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A first record of *Hypolimnas misippus* (Linnaeus, 1764) from northwest Africa (Lepidoptera: Nymphalidae)

Idriss Bouam, W. John Tennent, Fouad Bederrar, Abdelkarim Lachichi & Abdelwahab Chedad

Abstract

The Lepidoptera fauna of Algeria is well documented in Mediterranean regions but remains poorly known across the country's Saharan expanse. We report the first confirmed record of *Hypolimnas misippus* (Linnaeus, 1764) in northwestern Africa, based on a solitary male observed and photographed in the Ikenouine wetland in Illizi Province, southeastern Algeria. A notable migrant, the status of this species at the edges of its range remains fluid. The Ikenouine specimen is plausibly a naturally dispersed stray from sub-Saharan Africa. Several host plants associated with *H. misippus* are documented in the broader region. The presence of *H. misippus* at Ikenouine suggests that Saharan wetlands, including those in the Ahaggar and Tassili n'Ajjer massifs, may represent ecological refuges and dispersal stepping-stones along a northward route from sub-Saharan Africa. This record underlines the importance of continued field investigations in remote desert areas of Algeria to better understand Lepidoptera distributions and biogeographic patterns in the region.

Keywords: Lepidoptera, Nymphalidae, *Hypolimnas misippus*, geographic distribution, migration, Sahara, Algeria.

Premier signalement d'*Hypolimnas misippus* (Linnaeus, 1764) en Afrique du Nord-Ouest (Lepidoptera: Nymphalidae)

Résumé

La faune des Lepidoptera de l'Algérie est bien documentée dans les régions méditerranéennes, mais demeure largement méconnue dans l'étendue saharienne du pays. Nous rapportons le premier signalement confirmé d'*Hypolimnas misippus* (Linnaeus, 1764) en Afrique du Nord-Ouest, représenté par un spécimen unique mâle observé et photographié dans la zone humide d'Ikenouine, dans la wilaya d'Illizi, au sud-est de l'Algérie. Espèce migratrice remarquable, son statut aux marges de son aire de répartition demeure incertain. L'exemplaire d'Ikenouine semble être un erratique ayant atteint la région par dispersion naturelle depuis l'Afrique subsaharienne. Plusieurs plantes-hôtes associées à *H. misippus* sont recensées dans la région au sens large. La présence de *H. misippus* à Ikenouine suggère que les zones humides sahariennes, notamment celles des massifs de l'Ahaggar et du Tassili n'Ajjer, pourraient constituer à la fois des refuges écologiques et des relais de dispersion le long d'un axe de migration vers le nord depuis l'Afrique subsaharienne. Ce signalement souligne l'importance de poursuivre les prospections de terrain dans les régions désertiques reculées de l'Algérie, afin de mieux comprendre la répartition et les schémas biogéographiques des Lepidoptera dans la région.

Mots-clés: Lepidoptera, Nymphalidae, *Hypolimnas misippus*, distribution géographique, migration, Sahara, Algérie.

Primer registro de *Hypolimnas misippus* (Linnaeus, 1764) en el noroeste de África (Lepidoptera: Nymphalidae)

Resumen

La fauna de Lepidoptera de Argelia está bien documentada en las regiones mediterráneas, pero sigue siendo poco conocida en la extensión sahariana del país. Presentamos el primer registro confirmado de *Hypolimnas misippus* (Linnaeus, 1764) en el noroeste de África, basado en un macho solitario observado y fotografiado en el humedal de Ikenouine, en la provincia de Illizi, al sureste de Argelia. Esta especie, notable por su migración, tiene un estatus incierto en los límites de su área de distribución. El espécimen de Ikenouine es probablemente un ejemplar disperso de forma natural desde el África subsahariana. En la región se han documentado varias plantas hospedadoras asociadas a *H. misippus*. La presencia de *H. misippus* en Ikenouine sugiere que los humedales del Sáhara, incluidos los de los macizos de Ahaggar y Tassili n'Ajjer, pueden representar refugios ecológicos y puntos de dispersión a lo largo de una ruta hacia el norte desde el África subsahariana. Este registro subraya la importancia de continuar las investigaciones de campo en zonas desérticas remotas de Argelia para comprender mejor la distribución de los Lepidoptera y los patrones biogeográficos de la región.

Palabras clave: Lepidoptera, Nymphalidae, *Hypolimnas misippus*, distribución geográfica, migración, Sáhara, Argelia.

Introduction

The Lepidoptera fauna of Algeria is relatively well-documented, with the earliest data on its diversity provided by Linnaeus, who described several widespread Lepidoptera from Algeria in the mid-18th century (Honey & Scoble, 2001) as a direct result of specimens sent to him by Erik Brander, Swedish Consul in Algiers from 1753 to 1765 (Tennent, 1996). This was followed by several notable contributions, including those of Charles Oberthür (1845-1924) between 1909 and 1912, and Seurat's (1930) synthesis of existing literature, culminating in Tennent's (1996) monograph. In the past decade, there has been a renewed focus on Algerian Lepidoptera, with several studies expanding our knowledge of species diversity, particularly within the country's northern Mediterranean regions (Aissat & Belmihoub, 2024; Berkane et al. 2019; Bouam et al. 2024; Bougaham et al. 2023; Frahtia et al. 2022; Kacha et al. 2020; Laref et al. 2022; Remini & Moulaï, 2015; Saouli et al. 2022).

In contrast, the Sahara, which covers the majority of Algeria's territory, remains comparatively underexplored, largely due to the country's vast geographical expanse and the remoteness of many regions (Weiss et al. 2018), both of which make collection of comprehensive data challenging. Most available records are confined to the Ahaggar and Tassili n'Ajjer massifs (Nazari et al. 2025; Speidel & Hassler, 1989; Tennent, 1996). However, recent investigations in previously overlooked areas of the Algerian Sahara have begun to address this gap, enhancing our understanding of Lepidoptera diversity in the region and documenting taxa previously unrecorded in both Algeria and North Africa (Bougaham et al. 2024; Boulaouad et al. 2024).

Hypolimnas misippus (Linnaeus, 1764), commonly known as the Diadem, Danaid Eggfly, or False Plain Tiger, is a medium-sized nymphalid renowned as a strong migrant, having been recorded as far as 322 km out in the ocean (Scott, 1986). The species has a wide pantropical distribution with limited extension into temperate zones, occurring across sub-Saharan Africa, the eastern Mediterranean, the Arabian Peninsula, Indomalaya, Oceania (including the D'Entrecasteaux, the Louisiades and Vanuatu: historical and unpublished data), the Americas (Coetzer & Westrip, 2021), numerous islands, such as Macaronesia including the Cape Verde Islands (Tennent et al. 2013; Tennent & Russell, 2015), the Antilles (Scott, 1986), and Mauritius (Davis & Barnes, 1991). *H. misippus* is notable for its pronounced sexual dimorphism and is a classic example of sex-linked Batesian mimicry. Males are fundamentally black on the upperside, with a violet sheen and prominent white spots, while the various forms of the polymorphic females include striking mimicry of the toxic *Danaus chrysippus* (Linnaeus, 1758) (Orteu et al. 2024).

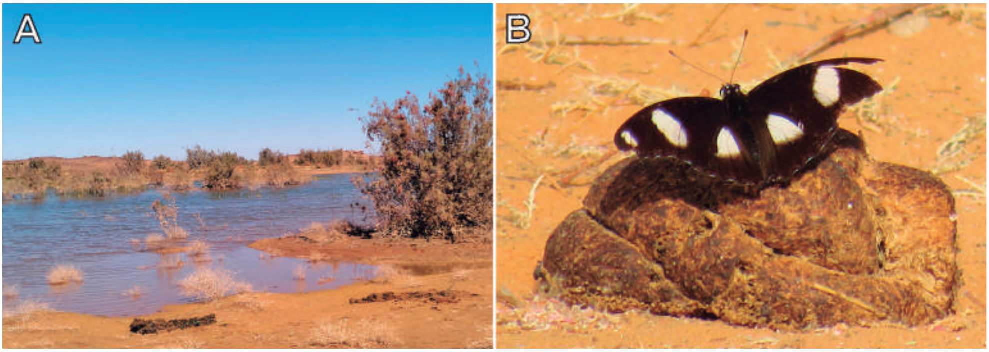
Herein, we document the first reported occurrence of *Hypolimnas misippus* in northwest Africa, specifically in southeastern Algeria.

Materials and Methods

Study area

Field observations were made during a wildlife photography expedition by the third and fourth authors in the Ikenouine wetland (27.0103ºN, 8.7581ºE; elevation: 505 m; Figure 1A), located in Illizi Province, southeastern Algeria. This wetland, covering approximately 60 hectares, forms part of a complex of three interconnected wetlands and lies within the North Saharan Xeric Steppe and Woodland ecoregion (Naia & Brito, 2021). Collectively, these sites provide habitat for a variety of taxa, including numerous migratory bird species. Climatic data extracted from the WorldClim database (~1 km² resolution; Fick & Hijmans, 2017), combined with Emberger's pluviothermic quotient as applied by Daget (1977), classify the area within the inferior Saharan bioclimatic zone, characterized by mild winters and extremely low annual precipitation, averaging 21 mm.

Figure 1. (A) View of the Ikenouine wetland, Illizi Province, southeastern Algeria, where the butterfly was observed. **(B)** ♂ *Hypolimnas misippus* (Linnaeus, 1764) photographed at the site on 28-XII- 2024, settled on dung near the water margin. Photographs by Fouad Bederrar.



Data collection

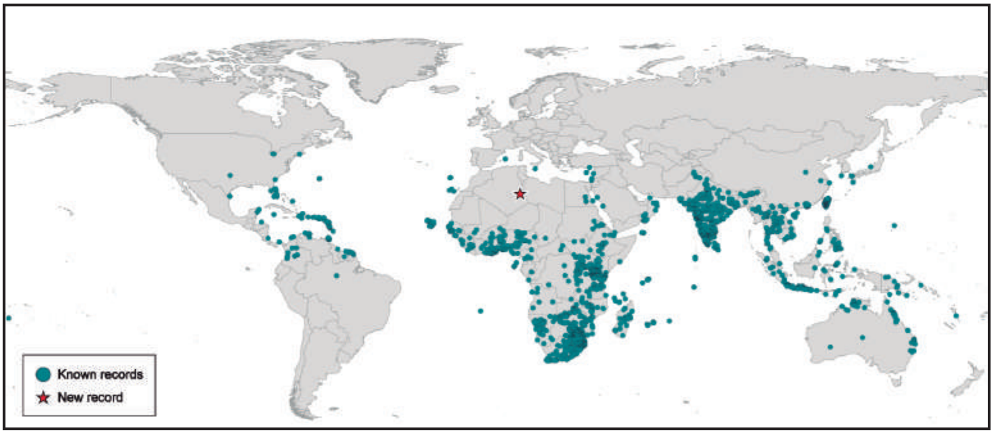
To map the global records of *Hypolimnas misippus*, occurrence data were retrieved from the Global Biodiversity Information Facility (GBIF, 2025). While GBIF provides a broad and valuable repository of biodiversity data, its records are subject to various sources of error and spatial bias (Maldonado et al. 2015). To mitigate these limitations, data cleaning procedures were implemented using the "*CoordinateCleaner*" R package (Zizka et al. 2019). Records were excluded if they contained missing or invalid geographic coordinates, coordinate uncertainties exceeding 10 km, or precision values of less than one decimal degree. Additional filtering removed duplicate entries, occurrences located in marine environments, and records falling on country, province, or capital centroids, as well as biodiversity institution coordinates. Further manual validation was performed to ensure data integrity. We also manually added four reliable occurrence points from Turkey, Lebanon, Malta, and Cyprus based on published literature (Hesselbarth et al. 1995; John et al. 2023; Mérit & Mérit, 2007; Sciberras & Sciberras, 2011). The final curated dataset comprised 4,182 occurrence records, which were visualised using ArcGIS v. 10.8.

Results and Discussion

On 28-XII-2024, a solitary male *Hypolimnas misippus* (Figure 1B) was observed in active flight and subsequently photographed at the Ikenouine wetland. The individual, which was not collected, had moderate wing damage on the right forewing but appeared otherwise in good condition. This constitutes the first documented record of *H. misippus* in northwestern Africa (Figure 2).

