atirrensis*, 20-XI-2018, ecl. 02-I-2019, Manuel Rios, 18-SRNP-32064, USNMENT 01942690 [missing abdomen], [USNM] • 1♂, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Mismo, (10.98758°, -85.41967°), el. 680 m, On *Ocotea atirrensis*, 08-X-2018, ecl. 16-XI-2018, Calixto Moraga, 18-SRNP-31940, USNMENT 01942691, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, San Cristobal, Rio Blanco Abajo, (10.90037°, -85.37254°), el. 500 m, On *Ocotea atirrensis*, 19-VII-2018, ecl. 31-VIII-2018, Carolina Cano, 18-SRNP-1582, USNMENT 01942692, [USNM] • 1♀, COSTA RICA: Alajuela, ACG, San Cristobal, Rio Blanco Abajo, (10.90037°, -85.37254°), el. 500 m, On *Ocotea atirrensis*, 19-VII-2017, ecl. 12-IX-2017, Gloria Sihezar, 17-SRNP-2010, USNMENT 01942693, [USNM] • 1♂, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Nacho, (10.98445°, -85.42481°), el. 710 m, On *Ocotea*

atirrensis, 21-IX-2011, ecl. 27-XI-2011, Petrona Rios, Genitalia slide: TAM-2024-527 (USNMI57126), 11-SRNP-33261, USNMENT 01942694, [USNM] • 1♀, COSTA RICA: Alajuela, ACG, San Cristobal, Sendero Perdido, (10.87940°, -85.38607°), el. 620m, On *Ocotea insularis*, 21-VII-2008, ecl. 30-VIII-2008, Osvaldo Espinoza, 08-SRNP-4385, USNMENT 01942695, [USNM] • 1♂, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Mismo, (10.98758°, -85.41967°), el. 680 m, On *Ocotea atirrensis*, 16-XII-2019, ecl. 09-I-2020, Freddy Quesada, 19-SRNP-31942, USNMENT 01942697, [USNM] • 1♀, COSTA RICA: Alajuela, ACG, Rincon Rain Forest, Camino Rio Francia, (10.90425°, -85.28651°), el. 410 m, On *Ocotea tenera*, 28-VIII-2011, ecl. 26-IX-2011, Anabelle Cordoba, 11-SRNP-43892, USNMENT 01942698 [missing abdomen], [USNM] • 1♀, COSTA RICA: Alajuela, ACG, San Cristobal, Sendero Huerta, (10.93050°, -85.37223°), el. 527 m, On *Ocotea atirrensis*, 19-XI-2012, ecl. 15-XII-2012, Elda Araya, 12-SRNP-5018, USNMENT 01942699, [USNM] • 1♂, COSTA RICA: Guanacaste, ACG, San Cristobal, Sendero Huerta, (10.93050°, -85.37223°), el. 527 m, On *Ocotea atirrensis*, 27-VII-2018, ecl. 22-VIII-2018, Gloria Sihezar, 18-SRNP-1622, USNMENT 01942700, [USNM] • 1♀, COSTA RICA: Alajuela, ACG, San Cristobal, Finca San Gabriel, (10.87766°, -85.39343°), el. 645 m, On *Ocotea insularis*, 09-VIII-2016, ecl. 31-VIII-2016, Gloria Sihezar, 16-SRNP-1203, USNMENT 01942701, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, San Cristobal, Rio Blanco Abajo, (10.90037°, -85.37254°), el. 500 m, On *Ocotea atirrensis*, 15-II-2007, ecl. 19-III-2007, Gloria Sihezar, 07-SRNP-767, USNMENT 01942702, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Memos, (10.98171°, -85.42785°), el. 740 m, On *Ocotea atirrensis*, 21-IX-2011, ecl. 01-XI-2011, Freddy Quesada, 11-SRNP-32731, USNMENT 01942703, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Cuestona, (10.99455°, -85.41461°), el. 640 m, On *Ocotea atirrensis*, 17-XII-2018, ecl. 10-I-2019, Freddy Quesada, 18-SRNP-32187, USNMENT 01942704 [missing abdomen], [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Memos, (10.98171°, -85.42785°), el. 740 m, On *Ocotea atirrensis*, 15-XI-2004, ecl. 28-XII-2004, Petrona Rios, 04-SRNP-56340, USNMENT 01942705 [missing abdomen], [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Cuestona, (10.99455°, -85.41461°), el. 640 m, On *Ocotea atirrensis*, 17-XII-2018, ecl. 08-I-2019, Freddy Quesada, 18-SRNP-32188, USNMENT 01942706 [missing abdomen], [USNM] • 1♂, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Mismo, (10.98758°, -85.41967°), el. 680 m, On *Ocotea atirrensis*, 08-X-2018, ecl. 28-XI-2018, Calixto Moraga, 18-SRNP-31941, USNMENT 01942707, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, San Cristobal, Sendero Huerta, (10.93050°, -85.37223°), el. 527 m, On *Ocotea atirrensis*, 01-XI-2013, ecl. 22-XI-2013, Elda Araya, 13-SRNP-5995, USNMENT 01942708, [USNM] • 1♀, COSTA RICA: Alajuela, ACG, San Cristobal, Sendero Huerta, (10.93050°, -85.37223°), el. 527 m, On *Ocotea atirrensis*, 14-XI-2013, ecl. 02-I-2014, Elda Araya, 13-SRNP-6538, USNMENT 01942709, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, San Cristobal, Sendero Huerta, (10.93050°, -85.37223°), el. 527 m, On *Ocotea atirrensis*, 14-XI-2013, ecl. 25-XII-2013, Elda Araya, 13-SRNP-6537, USNMENT 01942710, [USNM] • 1♀, COSTA RICA: Alajuela, ACG, San Cristobal, Sendero Huerta, (10.93050°, -85.37223°), el. 527 m, On *Ocotea atirrensis*, 24-II-2015, ecl. 23-III-2015, Gilbert Ampie, 15-SRNP-588, USNMENT 01942711, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Cuestona, (10.99455°, -85.41461°), el. 640 m, On *Ocotea atirrensis*, 12-IX-2018, ecl. 03-XI-2018, Freddy Quesada, 18-SRNP-31825, USNMENT 01942712 [missing abdomen], [USNM] • 1♂, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Mismo, (10.98758°, -85.41967°), el. 680 m, On *Ocotea atirrensis*, 08-X-2018, ecl. 26-XI-2018, Calixto Moraga, 18-SRNP-31942, USNMENT 01942713, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, San Cristobal, Rio Blanco Abajo, (10.90037°, -85.37254°), el. 500 m, On *Ocotea atirrensis*, 16-VIII-2020, ecl. 09-IX-2020, Gloria Sihezar, 20-SRNP-2424, USNMENT 01942714, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, San Cristobal, Rio Blanco Abajo, (10.90037°, -85.37254°), el. 500 m, On *Ocotea atirrensis*, 16-VIII-2020, ecl. 12-IX-2020, Gloria Sihezar, 20-SRNP-2426, USNMENT 01942716, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, San Cristobal, Rio Blanco Abajo, (10.90037°, -85.37254°), el. 500 m, On *Ocotea atirrensis*, 16-VIII-2020, ecl. 09-IX-2020, Gloria Sihezar, 20-SRNP-2425, USNMENT 01942715, [USNM] • 1♀, COSTA RICA: Alajuela, ACG, San Cristobal, Rio Blanco Abajo, (10.90037°, -85.37254°), el. 500 m, On *Ocotea atirrensis*, 16-VIII-2020, ecl. 09-IX-2020, Gloria Sihezar, 20-SRNP-2427, USNMENT 01942717, [USNM] • 1♂, COSTA RICA: Guanacaste, ACG, Pitilla, Sendero Evangelista, (10.98680°, -85.42083°), el. 660 m, On *Ocotea atirrensis*, 25-XI-2009, ecl. 19-XII-2009, Calixto Moraga, 09-SRNP-33379, USNMENT 01942718, [USNM] • 1♀, COSTA RICA: Alajuela, ACG, San Cristobal, Sendero Perdido, (10.87940°, -85.38607°), el.



Figure 4. *Chavariella* late instar larvae from ACG, Costa Rica. **A.** *C. lindapitkinae* Matson, *n. sp.*, reared on *Ocotea atirrensis*, 07-SRNP-32241 (reared adult absent from USNM). **B.** *C. lindapitkinae* Matson, *n. sp.*, reared on *Ocotea atirrensis*, 12-SRNP-31595 (pupa died of disease). **C.** **D.** *C. porcius*, reared on *Damburneya salicifolia*, 09-SRNP-35801 (USNMMENT 01942664).

620 m, On *Ocotea atirrensis*, 23-III-2013, ecl. 23-IV-2013, Carolina Cano, 13-SRNP-1508, USNMMENT 01942719, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, Rincon Rain Forest, Estacion Caribe, (10.90082°, -85.27640°), el. 391 m, 09-X-2007 @ Light Trap, F. Quesada & R. Franco, 07-SRNP-109027, USNMMENT 01942720, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, San Cristobal, Finca San Gabriel, (10.87766°, -85.39343°), el. 645 m, On *Ocotea atirrensis*, 08-IX-2013, ecl. 29-IX-2013, Carolina Cano, 13-SRNP-4685, USNMMENT 01942721, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, San Cristobal, Rio Blanco Abajo, (10.90037°, -85.37254°), el. 500 m, On *Ocotea atirrensis*, 22-IX-2012, ecl. 23-X-2012, Carolina Cano, 12-SRNP-4057, USNMMENT 01942722, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, San Cristobal, Sendero Colegio, (10.89296°, -85.37880°), el. 520 m, On *Nectandra hihua*, 21-VII-2017, ecl. 16-VIII-2017, Gloria Sihezlar, 17-SRNP-1754, USNMMENT 01942723, [USNM] • 1♀, COSTA RICA: Guanacaste, ACG, San Cristobal, Sendero Perdido, (10.87940°, -85.38607°), el. 620 m, On *Ocotea atirrensis*, 08-VII-2018, ecl. 05-VIII-2018, Elda Araya, 18-SRNP-1467, USNMMENT 01942724, [USNM] • 1♀, COSTA RICA: Alajuela, ACG, San Cristobal, Rio Blanco Abajo, (10.90037°, -85.37254°), el. 500 m, On *Ocotea atirrensis*, 22-IX-2012, ecl. 04-XI-2012, Carolina Cano, 12-SRNP-4059, USNMMENT 01942725, [USNM] • 1♂, COSTA RICA: Alajuela, ACG, San Cristobal, Estacion San Gerardo, (10.88009°, -85.38887°), el. 575 m, 21-XII-2006, @ Light Trap, R. Franco & H. Cambronero, 06-SRNP-109811, USNMMENT 01942726, [USNM] • 1♂, COSTA RICA: Heredia, 11km ESE La Virgen, (10°21'N, 84°03'W), INBio-OET-ALAS transect, Estacion Cantarrana, 03/L/00/048, 250-350m, 9-IV-2004, D.R. Davis, [USNM].

Etymology: *Chavariella lindapitkinae* is named for Linda Pitkin of the Natural History Museum (NHMUK), London, UK, in recognition of her 1990 course on moth genitalia and taxonomy taught to ACG parataxonomists at Costa Rica's

INBio and ACG, as well as her foundational publication on Costa Rican emerald moths (Pitkin, 1993).

Biology: In ACG, *C. lindapitkinae* has been reared 45 times from genera in the Supraocotea clade of Lauraceae (Penagos Zuluaga *et al.*, 2021), indicating a likely specialization on plants in this clade. It has been reared 41 times from *Ocotea atirrensis* Mez & Donn. Sm. ex Mez, twice from *Ocotea insularis* (Meisn.) Mez, once from *Ocotea tenera* Mez & Donn. Sm., and once from *Nectandra hihua* (Ruiz & Pav.) Rohwer. The moth is attracted to light traps infrequently or remains distant from the light source, as indicated by the abundance of reared individuals versus the limited number caught at light in the ACG. In general, emeralds are strikingly absent from ACG light traps (DHJ and WH).

Distribution: *Chavariella lindapitkinae* is currently known only from the Isthmian-Atlantic rainforests of northern and central Costa Rica, typically occurring at elevations between 250-750 m.

Molecular Data: COI barcodes of *C. lindapitkinae* fall within a single BIN: BOLD:AAA0804 (n=55, Costa Rica, Ecuador). The maximum pairwise distance within this BIN is approximately 2.57%, while the minimum distance to the nearest interspecific

neighbor is about 6.2%. The sole Ecuadorian individual within this BIN likely represents a related undescribed species, rather than *C. lindapitkinae*.

LARVAL BIOLOGY

The larval biology of *Chavarriella* is reported here for the first time, based on observations of two species, *C. lindapitkinae* (Figs. 4A, 4B) and *C. porcius* (Figs. 4C, 4D), reared from wild caught caterpillars in the intermediate-elevation rain forests of ACG in Costa Rica. Thus far, all known food plant records for *Chavarriella* are associated with the Supraocotea clade in the family Lauraceae (Penagos Zuluaga *et al.*, 2021).

In ACG, *Chavarriella lindapitkinae* has been reared 45 times, primarily from *Ocotea atirrensis*, but also from *Ocotea tenera*, *Ocotea insularis*, and *Nectandra hihua*. *Chavarriella porcius* has been reared only once, from *Damburneya salicifolia* (Kunth) Trofimov & Rohwer, a genus recently reinstated after *Nectandra* was determined to be diphyletic (Trofimov *et al.*, 2016).

DISCUSSION

Although four species of *Chavarriella* are now recognized from Central America, additional cryptic species may remain undescribed. To date, the genus is notably absent from Mexico, with its northernmost records reaching only as far as Nicaragua.

Pitkin (1993) adopted a conservative approach to species delimitation, and new data may suggest that one or more synonyms of *C. fallax* and *C. semiornata* may eventually require reinstatement. Unfortunately, we were unable to obtain material to determine whether a slightly variable form of *C. semiornata* observed on iNaturalist ([inaturalist.org/observations/106031758](https://www.inaturalist.org/observations/106031758)) from the Pacific coast of Puntarenas, southwestern Costa Rica, is conspecific with the more northern montane Costa Rican specimens currently identified as *C. semiornata* by TAM. Furthermore, the name *C. fallax* is tentatively applied in this manuscript to the Mesoamerican population, given that the type locality for this taxon is in South America.

Interestingly, among the four species recorded from ACG in Costa Rica, nearly all larval records (approximately 45) are of *C. lindapitkinae*, with only a single larval record of *C. porcius*. This is particularly notable given the relative abundance in museum collections of specimens of *C. semiornata* and *C. porcius*, presumed to come from light traps in Costa Rica.

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DNA barcoded under Costa Rican government permits issued to BioAlfa (Janzen and Hallwachs, 2019) (R-054-2022-OT-CONAGEBIO; R-019-2019-CONAGEBIO; National Published Decree #41767), JICA-SAPI #0328497 (2014) and DHJ and WH (ACGPI-036-2013; R-SINAC-ACG-PI-061-2021; Resolución N°001-2004 SINAC; PI-028-2021). We thank the reviewers for their comments on the manuscript.

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Morphology, natural history of the immature stages and larval shelter behavior of the Neotropical skipper *Quadrus cerialis* (Lepidoptera: Hesperiidae: Pyrginae)

Ricardo Russo Siewert^{1*} and André Victor Lucci Freitas²

1. Departamento de Ecologia e Evolução, Centro de Ciências Naturais e Exatas, Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul, Brazil.

2. Departamento de Biologia Animal and Museu de Diversidade Biológica, Instituto de Biologia, Universidade Estadual de Campinas, Rua Monteiro Lobato 255, 13083-862, Campinas, São Paulo, Brazil. *Corresponding author: ricardo.siewert@gmail.com

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Abstract: *Quadrus cerialis* (Stoll, 1782) (Hesperiidae: Pyrginae) is a widespread Neotropical butterfly. The morphology and natural history of the early stages of this butterfly are described and illustrated in detail herein based on specimens reared from southeastern Brazil. Larvae were reared on *Piper glabratum* Kunth (Piperaceae), remained inside the shelter almost the whole time, and built a two-cut shelter (type 5).

Keywords. Atlantic Forest, butterfly, caterpillar, *Piper*

Resumo: *Quadrus cerialis* (Stoll, 1782) (Hesperiidae: Pyrginae) é uma borboleta neotropical amplamente distribuída. A morfologia e a história natural dos estágios imaturos desta borboleta são descritas e ilustradas em detalhes com base em material obtido no sudeste do Brasil. As larvas foram criadas em *Piper glabratum* Kunth (Piperaceae), permaneceram dentro do abrigo durante todo o seu desenvolvimento e constroem abrigos com dois cortes (tipo 5).

Palavras chave. Mata Atlântica, borboleta, lagarta, *Piper*

INTRODUCTION

The neotropical skipper genus *Quadrus* Lindsey, 1925 belongs to the second most species rich Hesperiidae subfamily Pyrginae and comprises 42 recognized species (Zhang *et al.*, 2023). *Quadrus cerialis* (Stoll, 1782) (Fig. 1P) is a common and widespread species, occurring from Mexico to Argentina (Evans, 1953; Mielke, 2024). Adults are commonly found in sunlit areas, landing on top of the leaves with their wings open (Brown, 1992) but they also perch under a leaf in shady environments (Cock, 1996). Early stages of *Q. cerialis* have not been described in detail; the larva and pupa were described by Draudt (1917-1924) and Cock (1996), and their host plants are all species of *Piper* (Piperaceae) (Brown, 1992; Cock, 1996). Here, the immature stages of *Q. cerialis* from southeastern Brazil are described in detail, as well as general aspects of the natural history and larval shelter behavior of the species.

MATERIAL AND METHODS

Five eggs were obtained on plants of *Piper glabratum* Kunth (Piperaceae) on May 12, 2022 at Serra do Japi, an area of semi-deciduous forest located in the municipalities of Jundiáí and Cabreúva, in the state of São Paulo, southeastern Brazil. The immatures were reared individually in transparent 500 ml

plastic pots at room temperature, with fresh leaves of its host plant offered *ad libitum*, and larvae were checked daily for food replacement and cleaning when necessary. Head capsules were collected for further measurement. The measurements, duration of instars, and pupal development were recorded. Egg size is given as height and diameter; the head capsule width of larvae was considered to be the distance between the most lateral stemmata; the total length of the larvae and pupae were measured in dorsal view. General aspects of morphology were observed and photographed using a Zeiss SteREO Discovery V20 Stereomicroscope (Zeiss, Germany). This species is largely known by the name '*Q. cerialis*' from most of the Atlantic Forest, including the study site (Brown, 1992), and the wing pattern of our vouchers agrees with specimens identified as *Q. cerialis* in other Brazilian collections. However, we are aware that this group includes several cryptic species; to facilitate future study, voucher specimens are deposited in the entomological collection of Museu de Diversidade Biológica (MDBio) from Universidade Estadual de Campinas - Unicamp, Campinas, São Paulo, Brazil.