The nearest known *misippus* locality to our observation is Malta, approximately 1,120 km to the northeast, where the species has been reported and speculated to result from anthropogenic introduction, although no definitive evidence supports this claim (Sciberras & Sciberras, 2011). Similar uncertainties surround its occurrence in other regions, such as North America and the West Indies, where introductions have been proposed but remain unconfirmed (Scott, 1986). Notably, *H. misippus* has also been recorded on isolated oceanic islands, including numerous south Pacific islands (Tennent, 2006) and Saint Helena, over 2,000 km from the nearest mainland (GBIF, 2025), further underscoring the species' capacity for long-distance dispersal, whether natural or human-assisted.

Figure 2. Global records of *Hypolimnas misippus* (Linnaeus, 1764) based on curated occurrence data from GBIF (2025) and literature sources (Hesselbarth et al. 1995; Mérit & Mérit, 2007; Sciberras & Sciberras, 2011; John et al. 2023), shown as blue circles. The red star marks the new record documented in this study from the Ikenouine wetland, Illizi Province, southeastern Algeria.



The biogeographic status of *H. misippus* at the margins of its range is unstable and remains largely unresolved. In the Levant, Larsen (1975) interpreted its rare appearances as accidental or the result of sporadic incursions from Egypt, rather than evidence of regular migratory movements, a scenario which may equally account for our observation.While the provenance of the Ikenouine specimen remains uncertain, it is plausibly a naturally dispersed stray originating from sub-Saharan Africa. We note the recent detection of *Chilades eleusis* (Demaison, 1888), a Lycaenidae of Afrotropical origin, in the Algerian Sahara (Boulaouad et al. 2024).

H. misippus is strongly polyphagous, with host plants reported from numerous genera across at least ten plant families (John & Makris, 2022; Scott, 1986; Vane-Wright et al. 1977). Several of these families and genera, such as Amaranthaceae, *Ficus* (Moraceae), *Portulaca* (Portulacaceae), *Abutilon* and *Hibiscus* (Malvaceae), are documented in the Illizi region and in adjacent areas including Djanet, Tamanrasset, and further south near Timiaouine (Hammiche & Maiza, 2006; iNaturalist, 2025; Miara et al. 2019), suggesting that a gravid female would find suitable habitat in the region. The presence of *H. misippus* at Ikenouine suggests that Saharan wetlands, including those scattered across the Ahaggar and Tassili n'Ajjer massifs (GDF, 2016), which are positioned along a potential northward dispersal route from sub-Saharan Africa and where vegetation tends to concentrate in and around bodies of water, may act as temporary ecological refuges for a wide-ranging vagrant species. This interpretation is consistent with experimental findings indicating that even isolated or low-quality habitats can function as effective dispersal corridors, provided they are traversed within a single generation (Haddad & Tewksbury, 2005).

Although based on a single observation, this record contributes valuable data to the known distribution of *H. misippus* and highlights the need for further systematic biodiversity surveys in Saharan areas.

Conflict of Interest

The authors declare that they have no known financial interest or personal relationship that could have influenced the work presented in this article.

References

Aissat, L., & Belmihoub, H. E. (2024). Abundance and diversity of butterflies in urban green areas of Setif city (Algeria). *Journal of Insect Biodiversity*, *58*(2), 28-38. https://doi.org/10.12976/jib/2024.58.2.1

Berkane, S., Rahmani, A., Arifi, B., & Moulaï, R. (2019). Diversity and ecology of diurnal lepidoptera in Belezma National Park (Aurès, Algeria). *Zoology and Ecology*, *29*(2), 143-151. https://doi.org/10.35513/21658005.2019.2.11

Bouam, I., Tennent, W. J., Abdennebi, A., & Benmokhtar, E. (2024). Rediscovery of the Endangered *Pseudophilotes fatma* (Oberthür, 1890) (Lepidoptera: Lycaenidae) in Algeria after 71 years, with an update on its distribution and designation of a lectotype. *Zootaxa*, *5543*(2), 287-295. https://doi.org/10.11646/zootaxa.5543.2.10

Bougaham, A. F., Gougam, H., Soukkou, W., & Hadoun, A. (2023). First record of *Azanus jesous* (Stoll, 1782) in Algeria (Lepidoptera: Lycaenidae). *SHILAP Revista de lepidopterología*, *51*(203), 573-576. https://doi.org/10.57065/shilap.544

Bougaham, A. F., Hadoun, A., Seddiki, F., & Soukkou, W. (2024). First record of *Colotis amata* (Fabricius, 1775) in North Africa (Lepidoptera: Pieridae). *SHILAP Revista de lepidopterología*, *52*(207), 559-562. https://doi.org/10.57065/shilap.957

Boulaouad, B. A., Harzallah, B., Missoum, M., Ayyach, K., & Verovnik, R. (2024). Photographic survey of butterflies (Lepidoptera: Papilionoidea) in southern Algeria with the first record of the Sky-Blue Cupid, *Chilades eleusis* (Demaison, 1888) for the country. *Natura Croatica*, *33*(1), 159-165. https://doi.org/10.20302/NC.2024.33.12

Coetzer, A. J., & Westrip, J. R. S. (2021). *Hypolimnas misippus*. The IUCN Red List of Threatened Species 2021: e.T62148588A161331411. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T62148588A161331411.en

Daget, P. (1977). Le bioclimat méditerranéen: caractères généraux, modes de caractérisation. *Vegetatio*, *34*, 1-20. https://doi.org/10.1007/BF00119883

Davis, P. M. H., & Barnes, M. J. C. (1991). The Butterflies of Mauritius. *Journal of Research on the Lepidoptera*, *30*(3-4), 145-161. https://doi.org/10.5962/p.332210

Fick, S. E., & Hijmans, R. J. (2017). WorldClim 2: new 1-km spatial resolution climate surfaces for global land areas. *International Journal of Climatology*, *37*(12), 4302-4315. https://doi.org/10.1002/joc.5086

Frahtia, K., Attar, M. R., & Diabi, C. (2022). Diversity and richness of day Butterflies species (Lepidoptera: Rhopalocera) in the Chettaba Forest, Constantine, Northeastern Algeria. *Biodiversitas*, *23*(7), 3429-3436. https://doi.org/10.13057/biodiv/d230715

GBIF (2025). *GBIF Occurrence Download*. https://doi.org/10.15468/dl.pqjjyx

GDF (General Directorate of Forestry) (2016). Stratégie nationale de gestion ecosystémique des zones humides d'Algérie. https://medwet.org/publications/algeria-national-wetlands-strategy-2015-2030/

Gilbert, F. & Zalat, S. M. (2007). *Butterflies of Egypt: atlas, Red Data listing and conservation*. Egyptian Environmental Affairs Agency.

Haddad, N. M., & Tewksbury, J. J. (2005). Low-quality habitat corridors as movement conduits for two butterfly species. *Ecological Applications*, *15*(1), 250-257. https://doi.org/10.1890/03-5327

Hammiche, V., & Maiza, K. (2006). Traditional medicine in Central Sahara: Pharmacopoeia of Tassili N'ajjer. *Journal of Ethnopharmacology*, *105*(3), 358-367. https://doi.org/10.1016/j.jep.2005.11.028 PMid:16414225

Hesselbarth, G., Van Oorschot, H., & Wagener, S. (1995). *Die Tagfalter der Türkei unter Berücksichtigung der angrenzenden Länder*. Selbstverlag Sigbert Wagener.

Honey, M. R., & Scoble, M. J. (2001). Linnaeus's butterflies (Lepidoptera: Papilionoidea and Hesperioidea). *Zoological Journal of the Linnean Society*, *132*(3), 277-399. https://doi.org/10.1111/j.1096-3642.2001.tb01326.x

iNaturalist (2025). *iNaturalist Research-grade observations*. https://www.inaturalist.org

John, E., Aksoylu, E., Bağlar, H., & Ffrench-Constant, R. (2023). Larval polymorphism in *Danaus chrysippus* (Linnaeus) (Lepidoptera: Danainae) and the reappearance of its mimic *Hypolimnas misippus* (Linnaeus) (Lepidoptera: Nymphalinae) in Cyprus. *Entomologist's Monthly Magazine*, *159*(4), 1-14. https://doi.org/10.31184/M00138908.1594.4215

John, E., & Makris, C. (2022). *Butterflies of Cyprus. A field guide and distribution atlas*. CABI.

Kacha, S., Djerbaoui, M., Marniche, F., De Prins, W., Ramdani, M., Roger, F., & Moulaï, R. (2020). Diversity and abundance of Lepidoptera populations in the Theniet El Had National Park (Algeria). *Zootaxa*, *4743*(1), 35-46. https://doi.org/10.11646/zootaxa.4743.1.3 PMid:32230350

Laref, N., Rezzag-Bedida, R., Boukheroufa, M., Sakraoui, R., Henada, R. L. I., Hadiby, R., & Sakraoui, F. (2022). Diversity and status of day butterflies (Lepidoptera: Rhopalocera) in different plant associations of the Edough Forest Massif (Northeastern Algeria). *Biodiversitas*, *23*(2), 954-961. https://doi.org/10.13057/biodiv/d230238

Larsen, T. B. (1975). Provisional notes on migrant butterflies in Lebanon. *Atalanta*, *6*(2), 62-74. https://www.zobodat.at/pdf/Atalanta_6_0062-0074.pdf

Maldonado, C., Molina, C. I., Zizka, A., Persson, C., Taylor, C. M., Albán, J., Chilquillo, E., Rønsted, N., & Antonelli, A. (2015). Estimating species diversity and distribution in the era of Big Data: to what extent can we trust public databases? *Global Ecology and Biogeography*, *24*(8), 973-984. https://doi.org/10.1111/geb.12326 PMid:27656106 PMCid:PMC5012125

Mérit, X., & Mérit, V. (2007). Rediscovery of *Hypolimnas misippus* (Linnaeus,1764) as a unique female in Lebanon during spring 2003. *Atalanta*, *38*(3/4), 319-320. https://www.zobodat.at/pdf/Atalanta_38_0319-0320.pdf

Miara, M. D., Teixidor-Toneu, I., Sahnoun, T., Bendif, H., & Ait Hammou, M. (2019). Herbal remedies and traditional knowledge of the Tuareg community in the region of Illizi (Algerian Sahara). *Journal of Arid Environments*, *167*, 65-73. https://doi.org/10.1016/j.jaridenv.2019.04.020

Nazari, V., Habel, J. C., Schmitt, T., & Todisco, V. (2025). Desert biogeography in the Central Saharan highlands: insights from butterflies of the Hoggar Mountains. *Biological Journal of the Linnean Society*, *145*(2), blaf029. https://doi.org/10.1093/biolinnean/blaf029

Naia, M., & Brito, J. C. (2021). *Ecoregions of the Sahara-Sahel: characteristics and Conservation Status*. CIBIO/InBIO. Biodeserts Report EN-03. https://doi.org/10.13140/RG.2.2.25060.30082

Orteu, A., Kucka, M., Gordon, I. J., Ng'iru, I., van der Heijden, E. S. M., Talavera, G., Warren, I. A., Collins, S., Ffrench-Constant, R. H., Martins, D. J., Chan, Y. F., Jiggins, C. D., & Martin, S. H. (2024). Transposable element insertions are associated with Batesian mimicry in the pantropical butterfly *Hypolimnas misippus*. *Molecular Biology and Evolution*, *41*(3), msae041. https://doi.org/10.1093/molbev/msae041 PMid:38401262 PMCid:PMC10924252

Remini, L., & Moulaï, R. (2015). Diversity and structure of butterfly populations in agro-ecosystems of Mitidja (Algeria). *Zoology and Ecology*, *25*(4), 355-364. https://doi.org/10.1080/21658005.2015.1090119

Saouli, H., Boucif, A., Djabourabi, R., & Soualah Alila, H. (2022). Butterflies' biodiversity of Souk Ahras Forest (Mechroha and Ouled Driss north east of Algeria). *African Journal of Ecology*, *60*(4), 1081-1093. https://doi.org/10.1111/aje.13041

Sciberras, A., & Sciberras, J. (2011). Two specimens of *Hypolimnas misippus* (Linnaeus, 1764) (Lepidoptera: Nymphalidae) in the Maltese islands. *The Central Mediterranean Naturalist*, *5*(3-4), 59-60. https://www.um.edu.mt/library/oar//handle/123456789/15422

Scott, J.A. (1986). *The Butterflies of North America*. Stanford University Press. https://doi.org/10.1515/9781503624450

Seurat, L. G. (1930). *Exploration Zoologique de l'Algérie : De 1830 à 1930*. Masson et Cie.