RESULTS

Description of immature stages

Egg (Fig. 1A, B). White and hemispherical, with 11 vertical ribs. Dark

head capsule of larva becomes visible near hatching (Fig. 1B). Height: 0.85-0.87 mm (n = 5); diameter: 1.02-1.04 mm (n = 5); duration: 3-8 days (n = 5).

First instar (Fig. 1C). Head capsule width 0.49 mm; body length 3.60 mm. Head black, smooth, without scoli; body smooth, translucent light green; dorsal prothoracic plate black on T1; legs and prolegs light green. Duration 7-8 days.

Second instar (Fig. 1D). Head capsule width 0.75 mm; body length 7.94 mm. Similar to first instar; prothoracic plate black, smaller than on first instar; tracheal system visible; males with a pair of gonads dorsally visible on A6. Duration 9 days.

Third instar (Fig. 1E). Head capsule width 1.03 mm; body length 11.7 mm. Similar to previous instars; prothoracic plate absent; tracheal system visible, forming a lateral white line connecting spiracles. Duration 5-7 days.

Fourth instar (Fig. 1F). Head capsule width 1.11 mm; body length 16.37 mm. Similar to third instar, but larger. Duration 8 days.

Fifth (last) instar (Fig. 1G). Head capsule width 1.24 mm; body length 16.49 mm. Head light brown with darker lateral areas; body green, darker compared to fourth instar; males with a pair of gonads dorsally visible on A6. Pre-pupa (Fig. 1H) became completely white, with small scattered black marks on all segments. Duration 9 days.

Pupa (Figs 1I, J, K). Length: 15.5 mm. Slightly elongated and smooth; completely white, with abdominal segments ventrally black with a pair of white dots in segments A5-A6. Attached to leaf by a silk girdle in thoracic region. Duration 14 days.

Natural history and larval behavior

The eggs were found isolated on the upper surface of *Piper glabratum*. After hatching, the larva eats the chorion, moves to the leaf margin and builds a rounded shelter (Fig. 1N, O). During its life cycle, the larvae of *Q. cerialis* build one type of shelter, a two-cut shelter (Type 5 of Greeney, 2009). The larvae remained almost the whole time inside the shelter, leaving only to feed. Larvae of 4th and 5th instars were observed throwing fecal pellets with the aid of an anal comb (Fig. 1L, M) present in A10.

DISCUSSION

The most recent molecular phylogeny of Hesperiiidae recovered *Ouleus* Lindsey, 1925 and *Zera* Evans, 1953 as subgenera of *Quadrus* (Zhang *et al.*, 2023). Additionally, five new subgenera have been proposed for *Quadrus*: *Trifa* Grishin, 2023, *Tuberna* Grishin, 2023, *Ebona* Grishin, 2023, *Noctis* Grishin, 2023 and *Cyrna* Grishin, 2023 (Zhang *et al.*, 2023). In the same study, *Gindanes* Godman & Salvin, 1895 was recovered as the sister genus of *Quadrus*. However, despite similarities between the immature stages of some nearby genera and those of *Quadrus*, broad comparisons are not currently possible due to a lack of comprehensive knowledge about the group.

The immature stages of *Quadrus (Quadrus) contubernalis* (Mabille, 1883), *Quadrus (Zera) hosta* (Evans, 1953), and *Quadrus (Cyrna) cyrna* (Mabille, 1895) are very similar to *Q. cerialis*, presenting the same morphological pattern, including the shape of the head capsule. The last species also feeds on *Piper* species, while *Q. contubernalis* and *Q. hosta* feed on several species of Lauraceae (Young, 1991; Janzen & Hallwachs,

2009). Other species from the genus, such as *Quadrus (Tuberna) deyrollei* (Mabille, 1877) and *Quadrus (Quadrus) lugubris* (R. Felder, 1869), also feed on *Piper* species (Young, 1991). The morphology of the early stages of *Q. cerialis* from southeastern Brazil is very similar to those reared from Área de Conservación Guanacaste, Costa Rica (Janzen & Hallwachs, 2024), and also to *Q. contubernalis*, presenting the same overall morphological patterns, including pupa with abdominal segments black with a pair of white dots (Young, 1991). Detailed descriptions of more species of *Quadrus* and related genera could help to understand how similar are the immature stages, and if there are any subtle differences between genera and species of this group.

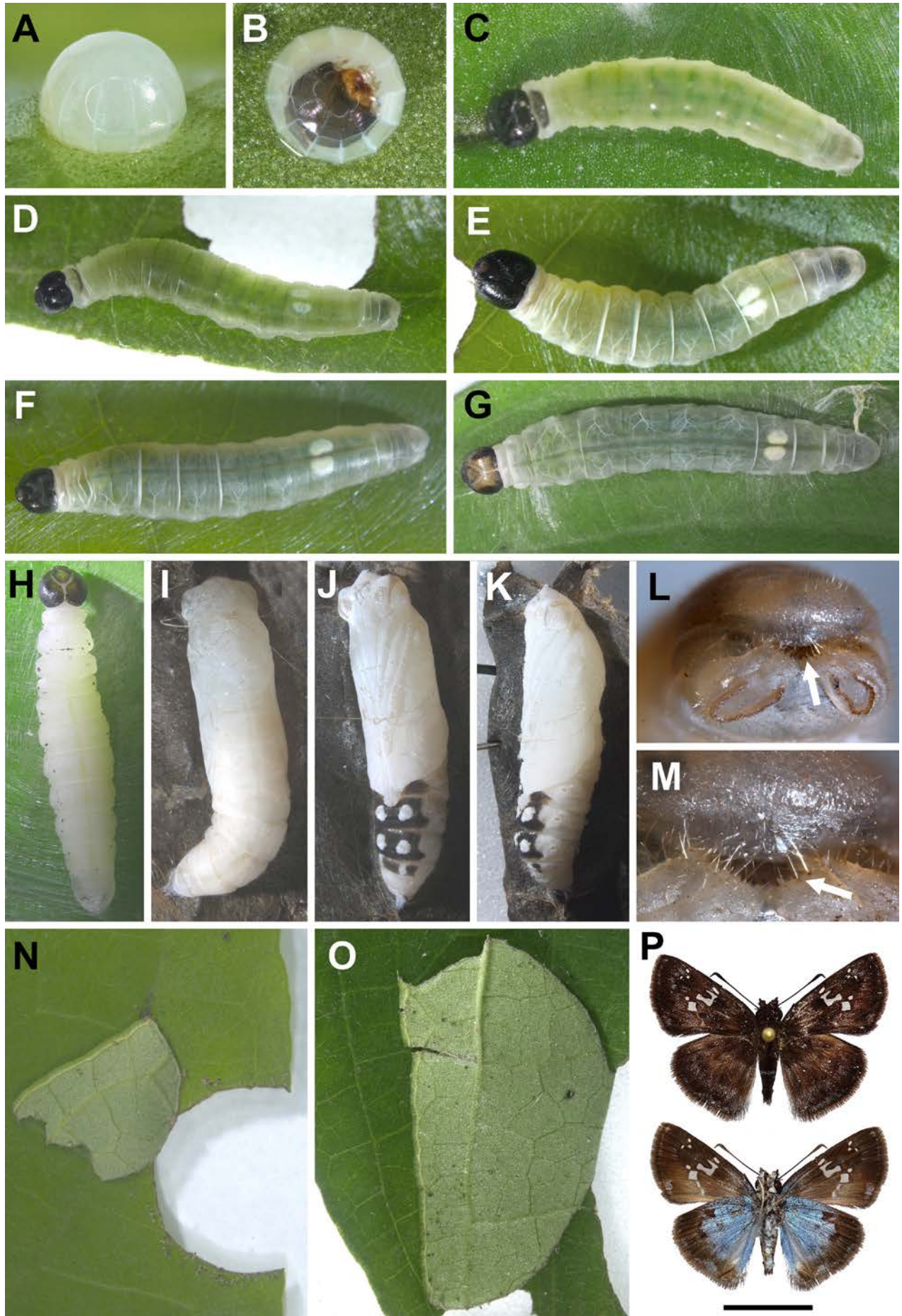
According to the classification scheme for shelter building in skippers (Greeney & Jones, 2003; Greeney, 2009), the larvae of *Q. cerialis* built only a type 5 shelter, which consists of a rounded cut from the leaf margin, folding the leaf cut and maintaining it attached with silk. The same type of shelter was registered in *Q. cerialis* reared in Costa Rica, and in *Q. contubernalis* (Young, 1991; Greeney, 2009). However, the shelters built by these two species present perforations, which are modifications made by feeding damage (Greeney, 2009). These perforations were not recorded on the shelter built by *Q. cerialis* in the present study. In addition, Greeney (2009) reported that last instars of *Quadrus* construct one-cut shelters (Type 4), not observed in our study. These differences could be related to the rearing conditions in the laboratory, which could affect larval behavior. In fact, one-cut shelters with perforations have been reported for *Q. cerialis* in the wild, both in the study site and in other localities (e.g., Kaminski 2022; AVLF pers. obs.).

As previously described, larvae of *Q. cerialis* were observed throwing fecal pellets with the aid of an anal comb. Frass ejection has been reported for almost 20 families of Lepidoptera, being especially prevalent in shelter-building caterpillars (Weiss, 2003, 2006). Previous studies have suggested that frass may act as a chemical and visual cue to natural enemies (Moraes *et al.*, 2012 and references therein), especially wasps and ants (Weiss, 2003; Moraes *et al.*, 2012; Bächtold *et al.*, 2012, 2017). Whether frass ejection away from the host plant plays a role in reducing the risk of predation on caterpillars of *Q. cerialis* requires investigation.

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Figure 1 (facing page). Early stages and larval shelter behavior of *Quadrus cerialis* reared on *Piper glabratum* Kunth (Piperaceae): (A) Egg, lateral view; (B) Egg, dorsal view with head capsule of first instar apparent; (C) First instar, dorsal view; (D) Second instar, dorsal view; (E) Third instar, dorsal view; (F) Fourth instar, dorsal view; (G) Fifth instar, dorsal view; (H) Pre-pupa, dorsal view; (I, J, K) Pupa, dorsal ventral, lateral; (L, M) Two views of the last segment of the fifth instar showing the anal comb (arrow); (N, O) Shelters of first and fifth instar, respectively; (P) Adults male, dorsal above and ventral below (black bar = 1 cm).



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Description of the early stages of Salvin's Kite-Swallowtail (*Eurytides salvini*), from Honduras (Lepidoptera: Papilionidae)

Robert J. Gallardo

La Unión Suyapa, Las Vegas, Santa Bárbara, Honduras; email: rgallardo32@gmail.com

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Abstract: The early stages of *Eurytides salvini* (Bates, 1864) are described for the first time after a female was detected ovipositing on a small tree inside montane forest in western Honduras. Two eggs were collected, and both larvae were reared successfully to the pupal and eclosion stages. The hostplant, *Desmopsis dolichopetala* R.E.Fr. (Annonaceae), is endemic to the highlands of Honduras.

Resumen: Las primeras etapas del ciclo de vida de *Eurytides salvini* (Bates, 1864) son descritas por primera vez después del hallazgo de una hembra poniendo huevecillos sobre un árbol pequeño dentro de un bosque montano en el occidente de Honduras. Se recogió dos huevecillos, y ambas larvas fueron criadas exitosamente hasta las etapas de crisálida y eclosión. La planta hospedera, *Desmopsis dolichopetala* (Annonaceae), es endémica a las tierras altas de Honduras.

Key Words: Annonaceae, *Desmopsis*, endemism, Honduras, immatures, Lake Yojoa, montane forest, pupa.

INTRODUCTION

The genus *Eurytides* contains forty-six currently recognized species (Warren *et al.*, 2025) and is widely distributed throughout the New World, with most species occurring in the tropics. Eleven species have been reported for Honduras (Gallardo & Diaz, 2023). Salvin's Kite-Swallowtail (*E. salvini*) is a regionally endemic species that occurs from southern Mexico to central Honduras. Although it is listed as occurring in Honduras (Miller *et al.*, 2012), I had never observed this distinct species during more than thirty years of residing and carrying out butterfly inventories throughout the country. In Mexico, *E. salvini* is known only from the states of Oaxaca and Chiapas (De la Maza pers. comm.), and from there it ranges south to Guatemala, southern Belize, and into Honduras.

Published information on the natural history of this species is scant. Most observations are of males puddling on moist sand or soil. In terms of habitat preference, it appears that the species occurs in forest habitats on limestone and karstic formations (J. Shuey pers. comm. for Belize). Most records are from below 600m elevation (Warren *et al.*, 2025). Females of this species are rare in collections (Möhn, 2002), and none of its early life history or food plant relationships have ever been observed. Known food plants for other *Eurytides* species in the region within various genera include *Annona*, *Rollinia*, *Xylopia* (Annonaceae), and *Guatteria* (Annonaceae) (DeVries, 1987), and *Nectandra* (Lauraceae) (Beccaloni *et al.*, 2008). Here, I describe the history of *E. salvini* based on observations in Honduras.

On 29 April 2022, the author, Vernie Aikins (VA), and Leonel Chávez (LC, local guide) were hiking along a trail

inside montane forest at 1920 m in Santa Bárbara National Park (SBNP) near the community of El Cedral, Santa Bárbara (14°54'22.25"N, 88°06'06.79"W). This isolated mountain range reaches a maximum altitude of 2744 m and is comprised primarily of karstic formations. At 11:33 hrs I noticed a large, white, tailed butterfly inspecting a small tree growing in the forest understory (Fig. 1A). It alighted several times on new growth and VA took several in-flight photographs (Fig. 1D). From the photographs, we were able to determine that it was, in fact, ovipositing. We gathered several branches, carefully inspected the leaves, and found two eggs. Each egg was placed along the edges of the upperside of each leaf. The photos of the female taken by VA were sent to several taxonomists for consultation, and all agreed that the species was *Eurytides salvini*.

METHODS

The eggs and fresh leaves were taken to the author's residence at Emerald Valley International Butterfly Center approximately 11 km away from the locality, El Cedral, where they were collected. On 2 May 2022 both larvae hatched and were reared inside a five gallon bucket with a cloth mesh on top. They were fed with an ample supply of fresh cuttings of the native food plant placed in a jar with water covered with plastic, for the duration of the larval stages. Five additional trips were made to El Cedral where LC provided fresh food plant. Additional leaves with stems were stored in water in a bottle, covered in a plastic bag, and placed inside a refrigerator to retain freshness.

To identify the food plant, the leaves, an inflorescence

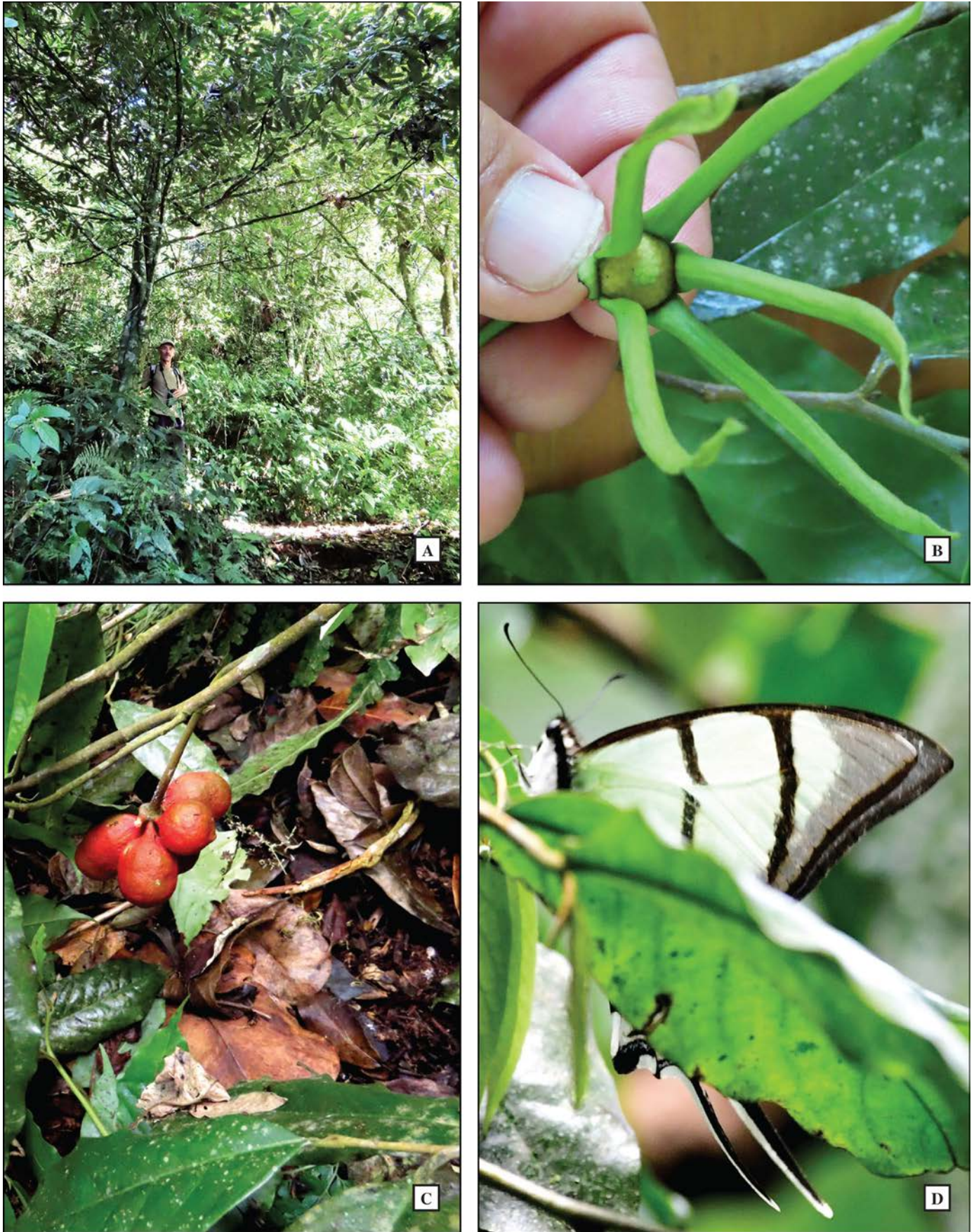


Figure 1. Hostplant of *Eurytides salvini*. **A.** Leonel Chavez standing next to *Desmopsis dolichopetala* within Santa Barbara National Park. **B.** Inflorescence of *Desmopsis dolichopetala*. **C.** Mature fruits of *Desmopsis dolichopetala*. **D.** Female *Eurytides salvini* ovipositing on food plant in cloud forest. Photo courtesy of Vernie Aikins.

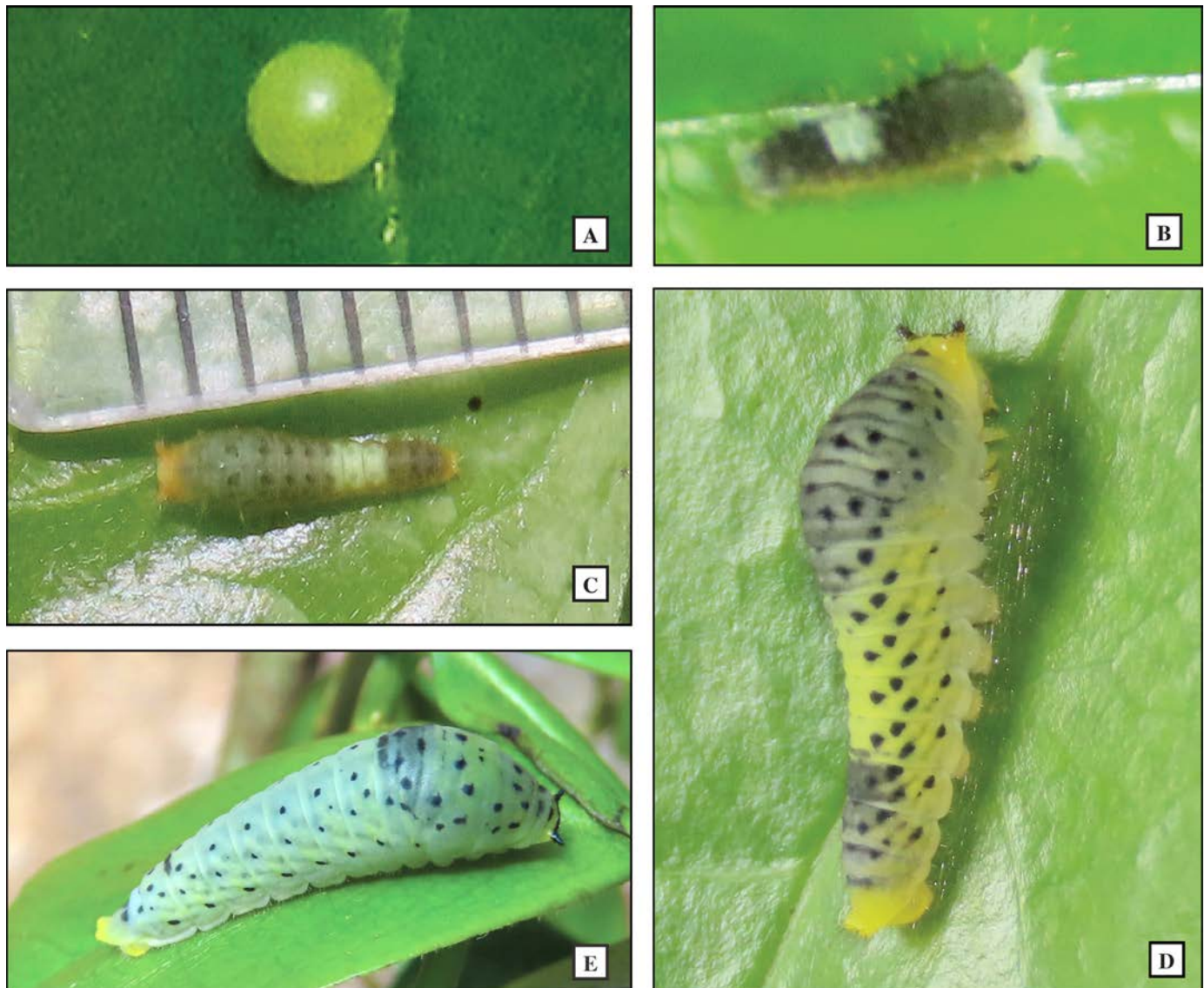


Figure 2. Early stages of *Eurytides salvini*. **A.** Ova on *Desmopsis dolichopetala* leaf. **B.** First instar larva. **C.** Second instar larva. **D.** Third instar larva. **E.** Fourth instar larva.

(Fig. 1B), and both ripe (Fig. 1C) and unripened fruit were collected and taken to Emerald Valley for inspection. There, measurements and photographs were taken, including those of the dissected ripened fruit and seeds. The images were sent to several botanists in Honduras and in the United States for identification.

RESULTS

Hostplant: The hostplant was identified as *Desmopsis dolichopetala* R.E.Fr. (Annonaceae).

Eurytides salvini early stages

Ova: pale green, unsculptured, and 1 mm in diameter (Fig. 2A).

First-instar larvae: On 2 May 2022 both larvae hatched and measured 2 mm in length. The dorsal color was brownish-green with a white patch on abdominal segments 3-5. The terminal segment was white, as well as the head capsule, which was adorned with two tubercles. The head capsule was black. Each

thoracic and abdominal segment had two small tubercles at the edge of the dorsum, each one possessing fine hairs (Fig. 2B).

Second-instar larvae: On 4 May 2022, the larger larva measured 5 mm in length. The overall body color changed to an olive-green, but retained the white patch on segments 3-5. The small tubercles on each thoracic and abdominal segment were highly reduced, but retained some fine hairs. The sides of the head capsule, tubercles, and terminal segment were a dark yellow while the front of the head capsule remained black (Fig. 2C).

Third-instar larvae: On 8 May 2022, the larger larva measured 8 mm in length and had undergone a drastic color change. The thoracic segments and the dorsal side of the first and last three abdominal segments were olive-green. The terminal abdominal segment and head capsule were bright yellow while the tips of the tubercles on the head were black. There was a small, black marking at the base of each tubercle on the head, and the front of the head capsule was a pale green. The remainder of the abdominal segments were a dull yellow and most of the body



Figure 3. Late instar, pupa, and eclosion of *Eurytides salvini*. **A.** Fifth instar larva. **B.** Pre pupa. **C.** Pupa. **D.** Freshly emerged adult.

was sparsely marked with prominent black spots of varying shapes. The larva no longer possessed tubercles or fine hairs on each segment (Fig. 2D).

Fourth-instar larvae: On 11 May 2022, the larger larva measured 24 mm in length and underwent another drastic color change. The majority of the body was pale green and possessed fewer, and smaller, black spots per segment. There was a black wash across some of the thoracic segments. The tip of the terminal segment and last pair of prolegs were yellow. The head capsule was yellow with black tubercles, a black line that connected the tubercles, and two black, oblong spots toward the backside of the head capsule (Fig. 2E).

Fifth/last-instar larvae: On 15 May 2022, the largest larva measured 35 mm in length and underwent one final color change. The entire body was bright green and the spotting further reduced. The terminal segment, last pair of prolegs, and the area surrounding the tubercles on the head were greenish-yellow. The tubercles remained black, but the black line was now divided into two separate bars (Fig. 3A).

Prepupae: On 22 May 2022, both larvae were in pre-pupal stage, having attached themselves to the undersides of the leaf petioles (Fig. 3B).

Pupa: Both pupae were bright green with a prominent projection in the head capsule area. Dark brown markings were present on the projection and head capsule area. The ventral side of the thoracic segments possessed a small, brown, t-shaped marking. The ventral side of the 5th abdominal segment possessed two dark, small, oblong spots (Fig. 3C). Both pupae were attached to the petiole on the underside of leaves.

After one year, there were no signs that either pupa was going to eclose. In early September 2023, Olivia Díaz began to mist-spray the pupae daily and placed them directly in the sun for 5-10 minutes. By late September, one had turned a pale green and was apparently going to eclose. On 1/10/2023, the first adult eclosed (Fig. 3D), and the second one on 18/10/2023.

Both were males and were incorporated into the collection at Emerald Valley (Figs. 4A and 4B). The pupal cases were also preserved.

DISCUSSION

The known range and habitat of the food plant recorded in this study, *Desmopsis dolichopetala*, is limited, so other food plants must presumably be utilized across the larger range of *E. salvini*. This small tree is endemic to the highlands of western Honduras and is known from only two botanical specimens, including one from SBNP. The species is known from a narrow altitudinal range between 1400-1800m (Schatz *et al.*, 2018). Interestingly, within Papilionidae, *Eurytides philolaus* is the only other species reported to utilize *Desmopsis* as a food plant (Beccaloni *et al.*, 2008).

The early instar larva of *Eurytides orabilis* Butler, 1872, ranging from Costa Rica to Colombia, differs by being mostly velvet black with a white V-shaped saddle on the posterior third segment. Its mature larva is olive green except for pairs of black spots along the dorsum. Its pupa is similar in color and shape to *E. salvini*, but lacks any distinct markings (DeVries, 1987). The location of the attachment, pupa shape, color, and markings in *E. salvini* are virtually identical to those of *Eurytides dolicaon* Cramer, 1775 (Tyler *et al.*, 1994). The last instar larva of *Eurytides protesilaus dariensis* Rothschild & Jordan, 1906, ranging from Costa Rica to N. Venezuela, is larger, and is bright green with a series of different shaped brown markings on the dorsal side of most segments. Its pupa is more angular in shape and has a proportionately larger projection in the head capsule area (Warren *et al.*, 2025).

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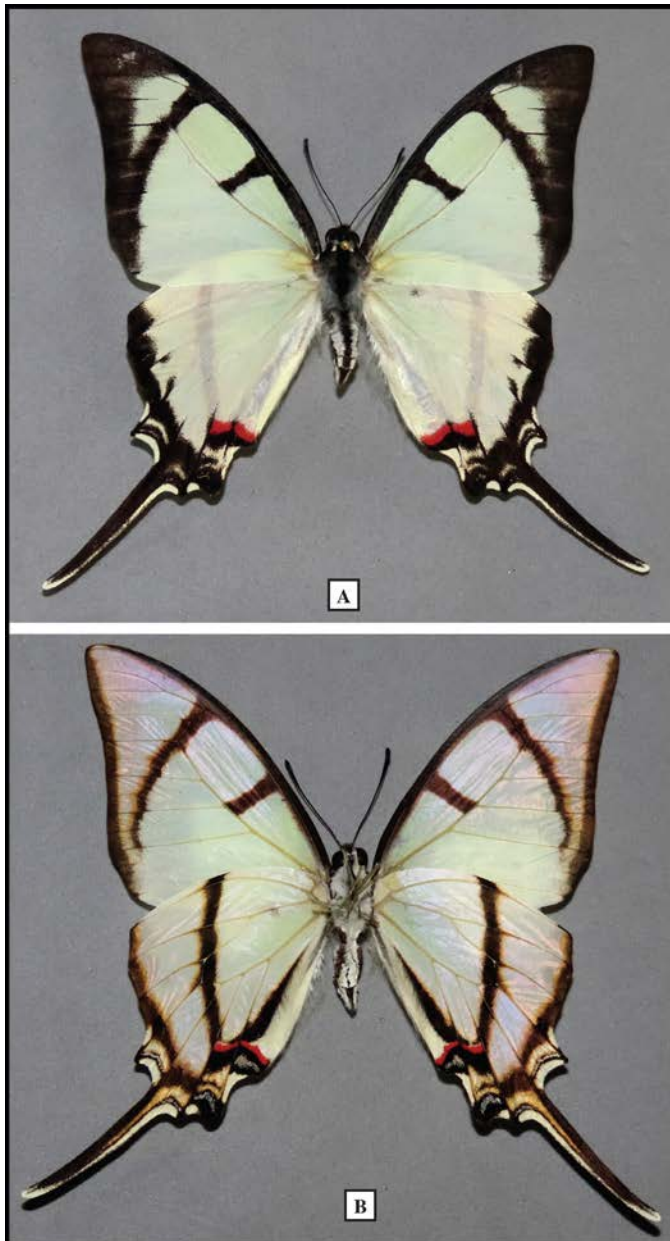


Figure 4. Pinned adult male of *Eurytides salvini*. **A.** Dorsal view. **B.** Ventral view.

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A new species of *Gymnandrosoma* Dyar from Florida, USA, the Bahamas, and Central America (Lepidoptera: Tortricidae)

James Hayden¹, Deborah L. Matthews², John Brown³, Alicia Timm⁴ and Megan X. Neal⁵

1. Florida State Collection of Arthropods, Florida Department of Agriculture and Consumer Services - Division of Plant Industry, 1911 SW 34th Street, Gainesville, FL 32605 USA (james.hayden@fdacs.gov) <https://orcid.org/0000-0003-1802-1064>.
2. McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611 USA (dlott@flmnh.ufl.edu) <https://orcid.org/0000-0002-2146-1055>.
3. Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20013-7012, USA (tortricidae.jwb@gmail.com) <https://orcid.org/0000-0001-5610-9855>.
4. Department of Agricultural Biology, Colorado State University, Fort Collins, CO 80523-1177 (Alicia.Timm@colostate.edu) <https://orcid.org/0000-0002-5800-5512>.
5. McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611 USA (mxiumei.neal@ufl.edu).

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Abstract: *Gymnandrosoma orarum* Hayden, **new species**, is described and illustrated from southern Florida, The Bahamas, Belize, and Costa Rica. It is most closely related to *Gymnandrosoma desotatum* Heinrich, but it can be distinguished by morphological features of the male and female genitalia and by DNA barcodes (i.e., sequence data from the mitochondrial gene cytochrome oxidase subunit I). *Gymnandrosoma orarum* is attracted to the lure of *Gymnandrosoma aurantianum* Lima, whereas *G. desotatum* is attracted to the lure of *Thaumatotibia leucotreta* (Meyrick). The oldest known specimens of *G. orarum* were collected in the Tampa Bay area of Florida in 1986.

Key words: DNA barcodes; *Ecdytolopha* group; genital morphology; Grapholitini; pheromones.

INTRODUCTION

As currently defined (Hu *et al.*, 2023), the *Ecdytolopha* group (tribe Grapholitini) comprises ten genera worldwide: *Ecdytolopha* Zeller, *Gymnandrosoma* Dyar, 1904, *Pseudogalleria* Ragonot, *Cryptophlebia* Walsingham, *Thaumatotibia* Zacher, *Thaumatovalva* Timm and Brown, *Thylacandra* Diakonoff, *Dracontogena* Diakonoff, *Multiquaestia* Karisch, and *Archiphlebia* Horak and Komai. The genera are scattered across the globe, from Australia, Asia, and Africa, to the New World. The group includes many economically important pests of fruit that are the targets of monitoring by agricultural regulatory agencies, of which two, False Codling Moth (*Thaumatotibia leucotreta* (Meyrick)) and Citrus Fruit Borer (*Gymnandrosoma aurantianum* Lima), are relevant to the present publication. The *Ecdytolopha* group has received considerable attention since its recognition (Diakonoff, 1957; Komai, 1999; Adamski & Brown, 2001; Horak & Komai, 2016) owing to the pest status of many of its members, its broad geographic distribution, and the documented invasiveness of some species.

Within the *Ecdytolopha* group, *Gymnandrosoma* comprises nine described species (Gilligan *et al.*, 2018). The adults and genitalia of most were illustrated by Adamski & Brown (2001), along with lists of their documented host plants. The

males of many species of *Gymnandrosoma* have secondary sexual characters, such as scale tufts, modified antennae, and scent-releasing wing scales (e.g., hairpencils), that are externally visible and often diagnostic at the species level. Nonetheless, many specimens must be dissected to confirm their identification. *Gymnandrosoma desotatum* Heinrich is one of the species for which dissection is usually necessary because males lack unique external secondary characters. In contrast to males, dissection is necessary for identification of virtually all females of *Gymnandrosoma* because secondary sexual characters are lacking.

Heinrich (1926) described *G. desotatum* from Florida, Dade County (now Miami-Dade Co.). It occurs most commonly in mangrove swamps in the state, and its known larval hosts are propagules of mangroves (Adamski & Brown, 2001). In 2014 and 2018, DM and JH respectively collected specimens of *G. desotatum* that differed from the typical form of the species in genitalic morphology. DM observed the variation first in specimens from The Bahamas, and JH independently noted the same differences in specimens collected at light in the Florida Keys in surveys by the Cooperative Agricultural Pest Survey (CAPS) and by independent moth collectors. After comparing notes, they found additional specimens collected in previous decades and deposited in the McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History. Although

the two species do not have obvious, consistent differences in maculation, the shape of the lamella postvaginalis in females and the shape of the sacculus of the male valvae consistently differ between the recently collected specimens and those of *G. desotatum*.

Many grapholitines share the same female pheromone attractant ((E)-8-dodecenyl acetate, or E8-12Ac) and its enantiomer Z8-12Ac (Komai, 1999; El-Sayed, 2024), and male moths of non-target species are regularly attracted to traps baited with the same lure. The United States Department of Agriculture (USDA) and the Florida Department of Agriculture and Consumer Services - Division of Plant Industry (FDACS-DPI) have monitored for *Thaumatotibia leucotreta* since 1984, and *G. desotatum* has been collected occasionally in traps baited with *T. leucotreta* lure, evidenced by specimens in the McGuire Center. In 2021, the Florida CAPS program began to monitor for *G. aurantianum* with a lure developed specifically for that species. The species detailed above and described below is reliably attracted to *G. aurantianum* lure when the traps are placed near coastal swamps.

In addition to morphological and pheromonal differences, sequencing of mtDNA COI (i.e., barcode) (Hebert *et al.*, 2004) revealed base-pair differences between the two entities consistent with species-level separation. The results linked specimens from Florida and The Bahamas with specimens from Belize and Costa Rica. The purpose of this contribution is to describe this species of *Gymnandrosoma* based on the aforementioned differences.

MATERIALS AND METHODS

Specimens were examined in the collection of the McGuire Center for Lepidoptera and Biodiversity, Gainesville, Florida (MGCL); the Florida State Collection of Arthropods, housed in the MGCL (FSCA); the Pest Identification Technology Laboratory, Fort Collins, Colorado (PITL); and the National Museum of Natural History, Smithsonian Institution, Washington, DC (NMNH). Specimens from The Bahamas were collected as part of comprehensive inventories of islands, sorted to morphospecies, and representatives dissected to facilitate identification. The specimens were collected at mercury vapor illuminated sheets, frozen in Kimwipe™ layers, and later relaxed overnight before pinning. The majority of Florida specimens were collected with ultraviolet light traps. Some specimens were collected in Delta traps serviced by CAPS between Federal and State agencies following Approved Methods (CAPS, 2015). Trap lures were designed for the target *Gymnandrosoma aurantianum* with primary attractant compounds E8-12Ac and E8-12OH. Moths in sticky traps were removed with Histo-clear 2 at 50°C; legs were removed for DNA extraction before rehydration and pinning.

Methods of dissecting genitalia followed Robinson (1976). Genitalia were stained with either Chlorazol black or Eosin Y, and wings with the latter. Eosin Y was a 1% solution in 70% ethanol, acidulated with 12 parts solution to 1 part 5% acetic acid. Parts were slide-mounted in Euparal. Morphological terms follow Adamski & Brown (2001).

Images of moth genitalia mounted on glass slides were

captured using a Leica DM6 microscope equipped with a Leica DMC6200 camera. To ensure the capture of detailed information across the entire specimen, a stack of 20 images was acquired for each slide at different z-planes, covering the entire focal depth. Stacks were then aligned and stacked using the Dmap algorithm in Zerene Stacker Version 1.04 Build T2022-04-21-0715. Stacked images were further processed using Adobe Photoshop 23.5.1, adjusting for brightness, contrast, and color balance. Dust artifacts in the stacked image were removed taking care that no content-altering modifications were made. The images were postprocessed, the venation in Fig. 12 was traced, and the figures were assembled with GIMP 2.10 (Kimball *et al.*, 2019). The map was prepared with georeferenced specimens with SimpleMappr (Shorthouse, 2010).