Speidel, W., & Hassler, M. (1989). Die Schmetterlingsfauna der südlichen algerischen Sahara und ihrer Hochgebirge Hoggar und Tassili n'Ajjer (Lepidoptera). *Nachrichten des entomologischen Vereins Apollo*, Supplement *8*, 1-156. https://www.zobodat.at/pdf/NEVA-SUP_8_0001-0156.pdf

Tennent, W. J. (1996). *The Butterflies of Morocco, Algeria and Tunisia*. Gem Publishing Company.

Tennent, W. J. (2006). A checklist of the butterflies of Melanesia, Micronesia, Polynesia and some adjacent areas. *Zootaxa*, *1178*(1), 1-209. https://doi.org/10.11646/zootaxa.1178.1.1

Tennent, W. J., Aguiar, A. M. F., Healey, D., & Ferreira A. (2013). Recent records of *Hypolimnas misippus* (Linnaeus, 1764) (Lepidoptera: Nymphalidae) from Madeira, Portugal, with a resumé of historical records from Macaronesia. *Entomologist's Gazette*, *64*(2), 101-108. https://www.researchgate.net/publication/236981321_Recent_records_of_Hypolimnas_misippus_Linnaeus_1764_Lepidoptera_Nymphalidae_from_Madeira_Portugal_with_a_resume_of_historical_records_from_Macaronesia

Tennent, W. J., & Russell, P. J. C. (2015). Butterflies of the Cape Verde Islands (Insecta, Lepidoptera). *Zoologia Caboverdiana*, *5*(2), 64-104. https://www.scvz.org/zoolcv/vol5no2/Tennent%20&%20Russell%20Cape%20Verde%20butterflies.pdf

Vane-Wright, R. I., Ackery, P. R., & Smiles, L. (1977). The polymorphism, mimicry, and host plant relationships of *Hypolimnas* butterflies. *Biological Journal of the Linnean Society*, *9*(3), 285-297. https://doi.org/10.1111/j.1095-8312.1977.tb00271.x

Weiss, D. J., Nelson, A., Gibson, H. S., Temperley, W., Peedell, S., Lieber, A., Hancher, M., Poyart, E., Belchior, S., Fullman, N., Mappin, B., Dalrymple, U., Rozier, J., Lucas T. C. D., Howes, R. E., Tusting, L. S., Kang, S. Y., Cameron, E., Bisanzio, D., Battle, K. E., Bhatt S., & Gething, P. W. (2018). A global map of travel time to cities to assess inequalities in accessibility in 2015. *Nature*, *553*, 333-336. https://doi.org/10.1038/nature25181 PMid:29320477

Zizka, A., Silvestro, D., Andermann, T., Azevedo, J., Ritter, C. D., Edler, D., Farooq, H., Herdean, A., Ariza, M., Scharn, R., Svantesson, S., Wengström, N., Zizka, V., & Antonelli, A. (2019). CoordinateCleaner: Standardized cleaning of occurrence records from biological collection databases. *Methods in Ecology and Evolution*, *10*(5), 744-751. https://doi.org/10.1111/2041-210X.13152

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COMITÉ PARA LA PROTECCIÓN DE LA NATURALEZA, PROYECTO DE INVESTIGACIÓN CIENTÍFICA DE SHILAP / *COMMITTEE FOR THEPROTECTION OF NATURE, SHILAP SCIENTIFIC RESEARCH PROJECT*

Solicitud de autorización para recoger Lepidoptera con fines científicos en España

Las solicitudes cumplirán las siguientes condiciones:

1.– Estar al día en el pago de la cuota anual de la Sociedad,antes de solicitar los permisos.

2.– Enviar un correo electrónico al Secretario General de SHILAP con todos los datos personales, incluyendo nombre, apellidos, dirección, DNI o número de pasaporte, número de teléfono (con código del país y prefijo) y correo electrónico. Estos datos serán enviados al Secretario General con un mínimo de 45 días de antelación al período de captura previsto.

3.– Se detallará el área donde se desea capturar el material (provincia y/o región), el período de tiempo (días, meses o todo el año); método de captura que se desea emplear (manga entomológica, grupo electrógeno, etc.), material que se desea recoger (especies, géneros, familias, y/o superfamilias) y cualquier otro dato que se desee añadir.

4.– Todos los socios de SHILAP que soliciten estos permisos para recoger Lepidoptera en España con fines científicos, serán incluidos en el Proyecto de Investigación Científica creado por la Sociedad y denominado: *“Faúnula Lepidopterológica Ibérica, Baleárica y región Macaronésica”*.

5.– Con el fin de contribuir con este Proyecto Científico, se ruega remitan a SHILAP, **o una copia por correo electrónico (e-mail), con el listado del material recogido en EXCEL**, sólo en este formato, indicando la Familia, Subfamilia, Tribu, nombre de la especie (género, especie, autor y año), localidad, coordenadas UTM (1 X 1) o GPS, provincia, fecha de captura, colector y número de machos y hembras capturados **(sólo 5 ejemplares por taxón y localidad, máximo)**. Por favor, utilice sólo el *“Catálogo sistemático y sinonímico de los Lepidoptera de la Península Ibérica, de Ceuta, de Melilla y de las islas Azores, Baleares, Canarias, Madeira y Salvajes (Insecta: Lepidoptera)”* (A. VIVES MORENO, 2014)”. Esta lista es necesaria para este Proyecto Científico de SHILAP y para nuevas autorizaciones.

6.–**Es obligatorio publicar en** SHILAP Revista de lepidopterología, las nuevas especies o subespecies que se descubran y remitir a SHILAP **una parte del material TIPO**, para su posterior incorporación a la colección de Lepidoptera del Museo Nacional de Ciencias Naturales en Madrid, España.

7.– Se recuerda a todos los socios de la obligación de estar autorizados para recoger Lepidoptera, con fines científicos, en España y que está prohibida todo tipo de actividad comercial, con el material capturado.

8.– Conocer los fines científicos de SHILAP y comprometerse a pagar los gastos de participación en este Proyecto Científico, que la Junta Directiva considere en cada momento.

Application for permits to collect Lepidoptera in Spain for scientific purposes

Applications must abide by the following conditions:

1.– The Society’s annual fee must be paid before applyin for the permits.

2.– To send an electronic mail the General Secretary o SHILAP, with all the personal data, including name, sur-name, address, ID card number or Passport number, telephone number (with country code and prefix) and electronic mail address. These data must reach the General Secretary at least 45 days in advance of the foreseen collecting activity.

3.– The collecting area to be visited by the applicant should also be detailed (province and/or region), expected dates (days, months, or the whole year), collecting method (entomological net, generator, etc.), taxonomical groups of interest to be collected (species, genera, families and/or superfamilies); any other data the applicant wishes to add.

4.– All members of SHILAP who apply for these permits to collect Lepidopterain Spain with scientific purposes, will be included in the Scientific Research Project created by the Society and called: *“Lepidopterological Fauna of the Iberian Peninsula, Balearic Islands and Macaronesianregion”*.

5.– In order to contribute to this Scientific Project, it is requested to send to SHILAP, **either a copy by electronic mail (e-mail), with the listing of materials collected in EXCEL** (-only in this format, please), indicating the Family, Subfamily, Tribe, name of the species (genera, species, author’s name and year), town, UTM (1X1)or GPS coordinates, province, dates of capture, collector and numbers ofmales and females captured **(only 5 specimens per taxonand locality, maximum)**. Please, use only the “*Catálogo sistemático y sinonímico de los Lepidoptera de la Península Ibérica, de Ceuta, de Melilla y de las islas Azores, Baleares, Canarias, Madeira y Salvajes (Insecta: Lepidoptera)* (A.VIVES MORENO, 2014)”. This list is necessary for this Scientific Project of SHILAP and for new authorizations.

6.– **It’s obligatory to publish in** SHILAP Revista de lepidopterología, the new species or subspecies that are discovered and to remit to SHILAP **a part of the TYPE material**, for later incorporation into the Lepidoptera Collectionof the National Museum Natural Sciences, Madrid, Spain.

7.– All members are kindly reminded of the obligation to be duly authorized for collecting Lepidoptera, with scientific purposes, in Spain and that it is forbidden all type of commercial activity, with the captured material.

8.– To know about the scientific aims of SHILAP and to commit to pay the expenses of participation in this Scientific Project, that the Board of Directors considers at any given moment.

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First Record of *Vanessa atalanta* (Linnaeus, 1758) from India: An Extension of its Known Distribution in Eurasia (Lepidoptera: Papilionoidea, Nymphalidae)

Lovish Garlani

Abstract

This study reports the first confirmed record of *Vanessa atalanta* (Linnaeus, 1758) in India, marking a significant range extension of this species into the Eurasian region. A single specimen was documented during an opportunistic field survey conducted in April 2025 in the Dharamshala region of Himachal Pradesh. This observation expands the known geographical distribution of *V. atalanta* and provides preliminary insights into its local habitat preferences and potential larval host plants in the Western Himalayan ecosystem. These findings contribute to the broader understanding of the species' ecological adaptability and biogeographical dynamics in South Asia.

Keywords: Lepidoptera, Papilionoidea, Nymphalidae, migration, *Vanessa*, Western Himalayas, Eurasia.

Primer registro de *Vanessa atalanta* (Linnaeus, 1758) de la India: una extensión de su distribución conocida en Eurasia (Lepidoptera: Papilionoidea, Nymphalidae)

Resumen

Este estudio presenta el primer registro confirmado de *Vanessa atalanta* (Linnaeus, 1758) en la India, lo que supone una importante ampliación del área de distribución de esta especie en la región euroasiática. Se documentó un único espécimen durante un estudio de campo oportunista realizado en abril de 2025 en la región de Dharamshala, en Himachal Pradesh. Esta observación amplía la distribución geográfica conocida de *V. atalanta* y proporciona información preliminar sobre sus preferencias de hábitat local y las posibles plantas nutricias de las larvas en el ecosistema del Himalaya occidental. Estos hallazgos contribuyen a una comprensión más amplia de la adaptabilidad ecológica y la dinámica biogeográfica de la especie en el sur de Asia.

Palabras clave: Lepidoptera, Papilionoidea, Nymphalidae, migración, *Vanessa*, Himalaya occidental, Eurasia.

Introduction

The European Red Admiral *Vanessa atalanta* (Linnaeus, 1758) is a common and widely spread species and well-known for its active migration (Tuzov et al. 2000; Mikkola, 2003; Bozano & Floriani, 2012). The species currently comprises two distinct subspecies: the nominate form, which occurs across the Old World, and *Vanessa atalanta rubria* Fruhstorfer, 1909, which is distributed throughout North America, ranging from Canada to Mexico (Bozano & Floriani, 2012). Records of *Vanessa atalanta* in Central Asia remain sparse and are likely the result of incidental or migratory occurrences rather than established populations. The species has been observed as far east as the Altai Mountains and the Zaisan Valley in Kazakhstan (Tshikolovets et al. 2016). In the Altai Territory, the species has started to appear annually, but only in autumn (Chumakov et al. 2024). To date, *Vanessa atalanta* has not been recorded in Afghanistan (Tshikolovets et al. 2018) but is highly expected. In contrast, its presence in Iran is well established, with confirmed occurrences ranging from the southwestern regions, including the Zagros Mountains, to the northern provinces such as the Alborz range and areas along the southern coast of the Caspian Sea (Nazari, 2003; Naderi, 2019). Notably, there are currently no confirmed reports of its presence in regions such as China and Mongolia. *Vanessa atalanta* was first reported in South Asia from a specimen collected by Colonel Stockley in 1929 in Shinghar, located in the Zhob district of Balochistan province, at an elevation of approximately 2400 meters, in a forest dominated by *Pinus gerardiana* (Evans, 1932a; Roberts, 2001). The species was recently rediscovered in Pakistan, with two confirmed records from the Lower Chitral District in Khyber Pakhtunkhwa Province (Awan et al. 2022). After the recent rediscovery, the species has also been reported from various locations in Pakistan, including Upper Chitral, Swat, Taxila, Khyber, Noshehra and Rawalpindi (Awan, pers. comm., 2025). To date, there have been no verified records of its presence in India; therefore, the current study represents the first confirmed documentation of the species in this region.