Preliminary COI sequencing was done by the FDACS-DPI Molecular Diagnostics Laboratory by standard methods (Hebert *et al.*, 2004). Final COI sequencing was performed at Colorado State University for specimens of *G. desotatum*, *G. orarum* **new species**, *G. aurantianum*, and *G. leucothorax* Adamski & Brown. One leg was removed from each specimen, which was then pulverized using 2.3mm zirconia/silica beads in a mini-beadbeater (Biospec Products, Bartlesville, OK). Larval specimens were sampled non-destructively and are stored in 100% ethanol at the NMNH or PITL. DNA was extracted using the Lucigen MasterPure Complete DNA and RNA Purification Kit (Lucigen Corporation, Middleton, WI). Extracts are stored at -80°C at the PITL. DNA was amplified with the primer sets LepF1 and LepR1 (Hebert *et al.*, 2004), LCO1490 and HCO2198 (Folmer *et al.*, 1994) or LCO1490 and MlepR2 (Hebert *et al.*, 2013). Thermocycling and sequencing conditions were as described in Gilligan *et al.* (2019), although amplification products were purified with Exo-SAP-IT PCR Product Cleanup Reagent (Applied Biosystems, Foster City, CA, USA). Sequences were visually examined for quality, assembled, trimmed and consensus sequences generated using Geneious Prime® 2021.0.3. DNA barcode sequences of *G. gonomela* (Lower), *G. leucothorax*, *G. desotatum* and *G. orarum* were obtained from BOLD Systems (Ratnasingham & Hebert, 2007, www.boldsystems.org) and included in analyses. Specimen and genetic sequence numbers are in Table 1.

To examine *Gymnandrosoma* within a broader phylogenetic framework, several outgroup species were included based on their relationship to *Gymnandrosoma* (Hu *et al.*, 2023). Nuclear gene sequences were included for most of these outgroup species, as well as for *G. punctidiscanum* and *G. aurantianum*, to improve support values. Outgroups included *Aspila molesta* (Busck) and *A. funebrana* Treitschke, both of which are outside the *Ecdytophaga* group, and *Cryptophlebia ombrodelta* (Lower), *Thylacandra knysna* (Brown and Timm), *Thaumatotibia leucotreta*, *T. batrachopa* (Meyrick), *Pseudogalleria inimicella* (Zeller), *Ecdytophaga occidentana* Adamski & Brown, *E. insiticiana* Zeller, *E. nigrita* (Brown), *E. palmetum* (Heinrich), and *Dracontogena continentalis* Karisch, all of which are within the *Ecdytophaga* group. Since partial sequence data for five nuclear genes, including carbamoyl-phosphate synthetase II (CAD - 2193 bp), elongation factor 1 alpha (EF1a - 2101 bp), glyceraldehyde-3-phosphate dehydrogenase GAPDH - 691 bp), cytosolic malate dehydrogenase (MDH - 407 bp), and wingless

(396 bp), were available for these outgroup species (Hu *et al.*, 2023), they were included in analyses with COI (657 bp). Partial sequence data for these nuclear genes were also included for *G. aurantianum* and *G. punctidiscanum*. DNA barcode data for *Lusterala phaseolana* Brown & Nishida was included as an additional outgroup. Sequence alignments were implemented using MAFFT (Kato & Standley, 2013) in Geneious Prime. When considering nuclear and COI sequences, partition models for the dataset were selected using IQ-TREE (Nguyen *et al.*, 2015), as implemented through the CIPRES Science Gateway (Miller *et al.*, 2010). Resulting partitions and substitution models for each were used in the Bayesian analysis, conducted using MrBayes (Huelsenbeck & Ronquist, 2001) as a plugin from Geneious Prime. Species Delimitation (Masters *et al.*, 2011), also implemented as a plugin from Geneious Prime, was carried out to test the validity of *G. orarum*, as well as intra- and interspecific distances. The consensus tree was edited with FigTree 1.4.4 (Rambaut, 2018).

RESULTS

The tree (Fig. 20) from the Bayesian analysis revealed several interesting relationships among members of the *Ecdytolopha* group, some of which were suggested by Hu *et al.* (2023). For example, the Australian *Gymnandrosoma gonomela* lies outside of *Gymnandrosoma*, probably requiring a new genus; *Thaumatotibia* appears to be paraphyletic; and the Neotropical *Lusterala phaseolana* lies within *Ecdytolopha*, suggesting that *Lusterala* is synonymous with *Ecdytolopha*. However, resolving these issues is beyond the scope of the current study. In regard to *Gymnandrosoma*, the tree (Fig. 20) shows *G. leucothorax* as sister to the remainder of the species sampled, followed by *G. punctidiscanum*, with the new species as the sister-species of *G. desotatum*. In addition, *G. aurantianum* appears to represent four distinct lineages which may represent cryptic species: one from South America (sequence data from Brazil, the country of type locality, and Peru), one from Central America (sequence data from Costa Rica and Guatemala), one from Mexico, and one from the Bahamas. Larvae intercepted from Mexico lack specific geographic information, and sequence data from these specimens are embedded in the clusters of specimens from Central America, Mexico, and the Bahamas, creating a baffling picture of the potential geographic distribution of the entities. Nonetheless, it is likely that specimens from Brazil and Peru represent “true” *G. aurantianum*.

Gymnandrosoma orarum Hayden, new species

Fig. 1-4, 9-10, 12-14, 16-17.

Diagnosis. *Gymnandrosoma orarum* is superficially most similar to *G. desotatum*, from which it cannot be reliably distinguished based on maculation alone. Males of *G. orarum* are usually monochromatic dark brown (Fig. 1), although at least two bicolored specimens are known (Fig. 2). In *G. desotatum* and in the known females of *G. orarum*, the monochromatic and dichromatic variants occur in a more equal ratio (Fig. 3, 4). Monochromatic male *G. orarum* are generally uniformly so, whereas in males of *G. desotatum*, the postmedial area of the

forewing usually has scales that are at least slightly paler than the proximal half of the forewing, even if not conspicuously so (Fig. 5). In the male genitalia of *G. orarum* (Fig. 9, 10), the concavity on the ventral margin of the valva is deeper than in *G. desotatum*. The sacculus ends in an obtuse angle that is slightly projected (Fig. 9: *sa*), whereas it is smoothly curved and not projected in *G. desotatum* (Fig. 11: *sa*), and the sacculus is longer than the concavity. In the unsclerotized area near the base of the valva, the ventral edge is as long as the dorsal edge, and roughly B-shaped with an indented distal margin (Fig. 9: *B*), whereas in *G. desotatum*, the ventral half of the unsclerotized area is not expanded, so the entire area is triangular, broadly P-shaped or like an elephant’s ear (Fig. 11: *P*). In the female genitalia of *G. orarum* (Fig. 13, 14, 16, 17), the two lateral arms of the lamella postvaginalis (Fig. 16: *lp*) are concave and bowed mesad and Y-shaped (Fig. 16, 17), whereas in *G. desotatum*, the lateral arms of the lamella postvaginalis are laterally straight and V-shaped (Fig. 15, 18; cf. Heinrich 1926: Fig. 123). In *G. orarum*, the colliculum is not longer than wide (Fig. 16: *c*); in *G. desotatum*, it is longer than wide (Fig. 18: *c*).

Description.

Head: Vertex rough-scaled, scales brown with whitish apices, some specimens with pale beige scales posteriad; frons brown; ocelli and chaetosemata present; labial palpus ca. 1.5× diameter of compound eye, brown on lateral side with some beige scales on second segment near base and subapically (scales often worn off), and beige scales on medial side; scales on antenna brown without constriction or flattened portion near base of flagellum; sensory setae 0.5-0.6× width of flagellomeres. **Thorax:** Tegula, anterior of mesonotum, and mesoscutellar scale tuft dark brown; middle of mesoscutellum paler brown; venter and legs pale beige without hairpencils or tufts. Male forewing length 6.5-8.0 mm (mean = 7.1 mm; *n* = 20), female forewing length 7.0-9.5 mm (mean = 8.8 mm; *n* = 6). Costal fold absent. Forewing (Fig. 12) with all veins originating from cell separately; chorda absent; M present inside cell; CuP vein tubular and thin on margin. Hind wing with all veins separate; Sc+R and Rs closely approximate at base, Rs faint at base; cell without visible M in cell; M₂ slightly curved at base at intersection with cell; M₃ and CuA₁ connate; CuP weak and present to margin; fusiform pocket absent from anal area. Maculation of forewings in two color forms: monochromatic (Fig. 1, 3) and dichromatic (Fig. 2, 4). Males almost always monochromatic, females mono- or dichromatic. Male monochromatic form not contrasted, mostly leaden and rust-colored, costal strigulae of alternating rust and black scales; basal and subbasal areas with mixed rust and leaden scales, with some black scales; leaden between subbasal area and median fascia; median fascia rust-colored with few black scales on distal margin; area between median and postmedian fasciae narrow, mostly unbroken leaden, split around pretornal patch with rust and black scales; postmedial area rust; termen gray, some specimens with paler gray subterminal spots between veins. Male dichromatic form mostly beige contrasted with dark gray and black, with a few scattered rust-brown scales; costal strigulae of alternating beige and dark gray scales; basal and subbasal areas with mixed beige, brown, and black scales; beige extended from subbasal area onto median fascia; median fascia narrowly gray and black, area between median and postmedian fasciae pale beige, split around pretornal patch with dark gray scales; postmedian band and termen gray. Males of both forms without scale tufts, but leaden scales slightly elevated in all areas. Hind wings brown, without concavity or scale tufts on anal area. Monochromatic females like monochromatic males. Dichromatic females with costa and anal area as in male, with scattered rust scales; differing in broad and continuous dark gray and black color from base to 2/3 of wing, triangularly narrowed to end of discal cell, white scales at end of discal cell; postmedial area dominated by a triangle cornered on apex, end of discal cell, and tornus, dark gray in one specimen, pale rust in another; subbasal beige spots between veins; termen gray and rust-brown. **Abdomen:** Dorsum grayish brown, venter slightly paler than dorsum, without special tufts or patches of scales. Male genitalia (Fig. 9, 10) with tegumen dorsally rounded; scaphal ridge slightly attenuate to somewhat elongate; valva moderately broad; cucullus apically rounded, with 2 to 6 short, robust setae on distal margin; distal margin of cucullus straight

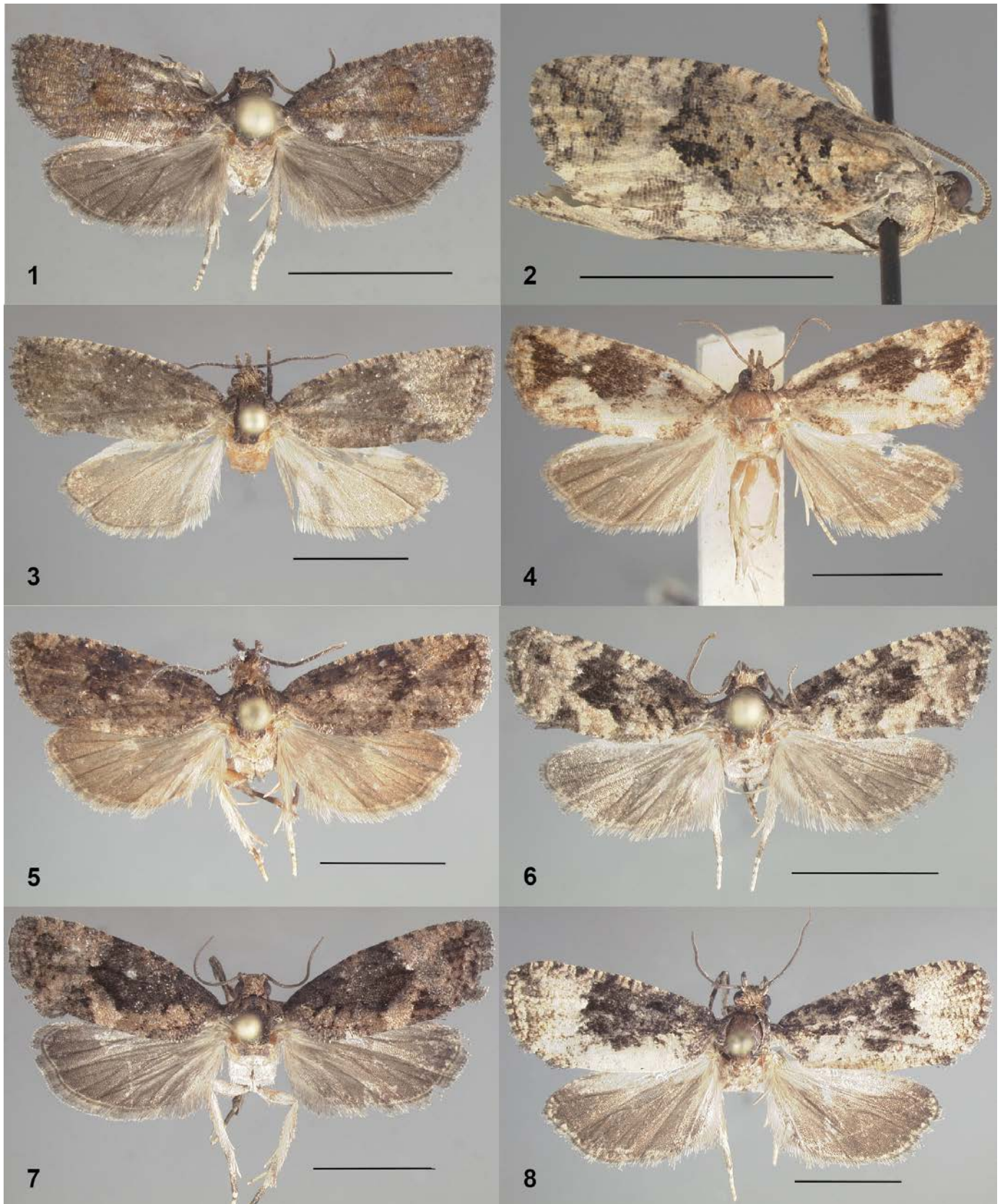


Figure 1-8: Habitus. 1-4, *G. orarum*; 5-8, *G. desotanum*. **1**, holotype, a monochromatic male (FL, Monroe Co., MGCL 1112936); **2**, dichromatic male (FL, Brevard Co., MGCL 1112941), paratype; **3**, monochromatic female (FL, Monroe Co., MGCL 1112942), paratype; **4**, dichromatic female (FL, Manatee Co., MGCL 1112943), paratype; **5**, monochromatic male (FL, Monroe Co., MGCL 1112944); **6**, dichromatic male (FL, Monroe Co., MGCL 1112945); **7**, relatively monochromatic female (FL, Indian River Co., MGCL 1112947); **8**, dichromatic female (FL, Collier Co., MGCL 1112948). Scale bars: 5 mm.

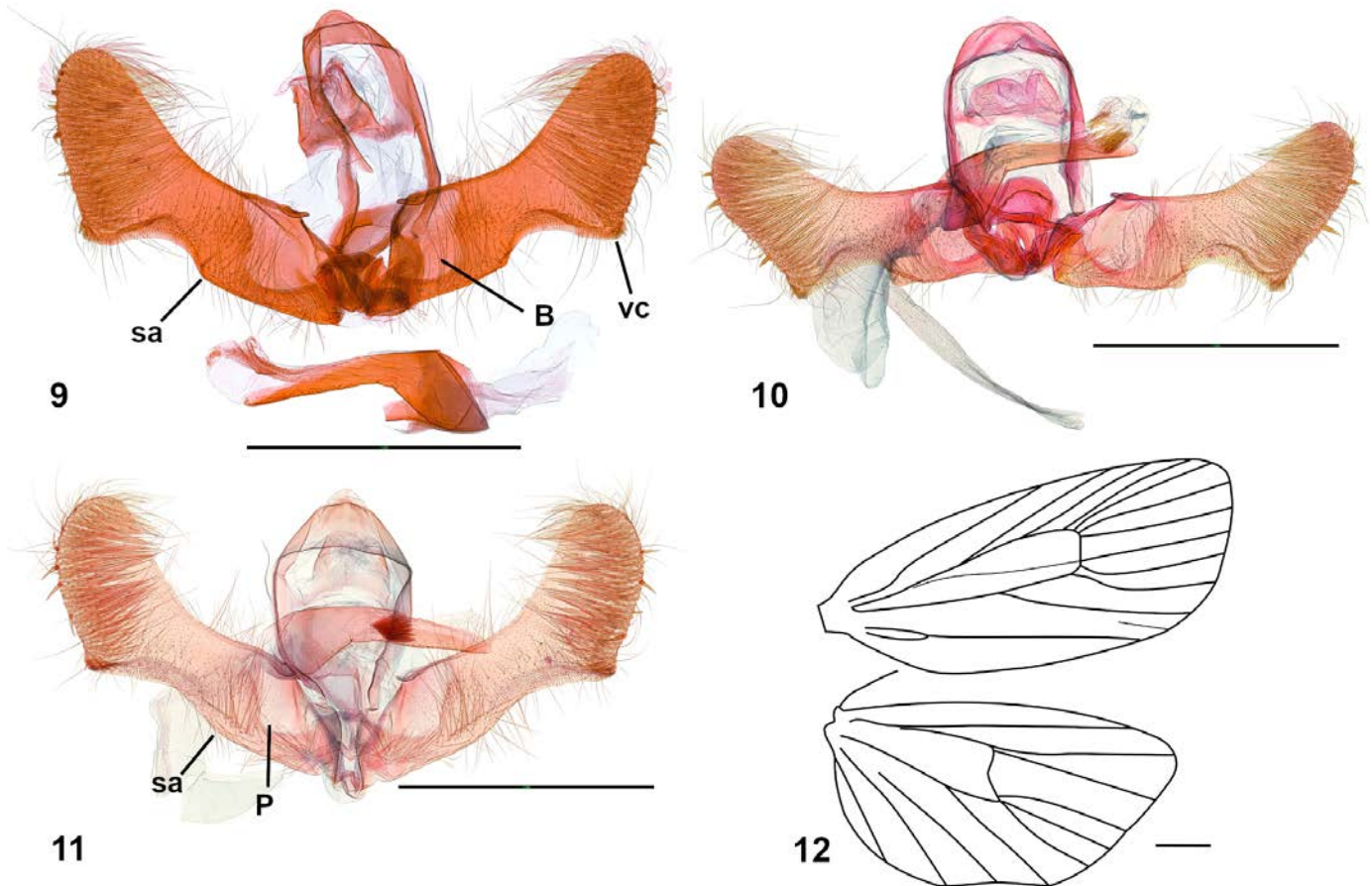


Figure 9-11, male genitalia; Figure 12, wings. 9, *G. orarum* (FL, Monroe Co., MGCL 1145529, MGCL slide 04689), paratype; **10, *G. orarum*** (The Bahamas, Grand Bahama Island, MGCL 238476, DM slide 1855), paratype; **11, *G. desotatum*** (FL, Indian River Co., MGCL 1145557, MGCL slide 06364); **12, wing venation of *G. orarum*** (FL, Monroe Co., MGCL slide 04689), paratype. *B*, B-shaped basal area of valva; *P*, P-shaped basal area of valva; *sa*, sacculus; *vc*, ventral corner of cucullus. Scale bars: 1 mm.

to ventral margin; ventral corner of cucullus (*vc*) variably straight to projected as short lobe; sacculus straight, distal end projected before concavity, sacculus (*sa*) occupying slightly more than half distance from base of valva to triangular projection at basal end of cucullus; concavity with microtrichiae and ridge on distal side bordering cucullus, without strong setae; weakly sclerotized basal area of valva B-shaped, with ventral part nearly as prominent as dorsal part (*B*). Phallus broad basally, weakly curved near base, narrowed to pointed apex, straight in distal half, with minute serrations on ventral side; cornuti numerous, deciduous, in a compact cluster as long as length of each cornutus, estimated 20-30 in number, angled about 20° from axis of phallus. Female genitalia (Fig. 13, 14, 16, 17) with ostium slightly invaginated in sternum 7; lamella postvaginalis (*lp*) with concave lateral margins; colliculum (*c*) as long as wide, situated halfway between ostium and base of ductus seminalis; ductus bursae straight, gradually widened anteriorly; double sclerite with granular texture present immediately posterior to corpus bursae, varying from rectangular to acutely triangular, with partial to complete longitudinal medial division; corpus bursae nearly spherical, slightly wider than long; signa two curved spines with broad bases and granular texture.

Immature stages: The morphology is not recorded. Moths have been reared from twigs of Red Mangrove, *Rhizophora mangle* L.

Distribution (Fig. 19): The Bahamas, Grand Bahama Island; Belize, Twin Cays; Costa Rica, coastal Guanacaste Province; USA, Florida, from Florida Keys north to Brevard Co. on the Atlantic Coast and Manatee Co. on the Gulf Coast.

Etymology: Latin *orarum*, of the coasts, genitive plural.

Type material:

Holotype: ♂: "USA, FL, Mon. Co. Key West 3990 S. Roosevelt Blvd. 24.56173, -81.75082 UVL trap 16-17-XI-2022 J.E. Hayden. Edge of mangrove swamp, along hotel entrance", "DNA JEH-2023-0628A", "UF FLMNH MGCL 1112936". Deposited in the FSCA.

Paratypes (31♂, 15♀): THE BAHAMAS: 1♂: Grand Bahama Island, Lucayan National Park, S. of Grand Bahama Hwy, 26.602538, -78.400230, 25-X-2014, J. Miller, M. Simon, R. Rozycki, D. Matthews, D. Matthews genitalia prep. #1855, MGCL 238476, DNA JEH20230629A; 1♀: same data, D. Matthews genitalia prep. #1856, MGCL 238475; 1♂, 1♀: same data, MGCL 238474, 238478 (not dissected) (MGCL). **BELIZE: Stann Creek District:** Twin Cays: 2♀, E shore of E Island, 19-I-1987, reared from seedling of *Rhizophora*, W. Mathis; 1♂, 1♀, mud flat nr. Lair Channel, 15-19-I-1987, malaise trap, W. Mathis & C. Feller; 1♀, same locality and date, "moth chrysalis on red mangrove," em: 19-I-1987, W. Mathis & C. Feller; 2♀, dock area, 18-I-1987, blacklight, W. Mathis & C. Feller (NMNH); 1♂, 1♀, West Bay, 17-27-I-1987, malaise trap, W. Mathis & C. Feller; 1♂, N shore of W Island, 17-I-1987, "chrysalis from r.mary seedling," em: 17-I-1987, W. Mathis; 1♀, 20-VI-1987, reared from red mangrove twigs, em: 27-I-1987, W. Mathis (NMNH). **COSTA RICA:** 1♂: **Guanacaste**, Sector Santa Elena, Manta Estero, 10.8552, -85.7894, 41 meters, light trap, 21 March 2012, H. Cambroner and R. Franco, 12-SRNP-100631 (NMNH). **USA, Florida, Brevard Co.:** 1♂: USA, FL, Brevard Co. Merritt Is. Sanders Lane 28.40965, -80.71384, CAPS *G. aurantianum* trap 25-VI-2021 S. Weihman E21-3689, DNA JEH-2023-0628C [genitalia in vial]; 1♂: same data except "22-VII-2021 S. Weihman E21-3770" and "DNA JEH-210803" [genitalia in vial]; 1♂: same data except "16-IX-2021 S. Weihman 10152021-6576, FLMNH-MGCL Slide 06352 [body in capsule]; 1♂: same data except "trap GA-B-3058-A. 10-

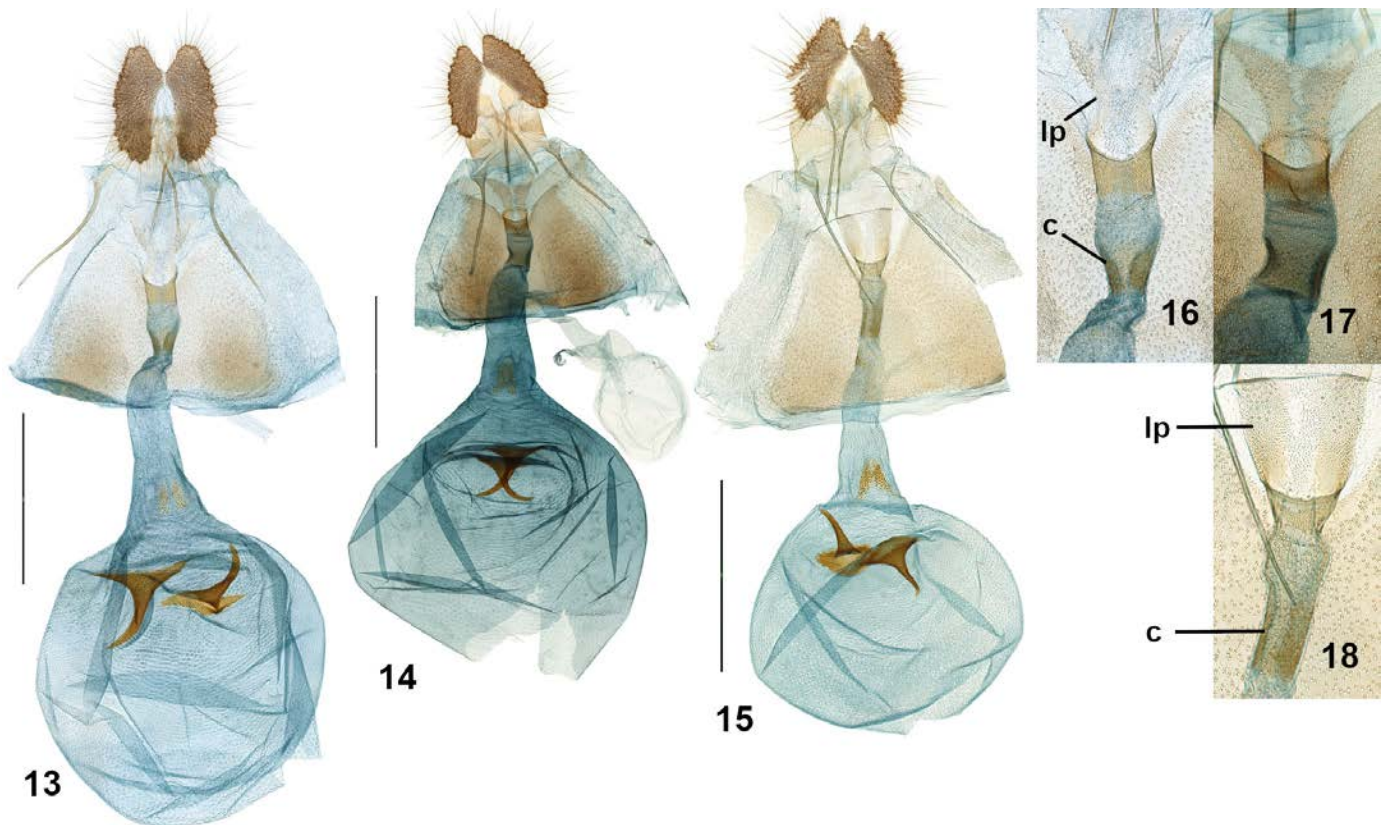


Figure 13-15, female genitalia; **Figure 16-18**, details of ostium bursae and ductus bursae. **13**, *G. orarum* (FL, Monroe Co., MGCL 1112942, MGCL slide 04687), paratype; **14**, *G. orarum* (Bahamas, Grand Bahama Island, MGCL 238475, DM slide 1856), paratype; **15**, *G. desotatum* (FL, Monroe Co., MGCL 1145565, MGCL slide 4699); **16**, same as Fig. 13; **17**, same as Fig. 14; **18**, same as Fig. 15. *c*, colliculum; *lp*, lamella postvaginalis. Scale bars: 1 mm.

XI-2021 Scott Weihman. 12082021-6814" [genitalia in vial]; 1♂: USA, FL, Brevard Co. Merritt Is. Hodge Orch. 28.40965, -80.71384 *G. aurantianum* lure 29-VI-2022 S. Weihman E22-06349 [genitalia in vial]; 1♂: USA, FL, Brevard Co. Merritt Is. Sanders Lane, 28.40965, -80.71384, 22-XI-2022 S. Weihman, CAPS *Gymnandrosoma aurantianum* trap NYS-GA-B-3058-A. ERJB0835-2022-1209-07 [genitalia in vial]; 1♂: USA, FL, Brevard Co. Merritt Is. 3000 S. Tropical Trail, 28.30473, -80.68327 CAPS *G. aurantianum* trap 26-IV-2023 S. Weihman ERAG0835-2023-0601-26 [genitalia in vial] (FSCA); **Collier Co.:** 1♂: Naples, 341 Sabal Palm Rd. 26.09479, -81.66298, 12-I-2023 S. Hayes CAPS *Gym. aurantianum* lure ERAG0835-2023-0117-01 (FSCA); **Indian River Co.:** 1♀: Vero Beach public trail near botanic garden, UVL, 5 April 2016, J. Brown TOR-DNA-1601 (NMNH); **Manatee Co.:** 2♂: USA, FL, Manatee Co. Bradenton, 27.47095 -82.49659 CAPS *G. aurantianum* trap 1-VI-2021 D. Restom-Gaskill E21-3034, [one] FLMNH-MGCL Slide 06240, DNA JEH-2023-0628B (FSCA); 1♂: Bradenton, 9800 17th Ave. SW, 27.51308, -82.65897, CAPS *Gymnandrosoma aurantianum* trap, 5-VI-2023, D. Restom-Gaskill, ERAG0835-2023-0612-01 [genitalia in vial]; 1♂: Terra Ceia Manatee Co. FL. 7 MAR 86 L.C. Dow, FLMNH-MGCL Slide 06241, J.E. Hayden photo index 500 (MGCL); 2♀: Terra Ceia FL Manatee Co. 28 APR 86 L.C. Dow, [one] FLMNH-MGCL Slide 06242 (MGCL); **Monroe Co.:** 2♂: USA, FL, Monroe Co. UPPER KEY LARGO 25.286°N 80.292°W March 11, 2015 JIM TROUBRIDGE, [one] FLMNH-MGCL Slide 04689; 1♀: USA, FL, Monroe Co. Upper Key Largo 25.287°N 80.292°W March 2, 2016 J. TROUBRIDGE, FLMNH-MGCL Slide 04687 (FSCA); 1♂: Key Largo FL. 26 Dec 87 Dow, FLMNH-MGCL Slide 04690; 1♀: same data plus "FLMNH-MGCL Slide 04688" (MGCL); 1♂: FLORIDA: Monroe Co. Long Key State Rec. Area, Long Key MV 22 DEC 1994 Terhune S. Dickel, FLMNH-MGCL Side 06652; 1♂: FLORIDA: Monroe Co., Bahia Honda State Recreation Area MAR 12, 1989 Terhune S. Dickel mercury vapor lamp; 1♀: USA, FL, Monroe Co. Bahia Honda St. Pk. Sandspur Beach house. 24.66170, -81.26482, UVL 10-11-IV-2018 J. Hayden, P. Corogin, B. Danner, J. Farnum, E. Talamas. E18-1833, FLMNH-MGCL Slide 04686, DNA-JEH-210927B (FSCA); 1♂: USA, FL, Monroe Co. BAHIA HONDA SP 24.666°N 81.253°W February 8, 2013 JIM TROUBRIDGE; 1♂: USA, FL, Mon. Co. Key West, S. Roosevelt

Bldv, edge mangrove swamp 24.56175, -81.75082 UVL trap 18-19-X-2022 J. Hayden; 4♂: USA, FL, Mon. Co. Key West 3990 S. Roosevelt Blvd. 24.56171, -81.75196 UVL trap 16-17-XI-2022 J.E. Hayden, Edge of mangrove swamp, behind hotel dumpster, [one] FLMNH-MGCL Slide 06585; **Volusia Co.:** 1♂: USA, FL, Volusia Co. Oak Hill 262 E. Halifax Ave. CAPS *Gym. aurantianum* trap NSY-GA-B-3067. 29-X-2021 S. Weihman E0979-11152021-1968 [body in capsule, genitalia in vial] (FSCA); 1♂: same data plus: "28.86495, -80.84359", "23-II-2023", "ERAG 0835-2023-0316-01, E1276-03172023-02436" [wings damaged, genitalia in vial]. UF FLMNH MGCL catalog numbers 1112940-1112943, 1145529-1145552, 1198105. Specimens are deposited in the FSCA unless noted.

Other material examined: Specimen in BOLD, not dissected: 1♂: COSTA RICA: Guanacaste: Sector Santa Elena, Manta Estero, 10.8552, -85.7894, 41 meters, light trap, 21 April 2012, H. Cambronero and R. Franco, 12-SRNP-101258.

Genetics: The new species corresponds to BOLD Barcode Index Number BOLD:ADB6094. Within seven sequences of *G. orarum*, the intraspecific distance was calculated as 0.007. It is <98.5% different from *G. desotatum*, as calculated by Neighbor-Joining implemented in BOLD, including the Costa Rican specimens but not those from Florida. The interspecific distance between *G. orarum* and *G. desotatum*, calculated using Species Delimitation, is 0.020. Rosenberg's P_{AB} , which represents the probability that random branching resulted in the monophyly of a group of sequences was significant (1.85E-03).

Remarks: Identification without dissection is difficult because two color forms occur in both species and both sexes. Like *G.*

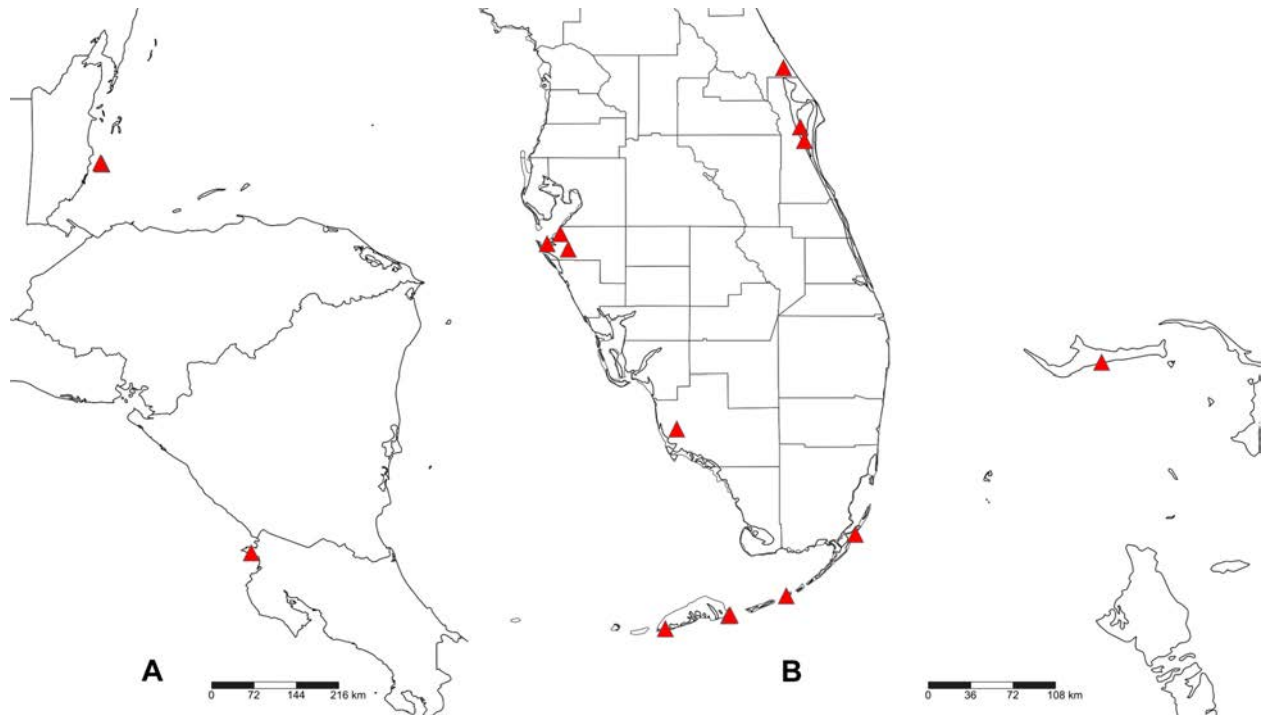


Figure 19: Collection localities of *G. orarum*, triangles. A, Belize and Costa Rica; B, southern Peninsular Florida (USA) and The Bahamas, northwestern islands.