Materials and Methods

On 22 April 2025, during an opportunistic field survey in the Thatharna region near Dharamshala, Himachal Pradesh, a single specimen of *Vanessa atalanta* (Figure 3a) was observed in association with multiple individuals of *Vanessa cardui* (Linnaeus, 1758) and *Vanessa indica* (Herbst, 1794). Thatharna is a famous trekking place around Dharamshala town of the district of Kangra, situated very close to the Dhauladhar mountains of the Western Himalayan range. The hilltop is a meadow with *Urtica dioica* L. (stinging nettle) (Figure 4), the host plants of *V. atalanta* (Newland et al. 2015), growing in abundance along with *Cirsium wallichii* DC. (Figure 5), a possible larval host of the species. The specimen was recorded at coordinates 32º13’39” N, 76º22’46” E, at an elevation of 2,500 meters (Figure 1), at approximately 14:45 local time. Notably, the individual was observed interacting with its larval host plant, stinging nettle, on two occasions and exhibited territorial behaviour by attempting to ward off *V. indica*. Photographic documentation included a few images of the upper wing surface and one additional distant image capturing the underside. *V. atalanta* closely resembles *V. indica* (Figure 3b) but differs in that the upper forewing of *atalanta* is characterised by a darker, crimson-red discal band that is compact and narrow, in contrast to the broader, paler scarlet-red band seen in *indica*, which typically has irregular margins. Unlike *V. indica*, the discal band in *V. atalanta* is not intersected by three prominent black spots. Additionally, the costal sub-apical spot on the upper forewing is distinctly white in *atalanta*, whereas it appears reddish in *indica*. Another distinguishing feature is the consistent presence of a spot in wing space 3 in *V. atalanta*, which is invariably absent in *V. indica*. Moreover, sub-apical spots on the upper forewing in a*talanta* are larger than those of *indica* (Evans, 1932b; Roberts, 2001).

Results and Discussion

The rediscovery of *Vanessa atalanta* in Pakistan after a 93-year interval, followed by subsequent records from the same region, suggested a possible range expansion of the species within the Indian subcontinent (Awan et al. 2022). A comprehensive review of existing literature on Indian Rhopalocera reveals no prior evidence of *V. atalanta* occurring in India (Evans, 1932b; Talbot, 1947; Tshikolovets, 2005; Varshney & Smetacek, 2015; Kehimkar, 2016; Sondhi & Kunte, 2018; Van Gasse, 2021). Furthermore, the checklist of butterflies of Jammu and Kashmir (Sheikh et al. 2021), the book Butterflies of Pirpanjal Range of Kashmir Himalaya (Parey & Sheikh, 2021) do not report this species in Jammu and Kashmir. The recently published annotated checklist of Rhopalocera of Himachal Pradesh (Garlani, 2024) makes no mention of this species. The present observation from Dharamshala, Himachal Pradesh, therefore, constitutes the first confirmed record of *V. atalanta* in India. This finding also adds a new species to the documented Papilionidea fauna of Himachal Pradesh, increasing the total recorded species count for the state to 440. This record indicates that *V. atalanta* may be more widely distributed across India than previously recognised and highlights the need for further surveys, particularly in the Western Himalayan region. The probable range of this species in India stretches along the Nepal border, and it will probably be found in Uttarakhand in the future, if explored.

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Conflict of Interest

The author declares that he has no financial interest or personal relationship that could influence the work presented in this article.

References

Awan, M. A., Eaton, J., & Hamza, Y. A. (2022). Rediscovery of the Red Admiral butterfly *Vanessa atalanta* (Lepidoptera: Nymphalidae) in Pakistan after the original record nearly a century ago. *Bionotes, 24*(3-4), 305-307.

Bozano, G. C., & Floriani, A. (2012). *Nymphalidae. Part V. Subfamily Nymphalinae. Tribes Nymphalini, Kallimini, Junoniini. Guide to the Butterflies of the Palearctic Region*. Omnes Artes.

Chumakov, S. V., Goshko, D. V., Korshunov, A. V., & Yakovlev, R. V. (2024). The Red Admiral (*Vanessa atalanta*) (Lepidoptera, Nymphalidae) continues to expand its range in Eurasia. *Acta Biologica Sibirica, 10*, 47-54. https://doi.org/10.5281/zenodo.10814373

Evans, W. H. (1932a). The Butterflies of Baluchistan. *Journal of the Bombay Natural History Society, 36*(1), 196-209.

Evans, W. H. (1932b). *The Identification of Indian Butterflies*. Second edition revised. Bombay Natural History Society.

Garlani, L. (2024). Annotated checklist of Rhopalocera of Himachal Pradesh, India (Insecta: Lepidoptera). *SHILAP Revista de lepidopterología, 52*(208), 623-676. https://doi.org/10.57065/shilap.1009

Kehimkar, I. (2016). *Butterflies of India*. Bombay Natural History Society.

Mikkola, K. (2003). The Red Admiral butterfly (*Vanessa atalanta*, Lepidoptera: Nymphalidae) is a true seasonal migrant: an evolutionary puzzle resolved? *European Journal of Entomology, 100*, 625-626. https://doi.org/10.14411/eje.2003.091

Naderi, A. (2019). *Field Guide to the Butterflies of Iran*. Iran-Shenasi Publisher. [in Persian]

Nazari, V. (2003). *The Butterflies of Iran*. Dayereh-Sabz Publishers. [in Persian]

Newland, D., Still, R., Swash, A., & Tomlinson, D. (2015). *Britain's butterflies: A field guide to the butterflies of Britain and Ireland* (3rd ed.). Princeton University Press.

Parey, S. H., & Sheikh, T. (2021). *Butterflies of Pirpanjal Range of Kashmir Himalaya*. Corvette Press.

Roberts, T. J. (2001). *The Butterflies of Pakistan*. Oxford University Press.

Sheikh, T., Akram Awan, M., & Parey, S. H. (2021). Checklist of butterflies (Lepidoptera: Rhopalocera) of Union Territory Jammu and Kashmir, India. *Records of the Zoological Survey of India, 121*(1), 127-171. https://doi.org/10.26515/rzsi/v121/i1/2021/154311

Sondhi, S., & Kunte, K. (2018). *Butterflies of Uttarakhand: A Field Guide*. Bishen Singh Mahendra Pal Singh.

Talbot, G. (1947). Butterflies (Danaidae, Satyridae, Amathusidae, Acraeidae). In *The Fauna of British India Including Ceylon and Burma*. Today and Tomorrow's Printers and Publishers.

Tshikolovets, V. (2005). *The Butterflies of Ladakh*. Published by the Author.

Tshikolovets, V., & Pagès, J. (2016). *The Butterflies of Palaearctic Asia. XII. The Butterflies of Pakistan*. Vadim Tshikolovets Publisher.

Tshikolovets, V., Pliushch, I., Pak, O., & Skrylnik, Y. (2018). *The Butterflies of Palaearctic Asia. XIII. The Butterflies of Afghanistan*. Vadim Tshikolovets Publisher.

Tuzov, V. K., Bogdanov, P. V., Churkin, S. V., Danchenko, A. V., Devyatkin, A. L., Murzin, V. S., Samodurov, G. D., & Zhdanko, A. V. (2000). Libytheidae, Danaidae, Nymphalidae, Riodinidae, Lycaenidae. *Guide to the Butterflies of Russia and Adjacent Territories (Lepidoptera, Rhopalocera)* (Vol. 2). Pensoft.

Van Gasse, P. (2021). *Butterflies of the Indian Subcontinent: Distributional Checklist*. Tshikolovets Publications.

Varshney, R. K., & Smetacek, P. (2015). *A Synoptic Catalogue of the Butterflies of India*. Bhimtal & Indinature Publishing.

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Figure 1. Location Map of the study site. The Blue dot represents the first record of *Vanessa atalanta* from India, confirming the extension of its distribution in the Indian subcontinent. [Developed with QGIS Bratislava].

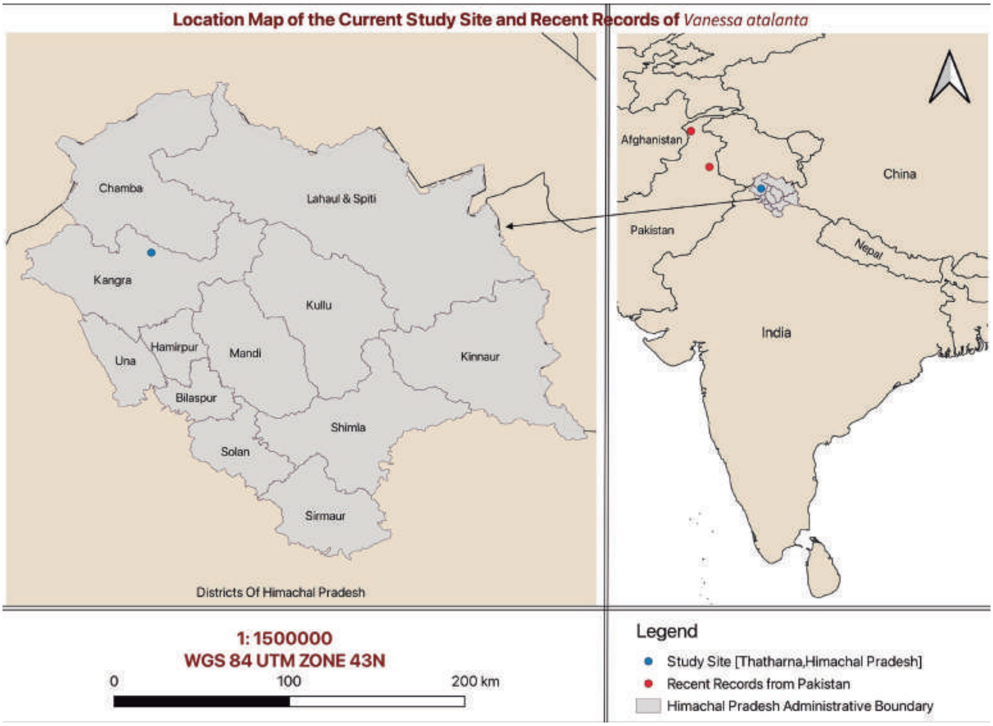

Figure 2. Habitat of *Vanessa atalanta* at the study site.

Figure 3. (a) *Vanessa atalanta* (Linnaeus, 1758). **(b)** *Vanessa indica* (Herbst, 1794).

Figures 4-5. 4. *Urtica dioica* L., recorded at the study site; a pre-reported larval host plant of *Vanessa atalanta.* **5.** *Cirsium wallichii* DC., host plant of *Vanessa indica* and a possible larval host of *Vanessa atalanta*.

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Estructura de la comunidad de Rhopalocera en ecosistemas boscosos en un gradiente altitudinal en el norte de la Orinoquia colombiana (Lepidoptera: Papilionoidea)

Juan Carlos Agudelo-Martínez, Néstor Pérez-Buitrago, Francisco Mijares-Santana & Fernando Hernández-Baz

Resumen

Se muestrearon Papilionoidea en fragmentos boscosos en un gradiente altitudinal de la Orinoquia colombiana a 132, 300, 500, 700 y 980 metros sobre el nivel del mar con el objetivo de describir la diversidad, los cambios en la estructura de la comunidad y relacionarlos con la composición florística. En cada localidad se utilizaron trampas Van Someren Rydon y capturas directas para recolectar Papilionoidea mientras que el inventario florístico de plantas leñosas se hizo en parcelas de 1.000 m^2 y las herbáceas en 1 m^2. Se recolectaron 152 ejemplares de Rhopalocera correspondientes a seis familias, 54 géneros y 66 especies. La riqueza osciló entre siete a 30 especies en los cinco fragmentos, y la similitud fue baja según el índice de Bray-Curtis con valores de 0,76 a 1, indicando baja similitud en la composición de especies de Papilionoidea. Se encontraron diferencias en la riqueza entre altitudes y una correlación del 97,8% entre las comunidades de plantas y Papilionoidea. Adicionalmente, encontramos que *Bunsius oileus* (Linnaeus, 1767), *Anartia amathea* (Linnaeus, 1758) y *A. jatrophae* (Linnaeus, 1763) están asociadas con 132 m s. n. m., mientras que *Rhetus dysonii* (Saunders, 1850) y *Actinote pellenea* (Hübner, [1821]) se asociaron con 980 m s. n. m. Los resultados sugieren que la estructura de la comunidad de Lepidoptera estuvo más influenciada por la estructura de la comunidad de plantas que por los cambios en la altitud. Las asociaciones de especies caracterizadas por una amplia tolerancia a perturbaciones antropogénicas, a 132 y 980 m. s. n. m. podrían indicar que actividades agrícolas y ganaderas generan cambios significativos en los fragmentos de bosque en la Orinoquia colombiana.
Palabras clave: Lepidoptera, Papilionoidea, Arauca, riqueza de especies, abundancia, Colombia.

Diversity and community structure of Rhopalocera in forest ecosystems along an elevational gradient from the north of Colombia´s Orinoco region (Lepidoptera: Papilionoidea)

Abstract

Papilionoidea were sampled in forest fragments along an altitudinal gradient in the Colombian Orinoquia at 132, 300, 500, 700, and 980 meters above sea level with the aim of describing diversity and changes in community structure and relating these to floristic composition. Van Someren Rydon traps and direct captures were used to collect Papilionoidea at each site, and the floristic inventory of woody plants was conducted on 1000 m^2 plots and herbaceous plants on 1 m^2 plots. A total of 152 specimens of Rhopalocera corresponding to six families, 54 genera and 66 species were collected. Species richness ranged from seven to 30 species in the five fragments, and the similarity was low according to the Bray-Curtis index, which ranged from 0.76 to 1, indicating low similarity in the species composition of Papilionoidea. Differences in richness were found between altitudes and a 97.8% correlation between plant communities and Papilionoidea. Additionally, we found that *Bunsius oileus* (Linnaeus, 1767), *Anartia amathea* (Linnaeus, 1758), and *A. jatrophae* (Linnaeus, 1763) are associated with 132 m.a.s.l., while *Rhetus dysonii* (Saunders, 1850) and *Actinote pellenea* (Hübner, [1821]) are associated with 980 m.a.s.l. The results suggest that the Lepidoptera community structurewas more strongly influenced by plant community structure than by changes in altitude. The associations of Lepidoptera with a wide range of anthropogenic tolerance at 132 and 980 m.a.s.l. would indicate that agricultural and livestock activities have probably caused changes in forest fragments in the Colombian Orinoquia.

Keywords: Lepidoptera, Papilionoidea, Arauca, abundance, species richness, Colombia.

Introducción

Los gradientes altitudinales son considerados laboratorios biológicos en los que las condiciones cambiantes de los factores ambientales permiten abordar preguntas sobre la relación existente entre los organismos y los ecosistemas que habitan, evaluando hipótesis acerca de los patrones y procesos ecológicos que estructuran la biodiversidad (Szewczyk & McCain, 2016). Una hipótesis ampliamente difundida que relaciona la altitud con la biodiversidad es el efecto de dominio intermedio, que establece la máxima diversidad biológica en las altitudes medias de los gradientes altitudinales debido a factores como la heterogeneidad de hábitats y las interacciones ecológicas (Becker et al. 2007; Szewczyk & McCain, 2016). Entender los factores que influyen sobre la diversidad a lo largo de los gradientes altitudinales es crucial tanto para la implementación de planes de manejo y conservación, así como para comprender como ocurren los cambios en la distribución de la diversidad en los ecosistemas asociados cobrando especial importancia en el escenario actual de cambio climático a nivel global (González et al. 2021; Molina-Martínez et al. 2013; Wilson et al. 2007). En Colombia se encuentran las últimas estribaciones del sistema montañoso de los Andes que surcan el país de sur a norte generando gradientes altitudinales que inducen cambios en factores ambientales y promueven la ocurrencia de gran variedad de ecosistemas propiciando presiones selectivas y adaptaciones en los organismos que los habitan (Schirpke et al. 2019; Willig & Presley, 2016). Este atributo es uno de los factores que hace de Colombia uno de los países megadiversos junto con Ecuador, Perú y Brasil (Mittermeier & Konstant, 2001).

Colombia posee una enorme biodiversidad (Rodríguez-Zapata & Ruiz-Agudelo, 2021). Entre los insectos, sabemos que el número de Papilionoidea registradas del país llega a 3.877 especies correspondiente al 20,7% de las especies descritas a nivel mundial; sin embargo, número que aumenta constantemente a medida que se aumenta el esfuerzo de muestreo en diferentes localidades del país (Garwood & Jaramillo, 2023). Los Lepidoptera diurnos desempeñan roles importantes dentro de los ecosistemas, son la principal fuente de alimento para algunos anfibios y aves, son eficientes polinizadores y por su alta vagilidad contribuyen a la diversidad genética de muchas especies vegetales (Wagner, 2020). Paralelamente, las relaciones Lepidoptera-planta pueden mostrar fidelidad ecológica (Moura et al. 2022) cuando los estados inmaduros dependen nutricionalmente de una sola especie de planta (Beccaloni et al. 2008). Esta estrecha afinidad resulta útil estudiar los cambios que experimentan los ecosistemas producto de actividades naturales o antrópicas y por esta razón algunas especies de Lepidoptera son considerados bioindicadores (Parmesan, 2019).

El uso de Papilionoidea en inventarios rápidos de biodiversidad es una herramienta útil para describir fenómenos ecológicos o eventos antrópicos que modifican los ecosistemas, minimizando los costos (en recursos y tiempo) y maximizando la información que puede aportar para entender las dinámicas en entornos naturales o perturbados (Villareal et al. 2004). El uso de evaluaciones rápidas es apropiado en localidades en las cuales se dificulta realizar estudios con rangos temporales amplios (Agudelo-Martínez & Pérez-Buitrago, 2020; Vanegas, 2010), como la Amazonia, el Chocó biogeográfico o la Orinoquia, cuyas condiciones logísticas restringen el acceso a localidades para la toma de muestras (Suárez et al. 2018).

La Orinoquia colombiana abarca aproximadamente el 22% del territorio colombiano (Rippstein et al. 2001), sin embargo, persisten vacíos de información sobre su biodiversidad e interacciones entre los organismos con los ambientes que habitan (Arbeláez-Cortés, 2013). Disminuir esta brecha en el conocimiento es fundamental para generar planes de conservación y manejo de la biodiversidad que permitan entender las dinámicas ecosistémicas en esta región del país. El objetivo de este estudio es documentar la riqueza y abundancia de Papilionoidea presentes en ciertos fragmentos de bosque en un gradiente altitudinal y relacionarlo con la diversidad florística de plantas leñosas en el norte de la Orinoquia colombiana.

Materiales y Métodos

Área de estudio

El estudio se desarrolló en un gradiente altitudinal en la vertiente oriental de la Cordillera Oriental de Colombia en el departamento de Arauca. Esta región presenta su mínima altura a 98 metros sobre el nivel del mar (m. s. n. m.) en el municipio de Cravo Norte y alcanza una altura máxima de 5.380 m. s. n. m. en el Ritak'uwa Blanco, el pico más alto de la Sierra Nevada del Cocuy-Güican (Rodríguez et al. 2018). La Orinoquia colombiana, ubicada entre los 98 a los 1.000 m. s. n. m., se denomina Llanos Orientales de Colombia por la predominancia de paisajes de sabana con fragmentos de bosque, bosques riparios y otros ecosistemas (Jaramillo-J. & Rangel-Ch., 2014; Rosales et al. 2010). Cinco fragmentos de bosque con diferentes características fueron muestreados. En el municipio de Arauca a 132 m s. n. m. un bosque ripario continuo asociado al caño El Ruano (6.990, -70.799); en el municipio de Tame los muestreos se llevaron a cabo a 300 m. s. n. m en un bosque intervenido continuo cercano a la cabecera municipal (6.427, -71.747), a 500 m. s. n. m. en un fragmento de bosque de aproximadamente 30 hectáreas discontinuo rodeado de potreros (6.493, -71.818), a los 700 m. s. n. m. en un bosque ripario continuo asociado al río Cravo Norte (6.4797, -71.8605) y a 980 m. s. n. m. se muestreó un bosque continuo (65.150, -71.8614) en límites con el Parque Nacional Natural (PNN) El Cocuy. Los fragmentos de bosque seleccionados delimitaron el estudio a las unidades fisiográficas de piedemonte, terrazas y llanura aluvial. El clima es de régimen unimodal con una temporada de lluvias de ocho meses desde abril hasta noviembre y una temporada seca de diciembre a marzo; la precipitación media anual es de 2.200 mm. y humedades relativas entre 65% y 80% (Rippstein et al. 2001).

Trabajo de campo

Se recolectaron Papilionoidea entre junio y noviembre de 2017 utilizando dos técnicas complementarias. Se instalaron siete trampas Van Someren Rydon (TVSR) cada 30 metros en un transecto perpendicular al borde del fragmento de bosque, cuatro fueron instaladas dentro del fragmento, una en el borde y dos afuera con el fin de asegurar la recolección de Papilionoidea tanto de las coberturas boscosas como de su entorno. Los transectos de TVSR fueron recebados con banano en descomposición y revisados diariamente a las 8:00, 14:00 y 16:00 horas. La segunda técnica consistió la recolección directa de especímenes con redes entomológicas en transectos libres recorridos por dos personas entre las 8:00 a 17:00 horas, para capturar especies no atraídas por el cebo a las TVSR. Los especímenes fueron almacenados en sobres de papel milano, etiquetados y trasladados a la Colección Entomológica de la Universidad Nacional de Colombia Sede Orinoquia CEO (Registro Nacional de Colecciones Biológicas 220) en Arauca para su montaje, identificación y depósito. Las recolecciones se realizaron amparados en el Permiso Marco de Recolección de Especímenes de la Diversidad Biológica de la Universidad Nacional de Colombia y la identificación taxonómica se realizó mediante la comparación con especímenes depositados en la CEO y usando bibliografía especializada (D'Abrera, 1988; D'Abrera, 1987; García-Robledo et al. 2002; Warren et al. 2023).

Además, se usó información de las comunidades vegetales, incluyendo especies leñosas, arbustivas y herbáceas, en los sitios de muestreo que fueron registrados simultáneamente a los inventarios de Papilionoidea. En cada fragmento de bosque se establecieron parcelas de 1.000 m^2 (50 × 20 m) para muestrear todas las plantas leñosas con un diámetro a la altura del pecho (DAP) $\geq$ 2.5 cm (Melo & Vargas, 2002). Con el fin de describir la comunidad vegetal del estrato herbáceo y de regeneración natural (plántulas de plantas leñosas y lianas) se midieron ejemplares con altura de hasta 1.5 m en 10 parcelas de 1 m^2 (Vallejo et al. 2005). Las especies de plantas recolectadas fueron procesadas siguiendo técnicas estándar de herbario y depositadas en el Herbario Orinocence (HORI, Registro Nacional de Colecciones Biológicas 219) de la Universidad Nacional de Colombia, Sede Orinoquia.