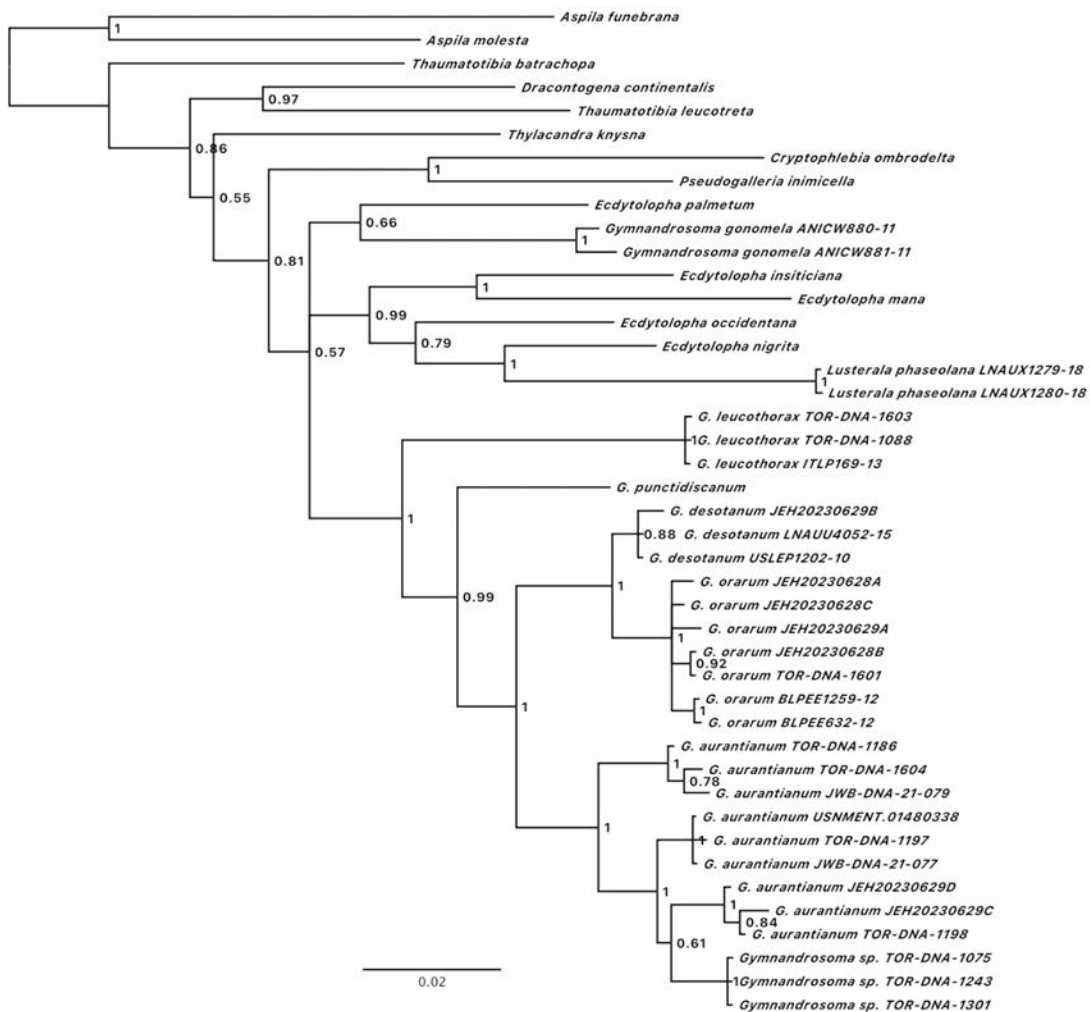


Figure 20: Bayesian inference of phylogeny for *Gymnandrosoma* and related outgroups. GenBank accession numbers for DNA barcode sequences are shown in brackets. The support values are posterior probabilities. Scalebar represents branch lengths.

Table 1. Specimen data for nucleotide sequences used in this study.

Species	Specimen locality	Collection Date	BOLD Process ID or specimen code	GenBank accession #	Source(s)
<i>Gymnandrosoma aurantianum</i>	Bahamas, Great Exuma	2014	JEH20230629D	OR707198	This study
	Bahamas, South Abaco	2016	JEH20230629C	OR707197	This study
	Interception from Mexico	2020	TOR-DNA-1198	OR707202	This study
	Costa Rica, Puntarenas	2014	USNMENT.01480338	OQ706465, OQ679386, OQ679210, OQ679134	Hu <i>et al.</i> , 2023
	Interception from Mexico	2020	TOR-DNA-1197	OR707206	This study
	Guatemala, San Marcos	2017	JWB-DNA-21-077	PQ848107	This study
	Brazil, Bahia	2015	TOR-DNA-1604	OR707203	This study
	Interception from Peru	2021	TOR-DNA-1186	OR707204	This study
	Brazil, Bahia	2015	JWB-21-079	PQ848108	This study
	<i>desotanum</i>	Bahamas, San Salvador	2015	JEH20230629B	OR707199
United States, Florida		1976	LNAUU4052-15	OR732316	This study
United States, Florida		2010	USLEP1202-10	HQ583318	Mined from BOLD
<i>leucothorax</i>	Dominican Republic, Pr. Monsenor	2019	TOR-DNA-1603	OR707193	This study
	Interception from Mexico	2019	TOR-DNA-1088	OR707196	This study
<i>orarum</i>	Dominican Republic, La Vega	1994	ITLP169-13	OR732317	This study
	United States, Florida	2022	JEH20230628A	OR707194	This study
	United States, Florida	2021	JEH20230628C	OR707200	This study
	The Bahamas, Grand Bahama	2014	JEH20230629A	OR712440	This study
	United States, Florida	2021	JEH20230628B	OR707195	This study
	United States, Florida	2016	TOR-DNA-1601	OR707201	This study
	Costa Rica, Guanacaste	2012	BLPEE1259-12	OR732319	Mined from BOLD
	Costa Rica, Guanacaste	2012	Field ID: 12-SRNP-101258 BLPEE632-12, Field ID: 12-SRNP-100631	OR732321	Mined from BOLD
<i>punctidiscanum</i>	United States, Virginia	2019	USNMENT.01480339	OQ706447, OQ679276, OQ679387, OQ679211, OQ679135, OQ679291	Hu <i>et al.</i> , 2023
Sp.	Interception from Mexico	2018	TOR-DNA-1075	OR707205	This study
Sp.	Interception from Mexico	2020	TOR-DNA-1243	OR707207	This study
Sp.	Interception from Mexico	2019	TOR-DNA-1301	OR707208	This study
Outgroups					
<i>Aspila funebrana</i>	Finland, Western Finland	2010	MM26369	OQ706476, OQ679378	Hu <i>et al.</i> , 2023
<i>Aspila molesta</i>	United States, Virginia	2012	11ANIC-12980, USNMENT.01480334	KF396799, OQ679381, OQ679130, OQ679290	Hebert <i>et al.</i> , 2013, Hu <i>et al.</i> , 2023
<i>Cryptophlebia ombrodelta</i>	Not available	Not available	11ANIC-12863	KF403816, JQ784418	Hebert <i>et al.</i> , 2013, Regier <i>et al.</i> , 2012
<i>Dracontogena continentalis</i>	Kenya, Coast, Taita Hills	2012	USNMENT.01480325	OQ706477, OQ679360, OQ679203, OQ679127	Hu <i>et al.</i> , 2023
<i>Ecdytolopha mana</i>	United States, Oklahoma	2008	MDOK-0858	GU799873	iBOL Data Release
<i>Ecdytolopha nigrita</i>	United States, Arizona	2017	USNMENT.01480327	OQ706438, OQ679129	Hu <i>et al.</i> , 2023
<i>Ecdytolopha insiticiiana</i>	United States, Virginia	2017	USNMENT.01480326	OQ706484, OQ679361, OQ679204, OQ679128, OQ679289	Hu <i>et al.</i> , 2023
<i>Ecdytolopha occidentana</i>	United States, New Mexico	2018	USNMENT.01480328	OQ706457, OQ679362, OQ679205, OQ679306	Hu <i>et al.</i> , 2023
<i>Ecdytolopha palmetum</i>	United States, Florida	2011	USNMENT.01480318	OQ706490, OQ679336, OQ679123, OQ679288	Hu <i>et al.</i> , 2023
<i>Gymnandrosoma gonomela</i>	Australia, Western Australia	1973	11ANIC-12880	KF405485	Hebert <i>et al.</i> , 2013
<i>Lusterala phaseolana</i>	Australia, South Australia	1999	11ANIC-12881	KF402029	Hebert <i>et al.</i> , 2013
	Costa Rica, San Jose	2000	CCDB-32978-D08 (LNAUX1279-18)	OR732318	This study
<i>Pseudogalleria inimicella</i>	Costa Rica, San Jose	2000	CCDB-32978-D09 (LNAUX1280-18)	OR732320	This study
	United States, Virginia	2014	USNMENT.01480345	OQ706423, OQ679405, OQ679139, OQ679309	Hu <i>et al.</i> , 2023
<i>Thaumatotibia batrachopa</i>	Kenya, Taita-Taveta Co.	2012	USNMENT.00808629	OQ706451, OQ679409, OQ679303	Hu <i>et al.</i> , 2023
<i>Thaumatotibia leucotreta</i>	Finland, Western Finland	2013	MM23383	KT782396, OQ679410, OQ679151, OQ679072	Pentinsaari <i>et al.</i> , 2016, Hu <i>et al.</i> , 2023
<i>Thaumatotibia knysna</i>	South Africa, Western Cape	2015	USNMENT.01480351	OQ706452, OQ679411, OQ679217	Hu <i>et al.</i> , 2013

orarum, males and females of *G. desotanum* may be relatively monochromatic (Fig. 5, 7), or obviously dichromatic (Fig. 6, 8). Most male specimens have the monochromatic maculation. Only two male specimens of *G. orarum* have been collected with a dichromatic pattern, both from the same locality on Merritt

Island, Florida. This may represent a population-specific trait, or it may be an effect of exposure to the elements on the trap.

Additional material examined:

Gymnandrosoma desotanum Heinrich (20♂, 7♀): **THE BAHAMAS:** 1♂: San Salvador Island; Gerace Research Centre, Alfred Pike Trail 24.117166°

-74.463864° 23.vii.2015 D. Matthews, T.A. Lott, R.W. Portell, SAN SALVADOR IS. SURVEY, D. Matthews *et al.*, MGCL Acc. # 2015-57, D. MATTHEWS GENITALIA PREP. # 1854, DNA JEH-2023-0629B, MGCL 244543 (MGCL). **USA, Florida, Brevard Co.:** 1♂: Merritt Is. 2000 Newfound Harbor Dr. 28.32362 -80.66102, 4-I-2023 S. Weihman, CAPS *Conogthes punctiferalis* trap COP-B-3094-A ERAG0835-2023-0113-16, E0240-01242023-00481; 1♂: Merritt Island, 9880 South Tropical Trail, 28.18165, -80.62556, CAPS *T. leucotreta* trap TL-B-3016-A, 7-I-2021 S. Weihman E2021-195; 1♂: same data except 25-VI-2021, E21-3692; 1♂: same data except CAPS *S.[tenoma] catenifer* trap, 25-VI-2021, E21-3793 (FSCA); **Broward Co.:** 1♂: Dania Beach, John Lloyd SP, 6503 N Ocean Dr. 26.08436°N 80.11192°W 24-IV-2012 UV light M. DaCosta E2012-3235, FLMNH-MGCL Slide 00544; 1♀: Dania Beach, John Lloyd SP, 6503 N Ocean Dr. UV. 21-VI-2012 CAPS IMS M. DaCosta, J. Garcia E12-5008, FLMNH-MGCL Slide 04691 (FSCA); **Collier Co.:** 1♀: Fakahatchee St. Pk 25.98° -81.39°, 27-III-2017 J. Troubridge, FLMNH-MGCL Slide 04697; 1♂: Marco Island, 15-VIII-1988, David Smith, 240, FLMNH-MGCL Slide 04698; 1♂: Delanor Wiggins Pass State Park, Malaise trap, 24-IV-27-V-2020 D. Serrano, State Permit #06201910 (FSCA); **Indian River County:** 1♀: Vero Beach, 27.732239, -80.393731 Reared ex *Avicennia germinans* seed 12-X-2021 A. Tasi 12222021-03434, FLMNH-MGCL Slide 06391; 1♂: Winter Beach, 69 St. dock, 27.720293, -80.408616 reared ex *Avicennia germinans* propagule coll. 1-X-2021 A. Tasi 11032021-5797♂ FLMNH-MGCL Slide 06364; 1♂: Vero Beach, SE 9 St. FMEL boat house 27.58688°N 80.37085°W 18-V-2012 UV J.E. Hayden, FLMNH-MGCL Slide 06268; 1♂: Vero Beach, Oslo Rd. Boat Ramp, 27.586668 -80.365240, mangrove swamp, UVL trap, 25-V-2022 N. Negron, A. Tasi E2022-04886 (FSCA); **Miami-Dade Co.:** 1♂: Key Biscayne, Bill Baggs SP, 1200 S. Crandon Blvd. 25.67783, -80.16425, CAPS-IMS UVL 31-VII-2014 E. Golden E14-5548, FLMNH-MGCL Slide 04692; 1♀: Cutler, USDA ARS SHRS, 25.6442275°N 80.292305°W MV+UVL 22-IV-2013 J. Hayden, FLMNH-MGCL Slide 01198; 1♂: Homestead, 25.48605, -80.53626 CAPS *Stenoma catenifer* trap 23-VI-2021 L. Pujol E21-3211, FLMNH-MGCL Slide 06252, NSY-SC-C-0001a (FSCA); **Monroe Co.:** 1♀: Big Pine Key, 4-IX-1972, J.B. Heppner, coll., at blacklight, FLMNH-MGCL Slide 06813; 1♂: Bahia Honda State Recreation Area MAR 3, 1989 Terhune S. Dickel mercury vapor lamp, FLMNH-MGCL Slide 06614; 1♂: Key West 3990 S. Roosevelt Blvd. 24.56171, -81.75196 UVL trap 16-17-XI-2022 J.E. Hayden, Edge of mangrove swamp, behind hotel dumpster, FLMNH-MGCL Slide 06615; 1♂: Islamorada, 24.963°N 80.566°W 3-III-2014 Jim Troubridge; 1♀: Key West, Robbins Boat Yd 24.560618°N 81.736872°W CAPS IMS UVL 6-IX-2013 P. Perez, M. DaCosta E13-6765, FLMNH-MGCL Slide 04699; 1♂: Key West Naval Station Marina, UVL, 24.575478°N 81.707704°W MCS-44-BL-001A 19-VI-2013 P. Perez, M. DaCosta E13-4661, FLMNH-MGCL Slide 04693; 1♂: Key West, 3990 S. Roosevelt Blvd. 24.56173, -81.75082 UVL trap 16-17-XI-2022 J.E. Hayden. Edge of mangrove swamp, along hotel entrance, FLMNH-MGCL Slide 06617; 1♂: same data except 24.56175, -81.75085, 26-27-IV-2023, 05162023-05155 [genitalia in vial] (FSCA); 1: Big Pine Key, UVL, 27 Nov. 1976, D.C. Ferguson, LNAUU4052-15 (NMNH); **Pinellas Co.:** 1♀: Honeymoon Isl. St. Pk. 5-X-1986 Dow (MGCL). MGCL catalog nos. 1112944-1112948, 1145553-1145571, 1145582.

Gymnandrosoma aurantianum (2♂, 3 sex not recorded, 3 larvae): **THE BAHAMAS:** 1♂: South Abaco, Gilpin Point, S. of Crossing Rocks, 1.5 mi SE off Great Abaco Hwy 26.105899°, -77.18550° 3.vi.2016 J. Miller, M. Simon, G. Goss, D. Matthews, BAHAMAS SURVEY MGCL accession #2016-09, DNA JEH-2023-0629C, MGCL 246770; 1♂: Great Exuma Is. SE of Moss Town & airport 23.551167°, -75.863333° 27.v.2014 J. Miller, M. Simon, G. Goss, D. Matthews coppice/salt marsh transition, Bahamas Survey MGCL Accession No. 2014-14, D. MATTHEWS GENITALIA PREP. #1743, DNA JEH-2023-0629D, MGCL 234264 (MGCL). 2: **BRAZIL,** Bahia, Camacan, Serra Bonita Reserve, UVL, 5-15 March 2015, Neotropical Lepidoptera Course, [one] TOR-DNA-1604, [other] JWB-21-079 (NMNH). 1: **GUATEMALA,** San Marcos, Finca Nueva Grenada, 10-Aug-2017, L. M. Sandoval, Reared from *Macadamia integrifolia*, JWB-DNA-21-077 (NMNH). 2 larvae: **Port interception** from Mexico, 18-Jun-2020, [one] TOR-DNA-1197, [other] TOR-DNA-1198 (NMNH); 1 larva: Port interception from Peru, 3 March 2021, TOR-DNA-1186 (PITL).

DISCUSSION

Gymnandrosoma orarum has probably evaded detection because it is externally very similar to *G. desotatum*, it is habitat-restricted, and it may have been introduced to Florida relatively

recently. The first specimens of *G. orarum* collected in Florida were in the Tampa Bay area in 1986. In 1989, it was collected on Bahia Honda in the Florida Keys, and specimens from the Atlantic Coast of Florida were collected much more recently. In contrast, specimens of *G. desotatum* have been collected in Florida since 1912 (Adamski & Brown, 2002), and the dates on specimens in the FSCA generally track collecting efforts by contributors to the FSCA, showing increasing abundance from 1955 to the present. The two species are sympatric, so if they were both native, one would expect mixed series from the earliest dates.

Most of the specimens were collected near marine shores. Specimens from Grand Bahama were collected in a transition zone between mangrove swamp and whiteland coppice. One exception is a specimen collected in Naples, Florida, at a commercial orange grove several kilometers inland. The only documented host plant of *G. orarum* is Red Mangrove, *Rhizophora mangle* L. (Rhizophoraceae), and it has been recorded from “twigs.” Likewise, *Gymnandrosoma desotatum* has been reared from *Rhizophora mangle* (Adamski & Brown 2001), but from the seeds, and also from Black Mangrove, *Avicennia germinans* L. (Acanthaceae) (see Material Examined). Red Mangrove has been recorded along a canal less than six kilometers from the locality of the Naples specimen (Greensolstice, 2023), which may explain its occurrence.

Males of *G. orarum* are attracted to the pheromone lure for *G. aurantianum*, and *G. desotatum* is attracted to the lure for *Thaumatotibia leucotreta*. Both lures have the same major component, E8-12Ac. They differ in their minor components: the lure for *G. aurantianum* is E8-12Ac to E8-12OH in a ratio between 10:1 and 100:1 (Leal *et al.*, 2001), whereas formulations that attract *T. leucotreta* are usually more complex and involve Z8-12Ac (Newton *et al.*, 1993; El-Sayed, 2024). The different minor attractants may explain the differential attraction of *G. desotatum* and *G. orarum*.

The results of our molecular phylogenetic analysis are comparable to those of the morphology-based cladograms of Adamski & Brown (2001), albeit with better rooting. However, specimens included in our molecular analysis identified as *G. aurantianum* or *Gymnandrosoma* sp. actually represent four closely related lineages, with specimens from each lineage intercepted on imported commodities. These findings suggest the presence of cryptic species within *G. aurantianum*, which warrants further investigation of morphology, pheromones, and host usage.

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Two new species of *Palpita* Hübner from the Dominican Republic (Lepidoptera: Pyraloidea, Spilomelinae)

Bernard Landry^{1*} and M. Alma Solis²

1. Muséum d'histoire naturelle de Genève, C.P. 6434, Geneva 6, 1211, Switzerland; <https://orcid.org/0000-0002-6005-1067>.

2. Systematic Entomology Laboratory, Beltsville Agriculture Research Center, Agricultural Research Service, U.S. Department of Agriculture, c/o National Museum of Natural History, MRC 168, Smithsonian Institution, P.O. Box 37012, Washington, District of Columbia, United States of America, 20013-7012; alma.solis@usda.gov; <https://orcid.org/0000-0001-6379-1004>.

*Corresponding author: bernard.landry@geneve.ch

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Abstract: Two striking new species of *Palpita* Hübner, 1808 are described from the Dominican Republic as *P. hispaniolaensis* Landry & Solis, n. sp. and *P. maribelae* Landry & Solis, n. sp. The male and female morphological characters of their habitus and genitalia are illustrated.