Análisis de la estructura comunitaria

Para describir la composición de la comunidad de Papilionoidea se usó la riqueza de especies por localidad como una representación de la diversidad alfa. La diversidad beta, entendida como el recambio de especies entre altitudes se estimó aplicando el índice de Bray-Curtis para cualquier par posible de localidades y se representó mediante un dendrograma de distancias (Koleff et al. 2003; Lennon et al. 2001). La diversidad gamma que hace referencia al total de especies colectadas en el área de estudio se calculó implementando los estimadores no paramétricos que proporcionan una estimación robusta de la diversidad de especies incluso con tamaños de muestra pequeños y un esfuerzo de muestreo desigual (Chao et al. 2014; Hsieh et al. 2016; Yue et al. 2022).

Para describir la estructura de la comunidad se usó el análisis de similitud (ANOSIM) con el fin de estimar las diferencias en la riqueza de especies en cada altitud (Clarke, 1993) y las diferencias entre los posibles pares de alturas muestreadas se establecieron mediante un análisis de varianza usando matrices de distancia (ADONIS) (McArdle & Anderson, 2001). Para establecer la similitud de la composición de la comunidad de Papilionoiodea entre alturas se realizó un escalamiento multidimensional no métrico (NMDS) utilizando la abundancia de especies en cada localidad (Oksanen et al. 2022).

Para evaluar la relación entre la comunidad de Papilionoidea y la comunidad de vegetación dentro de los fragmentos de bosque, se usó el análisis de co-correspondencia (CO-CA). Este análisis combina las ideas del análisis de coinercia (CoI) con el modelo de respuesta unimodal familiar a los métodos de análisis de correspondencia (CA) o análisis de correspondencia canónico (CCA) (Schaffers et al. 2008). El objetivo es relacionar las dos matrices de abundancia o presencia de especies, de manera que la descomposición resultante en ejes sean aquellas combinaciones que mejor expliquen la covariación entre especies y observaciones en las dos matrices (Ter Braak & Schaffers, 2004). Para implementar el CO-CA, se transformaron las matrices de la comunidad de Lepidoptera y plantas usando el logaritmo del número absoluto de individuos. Se aplicó el método de análisis de especies indicadoras INDVAL (De Cáceres & Legendre, 2009) para establecer la relación entre las especies de Papilionoidea y la altitud a la que fueron registradas (De Cáceres et al. 2010). El cálculo de los estimadores no paramétricos se realizó mediante el programa EstimateS versión 9.1. y los análisis estadísticos restantes realizaron con el software estadístico R 3.5.1 (R Core Team, 2023) usando las librerías: Vegan para estimar la diversidad beta, ANOSIM y NMDS (Oksanen et al. 2022), Cocorresp para el análisis de co-correspondencias (Ter Braak & Schaffers, 2004) e Indicspecies para el análisis de especies indicadoras INDVAL (De Cáceres & Legendre, 2009).

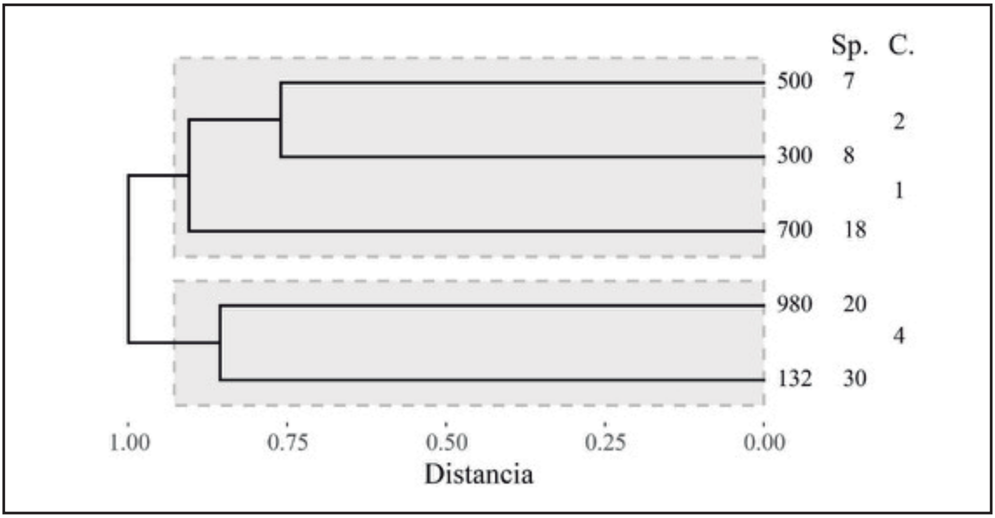
Resultados

En el gradiente altitudinal se recolectaron 152 ejemplares de seis familias, 54 géneros y 66 taxones. La familia mejor representada fue Nymphalidae con 41 especies (62,1%), seguida por Hesperiidae con 10 (15,2%), mientras que las familias Pieridae, Riodiniadae, Papilionidae y Lycaenidae estuvieron representadas por cinco especies o menos (< 8%). La diversidad por géneros sigue la misma tendencia, con Nymphalidae y Hesperiidae en los primeros lugares con 34 y siete géneros respectivamente, seguidos por Riodinidae con cinco, Pieridae con cuatro, Papilionidae y Lycaenidae con dos géneros cada uno. La altura con mayor número de especies únicas fue 132 m. s. n. m. con 19, seguida de 980 m. s. n. m. y 700 m. s. n. m. con 14 y 12 especies respectivamente, mientras que 300 m. s. n. m. y 500 m. s. n. m. tuvieron tres y dos especies únicas respectivamente. La diversidad alfa, representada como el número de especies en cada localidad osciló entre siete y 30 especies (promedio = 16,6 ± 9,5) (Tabla 1).

Respecto a la vegetación de los fragmentos se registraron en total 2.490 individuos, 1.667 correspondientes al estrato rasante y arbustivo y 823 al estrato arbóreo que pertenecen a 75 familias, 173 géneros y 253 especies. En todo el muestreo las cinco familias que presentaron el mayor número de géneros y especies fueron: Fabaceae con 17 géneros y 26 especies; Rubiaceae (10; 17), Bignoniaceae (10; 13), Sapindaceae (6; 10) y Myrtaceae (5; 10). El muestreo a 132 m.s.n.m. registró 45 especies, la especie arbórea más abundante fue *Allophylus amazonicus* (Mart.) Radlk. (Sapindaceae) con 43 unidades; la especie arbustiva más abundante fue *Tabernaemontana siphilitica* (L. f.) Leeuwenb. (Apocynaceae) con 47 individuos y la especie herbácea con mayor número de individuos fue *Oplismenus* cf. *hirtellus* (L.) P. Beauv. (Poaceae) con 37. En el muestreo localizado a 300 m.s.n.m. se encontraron 69 especies, la más abundante fue una palma *Oenocarpus minor* Mart. (Arecaceae) con 26 individuos; la especie arbustiva más abundante fue *Piper metanum* Trel. & Yunck. (Piperaceae) con siete individuos y herbácea fue *Ischnosiphon leucophaeus* (Poepp. & Endl.) Körn. (Marantaceae) con siete individuos. El fragmento a 500 m.s.n.m. presentó 71 especies. La especie arbórea más abundante fue *Rudgea crassiloba* (Benth.) B. L. Rob. (Rubiaceae) con 22 individuos, la especie arbustiva más abundante fue *Pombalia prunifolia* (Willd.) Paula-Souza (Violaceae) con 64 individuos y la especie herbácea más abundante fue *Calathea* cf. *villosa* Lindl. (Marantaceae) con 23 individuos. En el muestreo a 700 m.s.n.m. se encontró la mayor riqueza de especies con un total de 85, siendo la especie arbórea más abundante *Psidium* cf. *oligospermum* DC. (Myrtaceae) con 68 individuos, la especie arbustiva más abundante fue *P. metanum* (Piperaceae) con 23 individuos y la especie herbácea más abundante fue *Selaginella* cf. *horizontalis* (C.Presl) Springcon (Selaginellaceae) con 20 individuos. En el de 980 m.s.n.m se encontraron 55 especies. La especie arbórea más abundante fue *Apeiba* aff. *glabra* Aubl. (Malvaceae) con 88 individuos, la especie arbustiva más abundante fue *Cleidion castaneifolium* Müll. Arg.con (Euphorbiaceae) con 63 individuos y la especie herbácea más abundante fue *Adiantum pulverulentum* L. (Pteridaceae) con 16 individuos.

El cálculo del índice de Bray-Curtis entre localidades oscilo entre 0,76 y 1 indicando baja similitud en la composición de especies de Lepidoptera. La representación gráfica de este índice mediante un dendrograma generó dos nodos determinados por la riqueza de especies en cada una de las estaciones de muestreo (Figura 1). En uno de los nodos se agruparon los extremos del gradiente altitudinal 132 y 980 m. s. n. m. con riquezas de 30 y 20 especies respectivamente y en segundo nodo se agruparon las alturas intermedias del gradiente 300, 500 y 700 m. s. n. m. con ocho, siete y 18 especies respectivamente (Figura 1). La diversidad gamma indicó que la riqueza de especies en el gradiente altitudinal puede oscilar entre 172 (Chao 2) y 84 especies (Bootstrap) respectivamente. Así, las 66 especies colectadas representan entre el 38,3% y el 78,7% de las especies de Papilionoidea presentes en la zona.

Figura 1. Dendrograma mostrando la similitud del índice de Bray-Curtis entre las localidades del gradiente altitudinal del Norte de la Orinoquía colombiana. Sombreado en gris se señalan dos grupos, uno agrupando las altitudes intermedias y el otro los extremos del gradiente. Sp. Riqueza de especies por altura. C. número de especies compartidas.

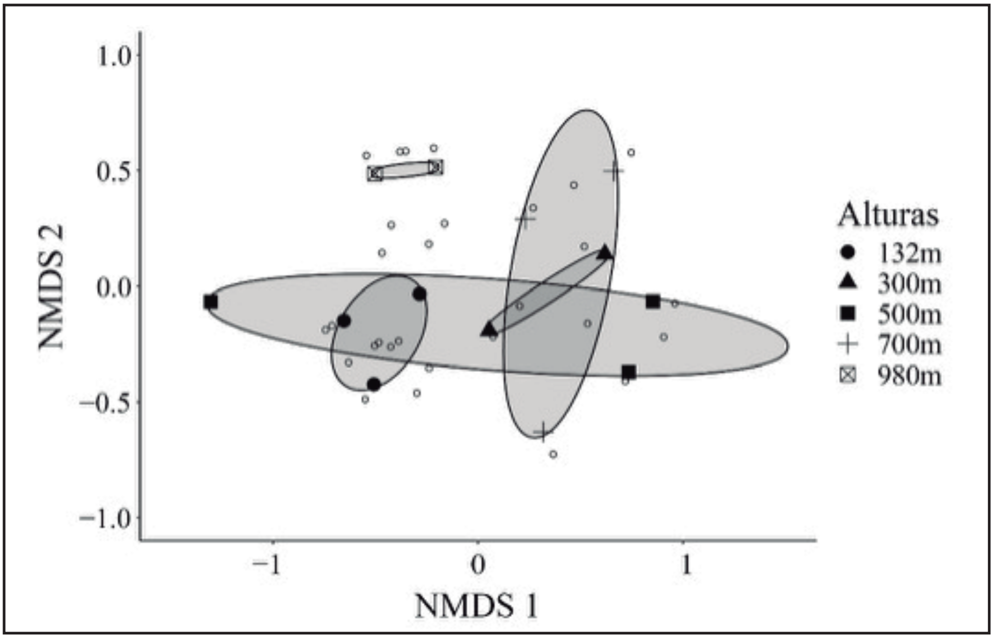


El análisis de similitud (ANOSIM) estableció que existen diferencias en la riqueza de especies en cada altitud (R = 0.53, p > 0.01). La prueba ADONIS indicó que la altura de 132 m. s. n. m. es diferente al resto de las demás alturas (valores de R entre 0.42 y 0.44, p = 0.1). Este análisis también detecto que las localidades 700 - 980 m. s. n. m. son diferentes en la composición de especies (R = 0.37, p = 0.1) y de igual manera las localidades de 500 y 980 también presentaron diferencias en la composición (R = 0.44, p = 0.1).

El análisis NMDS para evaluar la composición de especies con respecto a las alturas generó un ordenamiento donde se distinguen dos grupos, el primero en el que están las unidades muestrales de 980 m. s. n. m. y el segundo en donde se agrupan los muestreos del resto de las alturas muestreadas (Estrés = 0.09) (Figura 2).