Resumen: Se describen dos nuevas especies de *Palpita* Hübner, 1808 de la República Dominicana: *P. hispaniolaensis* Landry & Solis, n. sp. y *P. maribelae* Landry & Solis, n. sp. Se ilustran los caracteres morfológicos masculinos y femeninos de su hábito y genitales.

Key Words: Hispaniola Island; *Palpita isoscelalis* (Guenée, 1854); *P. citrina* (Druce, 1902); *P. estebanalis* (Schaus, 1920).

INTRODUCTION

The genus *Palpita* Hübner, as presently recognized, consists of 166 valid species distributed in all biogeographic regions worldwide, with 33 species in the Western Hemisphere, including the Galápagos Islands (Nuss *et al.*, 2024). The genus was recently placed in the tribe Margaroniini Swinhoe & Cotes, 1889 (Mally *et al.*, 2019).

Only four species and one subspecies have been described from the Antilles, i.e., *Palpita viettei* Munroe, 1959 from Guadeloupe and Haiti, *P. persimilis* Munroe, 1959 from Brazil and Guadeloupe, *P. isoscelalis goubeyrensis* Munroe, 1959 from Guadeloupe, and *P. punctalis* (Warren, 1896) from Jamaica. Described from Haiti, *Margarodes lustralis* Guenée (1854) has been considered a synonym of *Diaphania glauculalis* (Guenée, 1854) since Munroe (1995), but Becker (2024) provisionally transferred this species into *Palpita* based on larval foodplant.

The fauna of *Palpita* in the Dominican Republic is poorly known. Perez-Gelabert (2008) reported four species, namely *P. flegia* (Cramer, 1777), *P. quadristigmatalis* (Guenée, 1854), *Palpita kimballi* Munroe, 1959, and *Palpita viettei*, with the first three of these records being taken from Domínguez (1997). There are at least four species of *Palpita* recorded in iNaturalist (www.inaturalist.org) based on images, i.e., *P. flegia*, the largest species in the genus that cannot be confused with other smaller *Palpita* species based on the bluish color of the forewing costa, *P. quadristigmatalis*, and the two new species described below.

However, even though *P. quadristigmatalis* may very well occur on Hispaniola Island, there are several very similar species (*P. kimballi*, for example), and specimens collected by BL in the Dominican Republic proved to be *P. isoscelalis* (Guenée, 1854) based on dissections and comparison with Munroe (1959) and Villegas-Luján *et al.* (2019).

The present work stems from a species identification request based on a photograph taken by nature photographer and artist Carlos De Soto Molinari in the Dominican Republic; the photo represented the first species described below. Photos of both species described here were also posted on iNaturalist.org by four naturalists, as recorded below. Although six species of *Palpita* were collected by BL in the Dominican Republic during seven weeks of collecting, excluding *P. flegia*, only *P. isoscelalis* and the two new ones reported here could be identified. Thus, the fauna of *Palpita* in the Dominican Republic is richer than the records and reports indicate.

MATERIAL AND METHODS

All species of *Palpita* described from the New World were checked to conclude that the species described here are new; this meant reviewing the original descriptions as well as additional modern references, such as Munroe (1959), Hayden & Buss (2012), Sullivan & Solis (2013), Villegas-Luján *et al.* (2019).

The specimens recorded here were mostly collected by

BL with a 'lepiled' (Brehm, 2017), but sometimes also with ultraviolet neon lights, white incandescent lights, or mercury-vapor lights.

The specimens collected by BL and Jiri Hodecek are deposited in the Muséum d'histoire naturelle, Geneva, Switzerland (MHNG); some of these will be deposited at the Museo Nacional de Historia Natural Prof. Eugenio De Jesús Marcano, Santo Domingo, Dominican Republic (MNHNSD). The specimens collected by R.E. Woodruff are deposited in the Florida State Collection of Arthropods, Gainesville, Florida, USA (FSCA).

Images of moths were made at the MHNG with a Canon EOS R camera fitted with a Canon 100 mm F 2.8 lens, while those of specimen parts were taken with a Leica M205C binocular scope equipped with a Leica DMC5400 camera; all series of images were stacked with Zerene Stacker of Zerene Systems LLC.

To study the genitalia, the abdomen of a selected specimen was detached and placed in a $\pm 15\%$ KOH solution in an oven at 60°C for one hour. Dissections were performed under a binocular scope in 30% ethanol. The dissected and cleaned parts were stored in lactic acid stained with Orange G for staining the sclerotized parts and for their description. They were then stained in chlorazol black and placed in baths of 95% ethanol and isopropanol for an hour each before mounting on slides in Euparal.

The label data of the holotypes are cited verbatim, with vertical bars indicating changes of lines. The label data of

the paratypes are also cited verbatim, in chronological order of collecting dates, regardless of collecting years, without indication of changes of lines or mention of country name. The measurements of forewing length and wingspan were taken from all available specimens. The forewing length/width ratio was calculated on the images of the photographed specimens, the length including the fringe, the width measured from anal angle to costa at right angle. The terminology pertaining to the genitalia follows Mally *et al.* (2019).

RESULTS AND DISCUSSION

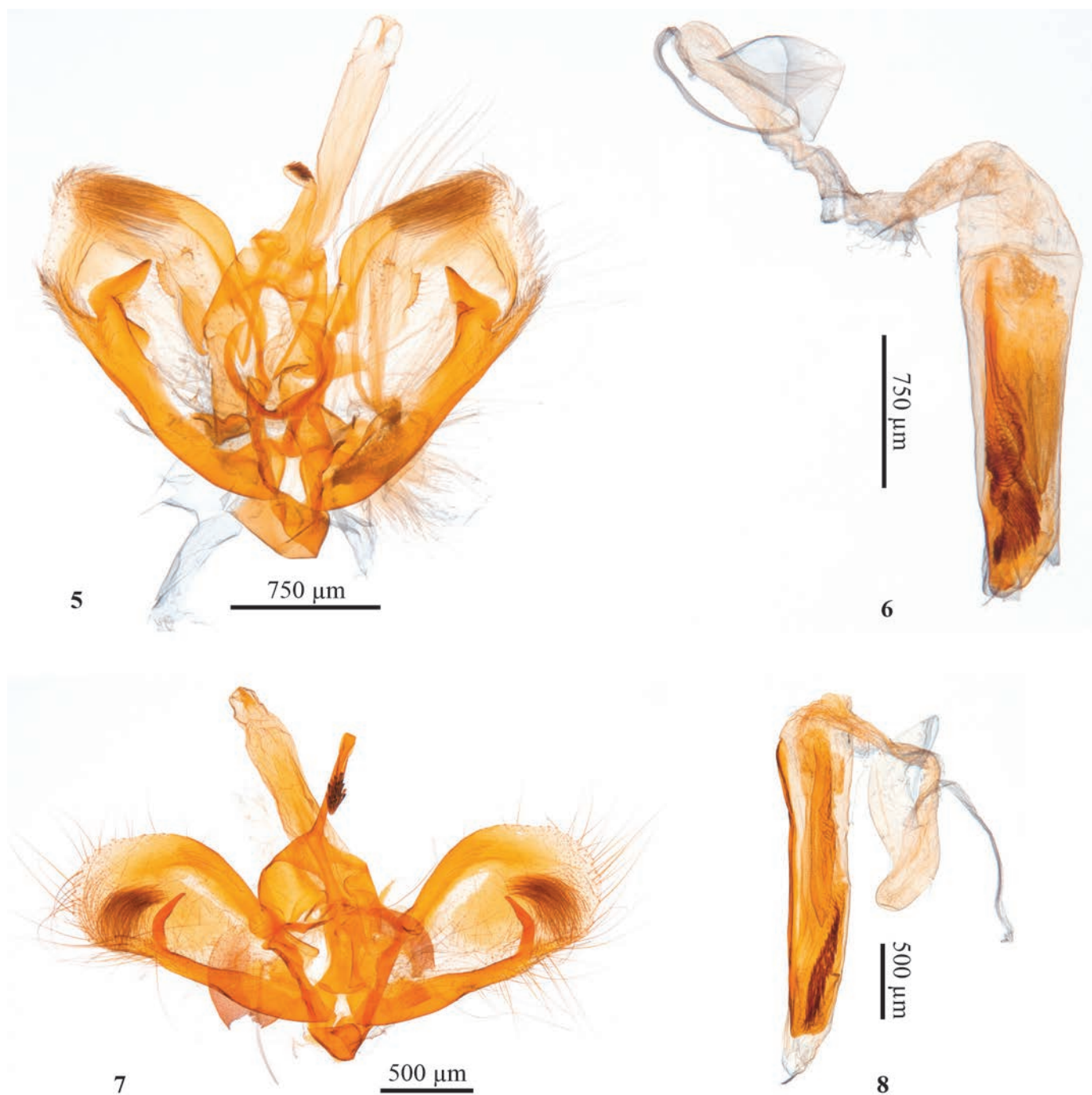
Palpita hispaniolaensis Landry & Solis, **new species**

Figs. 1, 2, 5, 6, 9

Diagnosis: The new species is readily separated from all congeners by the translucent dusky wings and the white median band running from the thorax to the tip of the abdomen flanked by brownish grey all along. No other *Palpita* species are known to have a similar thoraco-abdominal pattern. Only one other (unidentified) species in the Dominican Republic has dusky wings, but it is a whiter moth with a fully satiny-white abdomen and a more contrasting, warmer brown forewing costal band and other wing pattern elements restricted to the forewing consisting only of a small black discal spot and an even smaller one abutting the costal band at the level of the discal spot. In the male genitalia, the shape and ornamentation of the valva are similar to those of *P. isoscelalis goubeyrensis* Munroe, 1959



Figures 1-4. Specimens of the *Palpita* species treated here. **1-2.** *Palpita hispaniolaensis*. **1.** Female holotype. **2.** Male paratype East of Villa Pajón Eco-Lodge. **3-4.** *Palpita maribelae*. **3.** Female holotype. **4.** Male paratype from Reserva Científica Ebano Verde.



Figures 5-8. Male genitalia of the *Palpita* species treated here. **5-6.** *Palpita hispaniolaensis*, MHNG-ENTO-0261620. **5.** Whole genitalia without phallus, with only part of right coremata. **6.** Phallus. **7-8.** *Palpita maribelae*, MHNG-ENTO-0262644. **7.** Whole genitalia without phallus and coremata. **8.** Phallus.

but differ most notably in the simple fibula of the latter. In the female genitalia, the new species is most similar to a specimen identified as *P. isoscelalis* from the Dominican Republic (MHNG-ENTO-262652), but in that specimen sternite VII is more deeply emarginate medially, the ostium has convex lateral margins, the ductus bursae is shorter than the corpus bursae and wider than in *P. hispaniolaensis*, and the corpus bursae has only two short posterior projections: the most posterior small and the anterior one larger, broadly rounded and bearing the two signa.

Description:

MALE (n=8) (Fig. 2): *Head*: mostly brownish gray, with white scaling in pair of thin medially projecting tufts on occiput and vertex, laterally at apex of thin scales shortly projecting anteriorly between antennae, on scape ventrally, at posterior corners of appressed scale cover of fronto-clypeus, on haustellum, and on inner and ventral sides of labial palpi. *Thorax*: dorsally as illustrated (Fig. 2), ventrally satiny white. Prothoracic leg coxa and trochanter white to pale gray; femur ventrally pale gray, dorsally chestnut brown to dark brown at apex; tibia dark brownish gray with few white scales at apex; tarsi white. Mesothoracic leg white, with dark grayish brown outer side of shorter external spur of tibia. Metathoracic leg white, sometimes with few brown scales on



Figures 9-10. Female genitalia of the *Palpita* species treated here. **9.** *Palpita hispaniolaensis*, MHNG-ENTO-0261621. Arrows indicate the three lobes mentioned in the Description. **10.** *Palpita maribelae*, MHNG-ENTO-0262645.

dorsal edge of tibia. Forewing length: 13.0-14.0 mm; wingspan: 28.0-30.5 mm; forewing length/width ratio: 2.86. *Wings:* wing pattern and colors dorsally as illustrated (Fig. 2), with fine gray or white hair-like scales on dorsal surface of hindwing except apex; ventrally with white scaling at base of forewing, including retinaculum, and along anal vein, otherwise grayish brown; venation of hindwing with costa and Sc+R, stem broadly produced slightly near middle. *Abdomen:* dorsally as illustrated, with dorsal white band reaching apex, with lateral grayish brown bands becoming lighter warmer brown apically; ventrally white, with thin long scales surrounding genitalia white, light yellowish, gray, and black. *Genitalia* (n=2) (Figs. 5, 6): Uncus of medium length, about as long as tegumen, with base short, main shaft almost parallel-sided, with slight

constriction before short head with chaetae anterolaterally set with few short setae. Subscaphium narrow, gradually thinning, extending to tip of uncus and about middle of anal tube. Tegumen dorsal bridge very narrow, with pedunculi narrowing toward base to half their apical width. Transtilla a pair of narrow, 'swan-neck'-shaped sclerites abutting medially. Valva with broadly sclerotized costa, straight ventral margin, broadly rounded apical margin; sacculus with apical process a slightly asymmetrical double-pronged fibula directed dorsally towards tegumen-uncus, with smaller ventral prong more distinctly triangular on right valva; with pair of small, shortly setose knobs, one short, triangular, near costa and second longer, medially located, at level of fibula; and with submarginal sclerotized arc from fibula to thick apical bunch of setae directed

anteromedially. Juxta shaft laterally compressed, upcurved, slightly enlarged in distal half, with narrowly rounded apex. Vinculum short, curving upward, with basal margin straight in ventral view. Phallus slightly narrowing toward apex; vesica (in partly everted state, not shown) spiculate throughout, with rather wide but short curving bundle of short spines dorsally and two smaller bunches of similar spines ventrally, followed by short sclerotized and ribbed section of about 10 ribs narrowing toward apex, a narrow ill-defined ribbon, and apically with seemingly flat, narrowing sclerite about half as long as phallus shaft.

FEMALE (n=3) (Fig. 1): *Head*: as in male, except for thinner antennae. Forewing length: 12.5-13.5 mm (holotype: 13.0); wingspan: 26.5-29.0 mm (holotype: 28.0); forewing length/ width ratio: 2.53. *Thorax, abdomen*, and *wing* patterns and colors as in male; hindwing also with produced costal margin and Sc+R₁ vein and hair cover on hindwing. *Genitalia* (n=2) (Fig. 9): papillae anales moderately slender, with abundant setation longer along outer margin to very short along inner margin. Posterior apophyses slender, straight, reaching beyond middle of segment VIII. Segment VIII of medium length, about 1/4 longer dorsally, lightly sclerotized, with straight dorsobasal margin, bare dorsally along midline. Anterior apophyses slightly curving towards middle of segment, slightly thicker and about 1/4 longer than posterior apophyses. Posterior half of sternite VII more thickly sclerotized, medially split in two, with posterior margins of lateral sections fused with ventroapical margin of ostium bursae and medially thin keel encroaching into ventral wall of ostium bursae medially. Ostium bursae short, pouch-like with parallel lateral margins and slightly rounded posterior margin. Ductus bursae membranous, in direct continuation with ostium bursae and about 3 times its length, with shallow elongate ventral flap directed to left posteriorly. Corpus bursae membranous, about as long as ductus bursae and slightly decreasing in girth towards their intersection, produced at base into three lobes, most posterior one longest, anterior one bearing a pair of 'saber'-shaped signa of moderate length.

Types:

HOLOTYPE ♀: **DOMINICAN REPUBLIC**: 1- "RD, Prov. La Vega, PN Valle Nuevo| Villa Pajon Eco-Lodge, meadow | 18.8213817, -70.6836222, 2135 m | elev., lepid, 8.vi.2024, leg. B. Landry". 2- "Permis | d'exportation de | Bernard Landry | Rep. Dominicana | VAPB-13087". 3- "MHNG | ENTO ♀ | 0248843". 4- "HOLOTYPE| *Palpita* | hispaniolaensis| Landry & Solis" (MHNG).

PARATYPES (8 ♂, 2 ♀): **DOMINICAN REPUBLIC**: 1 ♀, MHNG-ENTO-0261649, Prov. Barahona, S Polo, road Polo - Los Cocos, 18.0422220, -71.3062732, 1.vi.2024, 834 m elev., road side next to forest, lepid, leg. B. Landry, C. De Soto, M. Armenteros. 1 ♀, MHNG-ENTO-0261621, Prov. Barahona, Reserva Bosque de las Nubes, 18.1115885, -71.2279869, 4.vi.2024, 1417 m elev., Road side next to small meadow, lepid, leg. B. Landry, C. De Soto, M. Armenteros. 1 ♂, MHNG-ENTO-0261643, Prov. La Vega, Arroyo Frío, M. Armenteros property, 18.9989976, -70.5827272, 1111 m elev., lepid, 13.vi.2024, leg. B. Landry. 3 ♂, FLMNH- MGCL 164862 (dissected, slide 07183), 164864, 164865, Prov. Barahona, nr. Filipinas, Larimar Mine, 6-11-VII-1993, blacklight trap, [leg.] R.E. Woodruff. 1 ♂, FLMNH-MGCL 164863, same data except mercury vap[or]. light. 1 ♂, Prov. Monsiñor Nouel, Complejo Ecoturístico Río Blanco, Estancia del Río, 18.878433, -70.507189, 645 m elev., white lights & lepid, 14.xi.2022, leg. B. Landry. 1 ♂, Prov. La Vega, PN J Pérez Rancier, forest & clearing E of Villa Pajon Eco-Lodge, 18.821486, -70.6833393, 2150 m elev., lepid & uv tubes, 24.xi.2022, leg. B. Landry, D. Néron. 1 ♂, MHNG-ENTO-0261620, Prov. La Vega, Reserva Científica Ebano Verde, trail above Río Arroyazo, 19.034556, -70.543124, 1110 m elev., lepid & uv tubes, 25.xi.2022, leg. B. Landry, D. Néron. (FSCA, MHNG, and MNHNRD)

iNaturalist records, from the Dominican Republic: Puerto Plata Province, Altamira, 19.64423, -70.85670 (Iljohnson); La Vega Province, Jarabacoa, 19.04116, -70.86892 (freddy126); La Vega Province, Constanza, 18.98516, -70.80668 (jiri-hodecek); same data except 18.99484, -70.83641; La Vega Province, Constanza, Arroyo Frío, 19.00429, -70.58918 (maribela).

Etymology: The new name refers to the island of occurrence, Hispaniola.

Distribution: Thus far this species has been found only in the Dominican Republic.

Palpita maribelae Landry & Solis, new species

Figs. 3, 4, 7, 8, 10

Diagnosis: Based on the yellow color of the moths, this species is similar to *Palpita citrina* (Druce, 1902) (type locality: Ecuador, Loja), and *P. estebanalis* (Schaus, 1920) (type locality: Venezuela, San Esteban Valley). However, with a wingspan of 23.0-23.5 mm, *P. maribelae* is smaller than *P. citrina* (wingspan: 33 mm) and *P. estebanalis* (wingspan: 26 mm) according to the original descriptions. Also, based on specimens in MHNG from Venezuela, Aragua (*P. citrina*) and Brazil, Bahia (*P. estebanalis*), the yellow color is less intense, the wings are more translucent, the forewing dash at the end of the cell is a thin line as opposed to a thick dash, and the hindwing possesses a thin, weak cellular dash which is absent in the other two species. Based on these same specimens the male of *P. estebanalis* also has a rather large, protruding scent organ arising from the intersegmental membrane between abdominal sternites II and III, with short, spatulate black scales covered with thinner white scales. In the male genitalia of *P. maribelae*, the long and very thin, thickly sclerotized uncus curving ventrally at right angle and the simple fibula are diagnostic with respect to the other two species for which the uncus is short, about as long as the tegumen, and weakly sclerotized, and the fibula is two-pronged. In the female genitalia, based on the MHNG specimens, both species have ostial sclerites protruding from the body wall and the corpus bursae is much longer than the ductus bursae, especially in *P. estebanalis* for which the corpus bursae is twice as long as the ductus bursae.

Description:

MALE (n=1) (Fig. 4): *Head*: dorsally yellow, with white scales laterally on vertex and occiput, dark brown laterally on fronto-clypeus, chestnut brown behind eye, white ventrally. Labial palpus mostly dark brown, paler brown on inner side, white ventrally until apex of second palpomere. Antenna: scape white ventrally, orange yellow dorsally; flagellomeres yellowish gray. Haustellum scaling whitish yellow. *Thorax*: dorsally yellow and laterally chestnut brown, ventrally satiny white. Prothoracic leg coxa and trochanter pale yellowish white; femur dark brown, black apically; tibia dark brown at base and distal half, yellow on basal half beyond dark-brown base, white midventrally; tibia with tarsomeres I-III white at base, pale yellow apically, with tarsomeres IV-V pale yellow. Mesothoracic leg white with brown on basal half of dorsal edge of tibia, with pale yellow on outer spine of tibia and on tarsomeres. Metathoracic leg white with pale yellow on ultimate two tarsomeres. Forewing length: 11 mm; wingspan: 23.5 mm; forewing length/ width ratio: 2.56. *Wings*: semitranslucent; pattern and colors dorsally as illustrated, with fine white hair-like scales on hindwing; ventrally like dorsal surface except costa more greyish brown, with white scaling along dorsum and as small patch at tip of retinaculum; venation of hindwing without produced costa and Sc+R₁ stem. *Abdomen*: dorsally yellow, as thorax, with row of white scales at apical margin of segments I-VI (more prominent from III-VI); more ochre on last two segments, including over genitalia; ventrally white. *Genitalia* (Figs. 7, 8): Uncus with distinct, narrow lateral arms at base; main shaft very thin, long, about twice as long as tegumen, thickly sclerotized, curving at right angle downward at about 3/5, apically with chaetae preceded by shorter section having about six medium-length setae. Subscaphium ventrally with thickly sclerotized narrow band reaching slightly beyond uncus. Tegumen dorsal bridge narrow, arms short, slightly bulging. Transtilla a pair of narrow 'boomerangs' narrowing in distal half and abutting medially. Valva with straight ventral margin, with broadly and evenly rounded dorsal margin and apex; apex of thickly sclerotized ventral margin ending in simple, rather short, slightly curved, apically narrowly rounded fibula followed by lightly sclerotized and swollen ventral edge terminating at thick bunch of medium-length setae mostly curving dorsomedially; inner side without other ornamentation but with short setae on surface medially and longer ones along margins beyond midlength. Vinculum short, curving upward, subglobular, with

short, straight basal margin in ventral view. Phallus of medium girth, rather long, about 1/3 longer than valva; vesica with slightly curved field of short cornuti about 2/5 as long as phallus shaft.

FEMALE (n=9) (Fig. 3): Head: as in male, except for more filiform antennae. Forewing length: 10.5 (holotype)-11.0 mm; wingspan: 22.5 (holotype)-23.5 mm; forewing length/width ratio: 2.28. *Thorax, abdomen, and wing patterns and colors* as in male. *Genitalia* (n=1) (Fig. 10): Papillae anales slender. Posterior apophyses thin, straight and pointed, reaching beyond middle of segment VIII. Segment VIII of medium length, about 1/3 longer dorsally, thickly sclerotized, with slightly rounded dorsobasal margin, bare dorsally except at apical margin. Anterior apophyses strong, straight, about 1/4 longer than posterior apophyses. Ostium bursae thickly sclerotized, slightly asymmetrical, curving, elongate, ventrally constricted, forming ridge. Ductus bursae with posterior sclerotized section at right angle from ostium bursae, curving and slightly enlarging, with inception of ductus seminalis lateral, near anterior end of this section; anterior section membranous, three times as long as posterior section and elbowing anteriorly from it. Corpus bursae slightly shorter than anterior section of ductus bursae, ventrally produced posteriorly to about twice girth of ductus bursae, narrowing anteriorly; posterior end lateroventrally with pair of moderately long and curved pointed signa with slightly serrated concave (dorsal) margin.

Types:

HOLOTYPE ♀: **DOMINICAN REPUBLIC**: 1- “RD, Prov. La Vega, Arroyo Frío | M. Armenteros property, 18.9929423 | -70.5869051, 1105 m elev., MVL & | lepiled, 14.vi.2024, leg. B. Landry | C. De Soto, M. Armenteros”. 2- “Permis | d’exportation de | Bernard Landry | Rep. Dominicana | VAPB-13087”. 3- “MHNG | ENTO ♀ | 0262648”. 4- “HOLOTYPE | *Palpita* | maribelae | Landry & Solis”. (MHNG)

PARATYPES (1 ♂, 8 ♀): **DOMINICAN REPUBLIC**: 1♀, Prov. La Vega, Constanza, 1740 m, 18°59’43”N, 70°49’23”W, 9.v.2024, leg. J. Hodecek. 3 ♀, Prov. La Vega, Constanza, 1630 m, 18°59’41”N, 70°50’11”W, 8.v.2024, leg. J. Hodecek. 1 ♀, Prov. La Vega, PN Valle Nuevo, Villa Pajon Eco-Lodge, meadow, 18.8216757, -70.6842558, 2135 m elev., lepiled, 6.vi.2024, leg. B. Landry. 1 ♀, same data as holotype. 1 ♀, MHNG-ENTO-0262645, Prov. La Vega, Reserva Científica Ebano Verde, trail above Rio Arroyazo, 19.034556, -70.543124, 1110 m elev., lepiled & uv tubes, 25.xi.2022, leg. B. Landry, D. Néron. 1 ♀, Prov. La Vega, Reserva Científica Ebano Verde, trail above Rio Arroyazo, 19.038446, -70.542041, 1120 m elev., lepiled & uv tubes (at El Balneario), 26.xi.2022, leg. B. Landry, D. Néron. 1 ♂, MHNG-ENTO-0262644, Prov. La Vega, Reserva Científica Ebano Verde, near Estación Casabito (telecom tower), 19.037340, -70.518643, 1450 m elev., lepiled & uv tubes, 27.xi.2022, leg. B. Landry, D. Néron. (MHNG and MNHNRD)
iNaturalist records, from the Dominican Republic: La Vega Province, Constanza, 18.99537, -70.82327 (jiri-hodecek); same data except 18.99486, -70.83642; same data except 18.99483, -70.83639; same data except 18.88357, -70.56559.

Etymology: The new name is in honor of Maribel Armenteros for field trip organization, friendship, and hospitality in the Dominican Republic.

Distribution: Thus far this species has been found only in the Dominican Republic.

ACKNOWLEDGMENTS

We are grateful to the Ministerio de Áreas protegidas y Biodiversidad of the Dominican Republic for the collecting and export permits. BL further thanks Maribel Armenteros and Carlos De Soto Molinari for organizing his visits to the Dominican Republic, help and companionship in the field, as well as hospitality at Arroyo Frío, Daniel Néron for help and companionship in the field, Gabriel de los Santos and Francisco Paz of the MNHNSD, for their help in securing the export permits and kind collaboration. We also thank James Hayden (Gainesville, Florida) for comments on the manuscript

and data on four additional specimens of *P. hispaniolaensis*, Jiri Hodecek (Lausanne) for the gifts of specimens, Florence Marteau (MHNG) for producing the plates, and two reviewers of the manuscript.

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Book Review: *An Amateur's Guide to the Butterflies of Eastern Ecuador and Peru. Volume 1: Papilionidae, Pieridae, Nymphalidae*, by David Geale (2024)

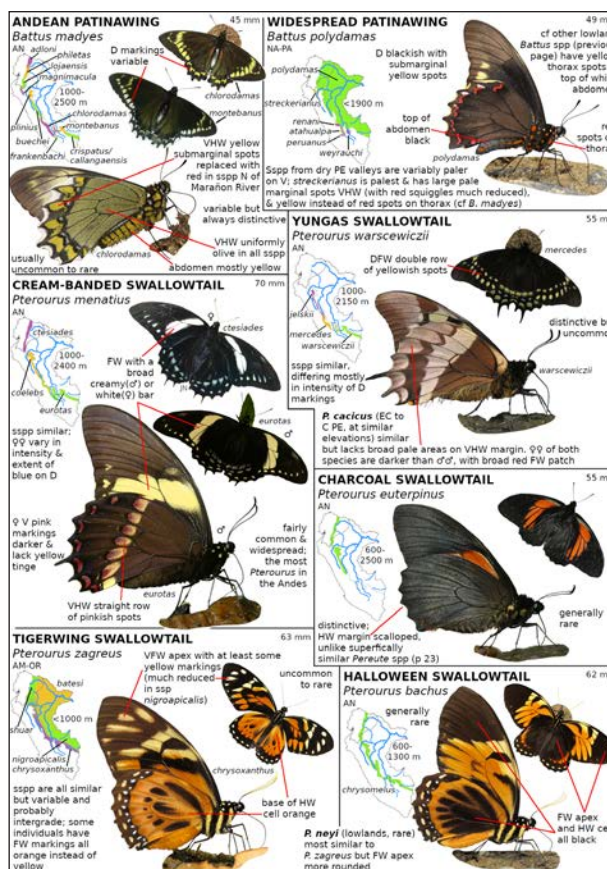
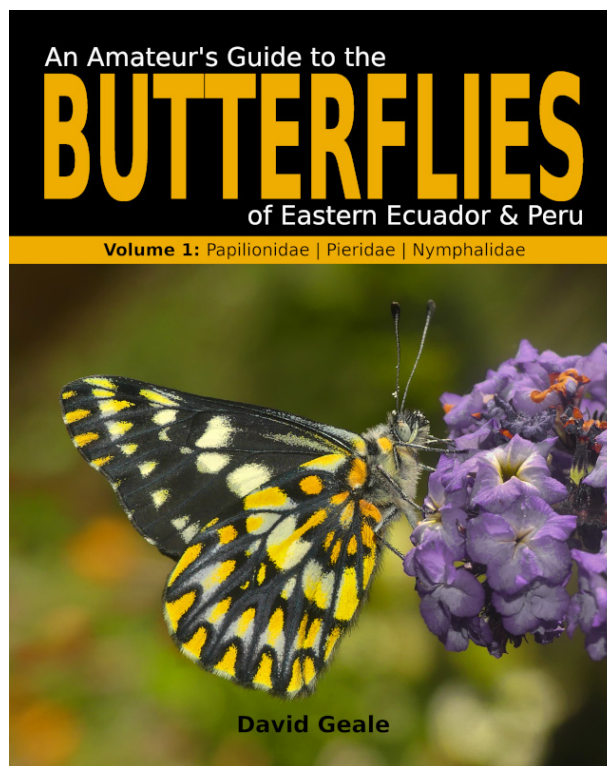
Willow Printing & Publishing Co., available from lapillusbooks.com. xiv + 204 pp.

The western Amazon and adjacent slopes of the eastern Andes form the most biodiverse area on Earth. Hundreds of miles of flat lowland rainforest and swamp suddenly rise up into the perpendicular slopes and vanishingly deep valleys of the Andes, covered in cloud forest and then montane grasslands. These forests, valleys and mountains contain, very roughly, between one fifth to one quarter of the world's butterfly species, and most of those occur in the region covered by this book, eastern Ecuador and Peru.

A decade ago, I would have considered the idea of writing a worthwhile field guide to the species of this region based on photographs of living butterflies to be impossible, but I would have been proven wrong by the author of this book. In a mere dozen years David Geale has succeeded in photographing an unfeasible proportion of Neotropical butterfly species – more than 90% of the 2100 images illustrating the 1241 species featured in this book were taken by the author. While difficult to estimate, this may represent 70% or more of the region's Papilionidae, Pieridae, and Nymphalidae, certainly almost all of the species likely to be readily encountered, and a good number of species that you'd be lucky to see once in a lifetime.

There are several unique and useful features of this book – where to begin? This is a thoroughly practical book, whose primary goal is to help users identify butterflies as quickly as possible. Given that the vast majority of images are of living butterflies, the book is particularly useful for butterfly photographers and watchers, who tend to see only one side of a butterfly's wings. In contrast, most tropical butterfly identification guides (with some exceptions such as Garwood & Lehman (2005), Garwood *et al.* (2007), Glassberg (2007), and Palo-Júnior (2017)) illustrate pinned specimens and focus on whatever characters most easily identify them, regardless of their visibility in nature. Photographers and watchers have thus had to discover a whole new set of identification characters to cope with the limited views available – as I personally realized while trying to identify several thousand images of *Adelpha* in iNaturalist.org with only the dorsal wings visible. That this book concentrates on such characters will be a boon for such readers, while still being of great value for those working with collections of butterfly specimens.

The book is mostly taken up with the plates, with a scant 14 pages of introductory text that explain how to use the book and justify the author's overall approach. As with several other butterfly guides featuring live individuals (e.g., some of those cited above), the author decided to include English names for all species. This is a contentious topic; many taxonomists consider the idea of 'common' names (in any language) for Neotropical butterflies to be a waste of time, given the extreme diversity and similarity of species and lack of existing names for most of them, whereas many in the main target audience for this book appreciate such names. My feeling is that comprehensive common name systems for butterflies are inevitable, and I see



only positive outcomes – if you don't like them, just don't use them. On the other hand, I cannot see any reason to disagree with the principles for such a name system that the author proposes. These include not giving butterflies the same group name as unrelated organisms (such as mammals or birds) and not using the same name for unrelated groups of butterflies. Beyond that, the author proposes that names should be informative and descriptive. The result is a large number of newly minted names alongside existing names that fulfill the above criteria, and, given the scope of the book in terms of butterfly diversity, this effort could contribute to developing coherent global systems of butterfly names in various languages. The remaining introductory pages include some helpful maps and tips about butterfly watching, most notably the use of rotting fish mixed with urine as a bait. Without the use of this bait, it is unlikely that this book could have been completed effectively.

The plates are arranged taxonomically and most species are illustrated with two or more images, many showing dorsal and ventral wings, in some cases with a hand-held (live) specimen for wing surfaces that are difficult to photograph in nature. The images are of high quality and backgrounds have been removed to help focus on the butterfly. Each species has an English name, scientific name, codes indicating the Neotropical range, an elevational range, and a distribution map for the region, color-coded by subspecies. Lines and text indicate key identification characters and similar species that are not illustrated are mentioned. Taxonomic uncertainties are addressed directly: “[*Hermeuptychia*] *fallax* & *H. maimoune* (lowlands) are perhaps indistinguishable; true *hermes* may not occur in our area”. In other cases, known undescribed species are illustrated and noted. Yes, these species cannot yet be reliably identified, but that shouldn't prevent identification of all of the other species.

The result is a book that is packed with information, economical in price, size and weight, and a beautiful tribute to the butterflies of this hyper-diverse region. One can only hope that it will inspire legions of butterfly photographers and watchers to follow in the footsteps of Geale and expand our knowledge of these complex, fascinating and spectacular insects. I look forward eagerly to future volumes on the remaining butterfly families!

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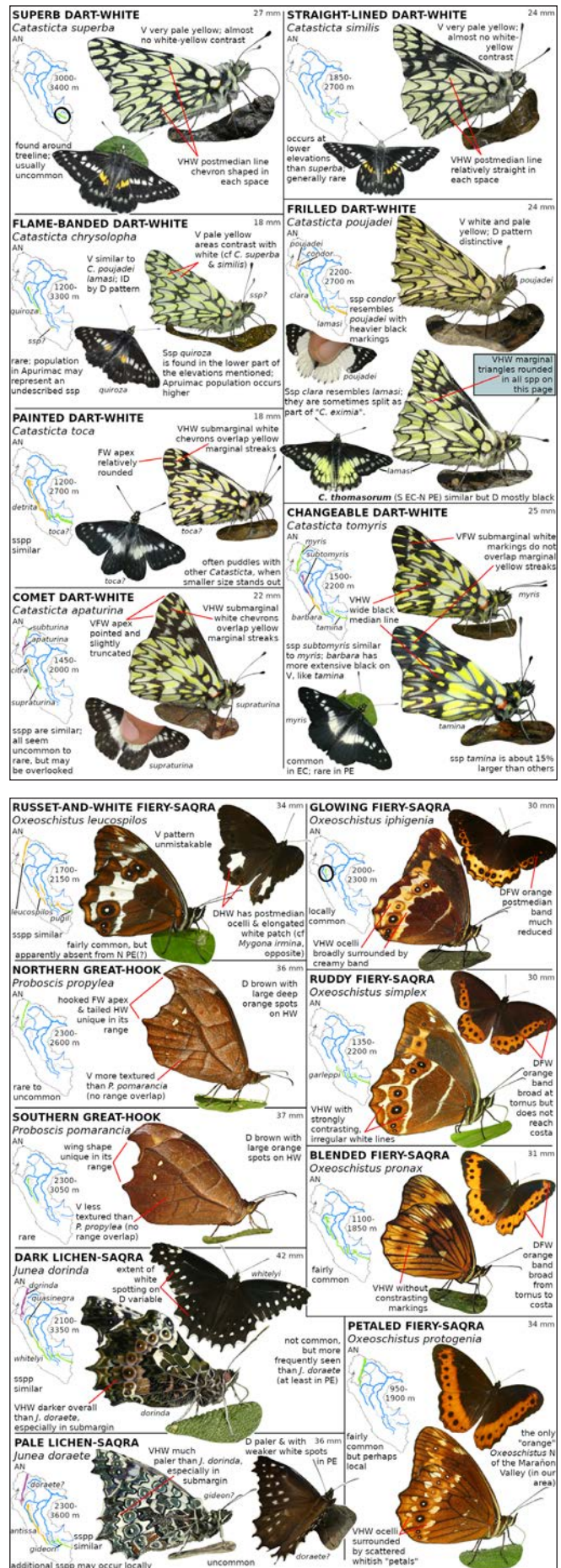
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Keith R. Willmott
McGuire Center for Lepidoptera and Biodiversity,
Florida Museum of Natural History,
Gainesville, FL, USA.



TROPICAL LEPIDOPTERA

Research

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