El análisis de co-correspondencia usado para explorar sí la composición de la comunidad de plantas en los bosques muestreados influía sobre la composición de la comunidad de Papilionoidea en cada una de las localidades detecto una alta correlación entre las comunidades (Inercia total = 5.70), con una variación explicada (Inercia explicada) de 5.58, lo que indica una correspondencia del 97.8% entre la comunidad de plantas y Papilionoidea. Los dos primeros ejes de los 14 calculados explicaron el 28.2% de la variación en la composición de la comunidad de Papilionoidea con respecto a la comunidad de plantas presentes en cada una de las localidades muestreadas (Figura 3). El análisis de especies indicadoras reveló la afinidad de cinco especies a diferentes alturas. Las especies *Burnsius oileus* (Linnaeus, 1767) (S = 0.91 p = 0.04), *Anartia amathea* (Linnaeus, 1758) (S = 0.885, p = 0.04) y *A. jatrophae* (Linnaeus, 1763) (S = 0.864, p = 0.05) se asociaron a los 132 m. s. n. m. y las especies *Rhetus dysonii* (Saunders, 1850) (S = 1, p = 0.03) y *Actinote pellenea* Hübner, [1821] (S = 0.937, p = 0.03) presentaron afinidad a los 980 m. s. n. m. Las 61 especies restantes no mostraron afinidades significativas a ninguna de las localidades muestreadas (p > 0.05).

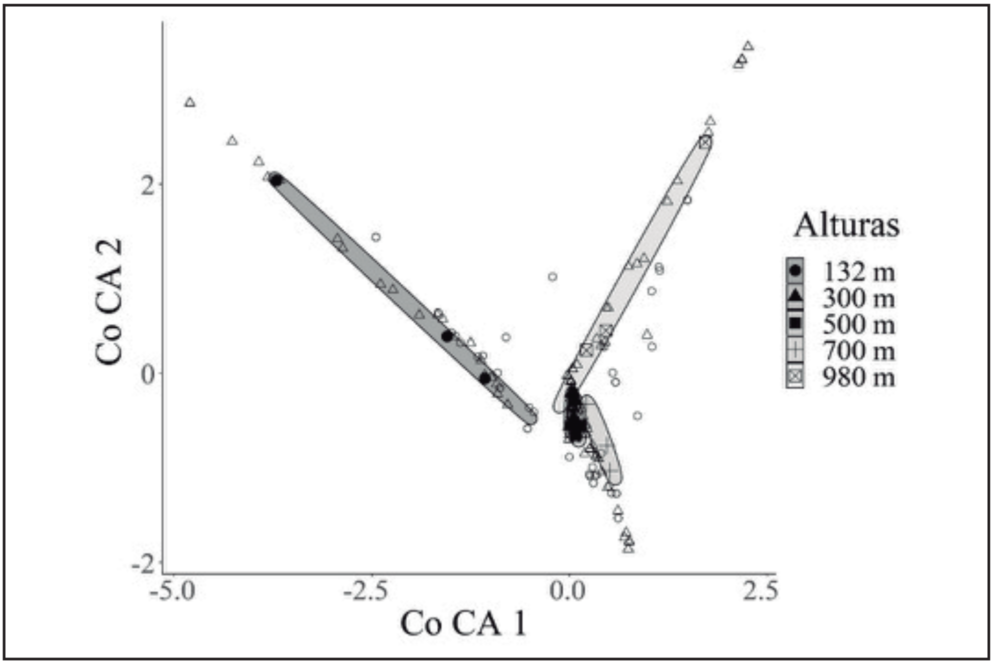
Figura 2. Análisis de escalamiento multidimensional no métrico (NMDS) para la comunidad de Papilionoidea en el gradiente altitudinal en el norte de la Orinoquia colombiana. Los óvalos representan cada una de las alturas muestreadas y los puntos vacíos representan las especies de Papilionoidea. Estrés 0.09.



Discusión

La riqueza de especies calculada mediante estimadores no paramétricos reveló que la eficiencia del muestreo estuvo entre el 38.3% y el 78.7% indicando que las técnicas empleadas fueron relativamente efectivas para documentar la riqueza de especies de Papilionoidea en el gradiente altitudinal. Las 66 especies recolectadas comparadas con las 1.115 conocidas de la Orinoquia Colombiana (Gantiva-Quintero & Andrade-Correa, 2022) representan una pequeña fracción de la riqueza de dicha región biogeográfica. La baja representatividad se explica teniendo en cuenta que fueron muestreados sólo cinco fragmentos de bosque correspondientes a un área muy pequeña respecto a la región (Rippstein et al. 2001). Aun así, la riqueza de especies reportada es similar a otros trabajos en gradientes altitudinales semejantes metodológicamente como el de Olarte-Quiñonez et al. (2016) que reportó 69 especies en un gradiente altitudinal entre los 2.400 a 3.700 m. s. n. m. en Norte de Santander, o el de Combita et al. (2022) que registró 101 especies para un gradiente altitudinal entre los 300 y 1.500 m. s. n. m. en el departamento de Santander. En cuanto a la composición de especies por familia, las familias mejor representadas fueron Nymphalidae (41 especies), Hesperiidae (10 especies) y Pieridae (cinco especies), similar a la reportado en otras localidades en las cordilleras Oriental y Occidental de Colombia (Henao-Bañol et al. 2018; Henao-Bañol & Stiles, 2018; Ramírez-Restrepo et al. 2007). Sin embargo, la composición de especies con el patrón: Nymphalidae, Hesperiidae, Pieridae no es constante cuando se compara con otras localidades del Neotrópico más al sur en la cordillera de los Andes en el cual predominan las familias Heperiidae y Pieridae en los primeros lugares de riqueza de especies (Farfán Larico, 2018; Pires et al. 2020; Zelada, 2004).

Figura 3. Análisis de co-correspondencia con una variación total (Inercia total) de 5.70. Biplot basado en los dos primeros ejes generados (Co CA 1 y Co CA 2). Elipses y puntos sólidos representan las localidades de muestreo. La relación entre las especies de Papilonoidea (Círculos vacíos) y las especies de plantas (triángulos vacíos) muestra una variación explicada (Inercia explicada) de 5.58, indicando una correspondencia del 97.8% entre la comunidad de plantas y la comunidad de Papilionoidea.



Respecto a la diversidad beta, el dendrograma de similitud generó dos grupos en respuesta a la riqueza de especies. El primero agrupó las dos localidades de los extremos del gradiente altitudinal (132 y 980 m. s. n. m.) con mayores riquezas reportadas, mientras que en el segundo se encuentran las alturas intermedias del gradiente (300, 500 y 700 m. s. n. m.) con riquezas entre siete y 18 especies. Los resultados de las pruebas de ANOSIM y ADONIS ratifican este resultado indicando que las diferencias en la composición de la comunidad de Lepidoptera se dan entre los extremos del gradiente altitudinal (132 y 980 m. s. n. m.) respecto a las alturas intermedias. El registro de mayores riquezas de especies en los extremos del gradiente altitudinal contradice la hipótesis de rango medio que plantea la disminución de la riqueza de especies a medida que aumenta o disminuye la elevación, mostrando un incremento en la riqueza las elevaciones medias del gradiente (Becker et al. 2007). La falta de ajuste de nuestros resultados a esta hipótesis de gradientes altitudinales se suma a una lista ampliamente documentada para trabajos con Lepidoptera (Cómbita et al. 2022; Molina-Martínez et al. 2013; Wilson et al. 2007) y otros grupos taxonómicos como ciempiés, Coleoptera de la familia Staphylinidae (Gilgado et al. 2022) e incluso pequeños mamíferos terrestres (McCain, 2005). Dentro de los factores que contribuirían a la falta de ajuste con el patrón de rango de riqueza medio en las comunidades se encuentran el clima (Wilson et al. 2007, Molina-Martínez et al. 2013 McCain, 2005), microclima, topografía y cobertura vegetal (Cómbita et al. 2022; Gilgado et al. 2022). El reemplazo de especies en función del incremento de la altitud es común para diferentes ordenes de insectos como Formicidae (Longino & Colwell, 2011) y Heterocera, (Brehm et al. 2007), sin embargo, los trabajos de gradientes altitudinales no son concluyentes en cuanto a la influencia de la altura como un factor preponderante en la estructuración de las comunidades biológicas y por lo tanto deberían tenerse en cuenta otros factores microclimáticos correlacionados (*i.e.* humedad relativa, temperatura) que contribuyen a explicar cómo se estructuran las comunidades biológicas de forma más eficiente (Becker et al. 2007).

En este estudio, el análisis de co-correspondencia demostró que un 97.8% de la variación en la comunidad de Papilionoidea fue explicada por la composición en la comunidad vegetal en las localidades estudiadas. El mecanismo subyacente involucra la amortiguación microclimatica generada por la vegetación (Montejo-Kovacevich et al. 2020) y teniendo en cuenta que el gradiente evaluado es moderado (848 m de altitud), las diferencias pequeñas de temperatura podrían permitir el movimiento de los Papilionoidea como se ha descrito particularmente en zonas ecuatoriales (Montejo-Kovacevich et al. 2020). Este resultado concuerda con otros estudios que plantean que las comunidades vegetales pueden ser el principal agente estructurador de las comunidades de Lepidoptera (Molina-Martínez et al. 2013; Pires et al. 2020; Valtonen et al. 2013) por aspectos alimenticios, reproductivos y fisiológicos (Grundel et al. 2020; Montejo-Kovacevich et al. 2020; Steigenga & Fischer, 2009), y otros grupos como escarabajos coprófagos (Nunes et al. 2016) y hormigas (Castro et al. 2020).

El análisis de INDVAL usado para evaluar la asociación de las especies a diferentes alturas indicó que existen cinco especies que se encuentran fuertemente relacionadas a ciertas altitudes. Por ejemplo, *B. oileus*, *A. amathea* y *A. jatrophae* se asocian a 132 m. s. n. m., especies de hábitos de vuelo muy activos usualmente encontradas en zonas abiertas (García-Robledo et al. 2002) como la sabana, ambiente que constituye la matriz de paisaje en el ecosistema en el bosque donde se registraron estas especies. *B. oileus* ha sido asociadas con plantas de la familia Malvaceae (Beccaloni et al. 2008), sin embargo, en los muestreos realizados de vegetación no se reportó esta familia botánica. Lo mismo ocurre con *A. amathea* y *A. jatrophae*, que reportan asociación con plantas de las familias Acanthaceae, Asteraceae, Lamiaceae y Verbenaceae, pero que no fueron registradas en el inventario botánico a 132 m. s. n. m.

Dos especies están asociadas a alturas de 980 m. s. n. m., *R. dysonii* (Riodinidae) suele encontrarse libando cerca de cuerpos de agua o ambientes húmedos (Ríos-Málaver, 2007) y aunque se trata de una especie comúnmente avistada, no se encontraron reportes de asociaciones conocidas con plantas. La segunda especie fue *A. pellenea,* que habita en zonas montañosas y húmedas, donde presenta un comportamiento gregario y generalmente se encuentran cerca de arbustos en flor de bordes de bosques cercanos a cursos de agua, e incluso, puede ocupar áreas como zonas residenciales de grandes ciudades (Núñez-Bustos, 2020).

A. pellenea cuenta con reportes de asociación a plantas de las familias Amaranthaceae (*Amaranthus)*, Asteraceae (*Chromolaena, Clibadium, Eupatorium, Helianthus, Mikania, Senecio, Tessaria*), Fabaceae (*Acacia, Mimosa*) y Verbenaceae (*Lantana*) (Beccaloni et al. 2008), aunque ninguno de estos registros coincide, con las especies de plantas encontradas en la zona de estudio, es posible encontrar plantas de la familia Asteraceae (*Clibadium*) y Fabaceae (*Inga*, *Swartzia* y *Pterocarpus)* que podrían estar asociadas a esta especie.

La asociación de las especies de Papilionoidea con plantas encontradas en este trabajo no coincide con los registros consultados. Esto podría explicarse por el hecho que nuestro muestreo fue realizado en el interior del bosque, con arbustos y hierbas diferentes a las encontradas en ambientes abiertos y que este tipo de estudios en ecosistemas en la Orinoquia son escasos. Así, este estudio contribuye a las asociaciones que los Papilionoidea tienen con especies de plantas no registradas en el catálogo de plantas huésped de especies neotropicales (Beccaloni et al. 2008), reflejando que la biodiversidad de la Orinoquia colombiana ha sido poco estudiada y es relativamente poco conocida (Arbeláez-Cortés, 2013).

La presencia y asociación de especies con tolerancia a ambientes transformados como *A. pellenea* en 980 m. s. n. m.*,* podría indicar que en alturas intermedias y altas del gradiente (desde 300 hasta 980 m. s. n. m.) las coberturas boscosas podrían estar sufriendo fuertes cambios antropogénicos, impulsados por actividades como la ganadería o la agricultura que transforman las coberturas originalmente boscosas en potreros o cultivos (Etter et al. 2006).

Aquí exploramos el efecto del cambio en la altitud sobre la comunidad de Papilionoidea en los Llanos

Orientales de Colombia. Nuestros resultados contrastan con la hipótesis del patrón de elevación media, mostrando precisamente el efecto contrario con mayor riqueza y abundancia de especies en los extremos del gradiente. Esta discrepancia podría sugerir que la estructura de la comunidad de Papilionoidea pudiera ser promovida por la comunidad vegetal, más que por la altitud. Se encontraron asociaciones estrechas entre cinco especies de Papilionoidea con diferentes alturas en el gradiente altitudinal, evidenciando la utilidad de los Lepidoptera como bioindicadores. Este hallazgo plantea la posibilidad de emplear estas especies como bioindicadores en procesos de monitoreo ecológico, con el fin de evaluar la relación entre la transformación de la cobertura boscosa y el incremento de las actividades antrópicas.

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Referencias

Agudelo-Martínez, J. C., & Pérez-Buitrago, N. (2020). Riqueza estacional y estructura de la comunidad de hormigas epígeas en fragmentos de bosque de sabanas inundables, Orinoquia Colombiana. *Revista de Biología Tropical*, *68*(3), 947-958. https://doi.org/DOI10.15517/RBT.V68I3.40546

Arbeláez-Cortés, E. (2013). Knowledge of Colombian biodiversity: Published and indexed. *Biodiversity and Conservation*, *22*(12), 2875-2906. https://doi.org/10.1007/s10531-013-0560-y

Beccaloni, G. W., Viloria, Á. L., Hall, S. K., & Robinson, G. S. (2008). *Catalogue of the hostplants of the Neotropical butterflies* (Vol. 8). Sociedad Entomológica Aragonesa.

Becker, A., Körner, C., Brun, J.-J., Guisan, A., & Tappeiner, U. (2007). Ecological and Land Use Studies Along Elevational Gradients. *Mountain Research and Development*, *27*(1), 58-65. https://doi.org/10.1659/0276-4741

Brehm, G., Colwell, R. K., & Kluge, J. (2007). The role of environment and mid-domain effect on moth species richness along a tropical elevational gradient. *Global Ecology and Biogeography, 16*(2), 205-219. https://doi.org/10.1111/j.1466-8238.2006.00281.x

Castro, F. S. D., Da Silva, P. G., Solar, R., Fernandes, G. W., & Neves, F. D. S. (2020). Environmental drivers of taxonomic and functional diversity of ant communities in a tropical mountain. *Insect Conservation and Diversity, 13*(4), 393-403. https://doi.org/10.1111/icad.12415

Carrero-Sarmiento, D. A., Sánchez-Montaño, L. R., & Tobar L, D. E. (2013). Diversidad y distribución de mariposas diurnas en un gradiente altitudinal en la región nororiental andina de Colombia. *Boletín Científico Centro de Museos Museo de Historia Natural*, *17*(1), 168-188.

Chao, A., Gotelli, N. J., Hsieh, T. C., Sander, E. L., Ma, K. H., Colwell, R. K., & Ellison, A. M. (2014). Rarefaction and extrapolation with Hill numbers: A framework for sampling and estimation in species diversity studies. *Ecological Monographs*, *84*(1), 45-67. https://doi.org/10.1890/13-0133.1

Clarke, K. R. (1993). Non-parametric multivariate analyses of changes in community structure. *Australian Journal of Ecology*, *18*(1), 117-143. https://doi.org/10.1111/j.1442-9993.1993.tb00438.x

Cómbita, J. L., Giraldo, C. E., & Escobar, F. (2022). Environmental variation associated with topography explains butterfly diversity along a tropical elevation gradient. *Biotropica*, *54*(1), 146-156. https://doi.org/10.1111/btp.13040

D’Abrera, B. (1988). *Butterflies of the Neotropical Region. Part V. Nymphalidae (conc.) & Satyridae.* Hill House.

D’Abrera, B. (1987). *Butterflies of the Neotropical Region. Part IV. Nymphalidae (partim)*. Hill House.

De Cáceres, M., & Legendre, P. (2009). Associations between species and groups of sites: Indices and statistical inference. *Ecology*, *90*, 3566-3574. https://doi.org/10.1890/08-1823.1

De Cáceres, M., Legendre, P., & Moretti, M. (2010). Improving indicator species analysis by combining groups of sites. *Oikos*, *119*(10), 1674-1684. https://doi.org/10.1111/j.1600-0706.2010.18334.x

Etter, A., McAlpine, C., Wilson, K., Phinn, S., & Possingham, H. (2006). Regional patterns of agricultural land use and deforestation in Colombia. *Agriculture, Ecosystems & Environment*, *114*(2-4), 369-386. https://doi.org/10.1016/j.agee.2005.11.013

Farfán Larico, J. (2018). Mariposas (Lepidoptera: Papilionoidea) de Arequipa, Perú: Lista preliminar con dos nuevos registros para Perú. *Revista Peruana de Biología, 25*(4), 357-370. https://doi.org/10.15381/rpb.v25i4.15536

Gantiva-Quintero, C. H., & Andrade-Correa, M. G. (2022). Las mariposas diurnas en la Orinoquía Colombiana. *Caldasia*, *44*(3), 514-523. https://doi.org/10.15446/caldasia.v44n3.92499

García-Robledo, C., Constantino, L. M., Heredia, M. D., & Kattan, G. (2002). *Mariposas Comunes de la Cordillera Central de Colombia*. Wildlife Conservation Society. Feriva editores.

Garwood, K., & Jaramillo, J. G. (2023). *Foto guía de Mariposas de Colombia/ Photo guide to the Butterflies of Colombia (Lepidoptera: Papilionoidea). BioButterfly Database. Edición 1 Congreso Colombiano de Lepidopterología.* https://www.butterflycatalogs.com/colombia.html

Gilgado, J. D., Rusterholz, H.-P., Braschler, B., Zimmermann, S., Chittaro, Y., & Baur, B. (2022). Six groups of ground-dwelling arthropods show different diversity responses along elevational gradients in the Swiss Alps. *Plos One, 17*(7), e0271831. https://doi.org/10.1371/journal.pone.0271831

González, V. H., Cobos, M. E., Jaramillo, J., & Ospina, R. (2021). Climate change will reduce the potential distribution ranges of Colombia's most valuable pollinators. *Perspectives in Ecology and Conservation*, *19*(2), 195-206. https://doi.org/10.1016/j.pecon.2021.02.010

Grundel, R., Dulin, G. S., & Pavlovic, N. B. (2020). Changes in conservation value from grasslands to savannas to forests: How a temperate canopy cover gradient affects butterfly community composition. *Plos One*, *15*(6), e0234139. https://doi.org/10.1371/journal.pone.0234139

Henao-Bañol, E. R., Páez, A., & Rodríguez-M., J. V. (2018). Inventario de mariposas diurnas (Lepidoptera: Hesperioidea-Papilionoidea) de la reserva forestal productora protectora de la cuenca alta del río Bogotá (RFPP-CARB). *Boletín Científico Centro de Museos Museo de Historia Natural*, *22*(2), 144-171. https://doi.org/10.17151/bccm.2018.22.2.11

Henao-Bañol, E. R., & Stiles, F. G. (2018). Un inventario de las mariposas diurnas (Lepidoptera: Hesperioidea-Papilionoidea) de dos reservas altoandinas de la Cordillera Oriental de Colombia. *Revista de la Facultad de Ciencias*, *7*(1), 71-87. https://doi.org/10.15446/rev.fac.cienc.v7n1.67837

Hernández-Baz, F., López-L., J. D., & Hernández-G., A. L. (2022). Visitantes florales o polinizadores: No son iguales. *Revista La Ciencia y El hombre, 35*(3), 58-59.

Hsieh, T. C., Ma, K. H., & Chao, A. (2016). iNEXT: An R package for rarefaction and extrapolation of species diversity (Hill numbers). *Methods in Ecology and Evolution*, *7*(12), 1451-1456. https://doi.org/10.1111/2041-210X.12613

Jaramillo-J., A., & Rangel-Ch, J. O. (2014). Las unidades del paisaje y los bloques del territorio de la Orinoquía. En J. Rangel-Ch (Ed.), *Colombia Diversidad Biótica XIV. La región de la Orinoquía de Colombia* (pp. 101-152). Universidad Nacional de Colombia - Instituto de Ciencias Naturales.

Koleff, P., Gaston, K. J., & Lennon, J. J. (2003). Measuring beta diversity for presence-absence data. *Journal of Animal Ecology*, *72*(3), 367-382. https://doi.org/10.1046/j.1365-2656.2003.00710.x

Le Crom, J. F., Llorente-Bousquets, J. E., Constantino, L. M., & Salazar, J. (2004). Pieridae. *Mariposas de Colombia* (Vol. 2). Carlec Ltda.

Lennon, J. J., Koleff, P., Greenwood, J. J. D., & Gaston, K. J. (2001). The geographical structure of British bird distributions: Diversity, spatial turnover and scale. *Journal of Animal Ecology*, *70*(6), 966-979. https://doi.org/10.1046/j.0021-8790.2001.00563.x

Longino, J. T., & Colwell, R. K. (2011). Density compensation, species composition, and richness of ants on a neotropical elevational gradient. *Ecosphere*, *2*(3), 1-20. https://doi.org/10.1890/ES10-00200.1

Måsviken, J., Marquina, D., Norén, K., Dalén, L., & Dalerum, F. (2023). Elevational variation of spider and insect communities in the Swedish mountains. *Ecosphere*, *14*(6), e4540. https://doi.org/10.1002/ecs2.4540

McArdle, B. H., & Anderson, M. J. (2001). Fitting multivariate models to community data: A comment on distance-based redundancy analysis. *Ecology*, *82*(1), 290-297. https://doi.org/10.1890/0012-9658

McCain, C. M. (2005). Elevational gradients in diversity of small mammals. *Ecology*, *86*(2), 366-372. https://doi.

org/10.1890/03-3147

Melo, O., & Vargas, R. (2002). *Libro Evaluación ecológica y silvicultural de ecosistemas boscosos* (I). Universidad del Tolima, CRQ.

Mittermeier, R. A., & Konstant, W. R. (2001). Biodiversity conservation: Global priorities, trends, and the outlook for the future. In I. A. Bowles & G. T. Prickett (Eds.), *Footprints in the Jungle: Natural Resource Industries, Infrastructure, and Biodiversity Conservation*. Oxford University Press.

Montejo-Kovacevich, G., Martin, S. H., Meier, J. I., Bacquet, C. N., Monllor, M., Jiggins, C. D., & Nadeau, N. J. (2020). Microclimate buffering and thermal tolerance across elevations in a tropical butterfly. *Journal of Experimental Biology*, jeb.220426. https://doi.org/10.1242/jeb.220426

Moura, P. A., Corso, G., Montgomery, S. H., & Cardoso, M. Z. (2022). True site fidelity in pollen feeding butterflies. *Functional Ecology, 36*(3), 572-582. https://doi.org/10.1111/1365-2435.13976

Nunes, C. A., Braga, R. F., Figueira, J. E. C., Neves, F. D. S., & Fernandes, G. W. (2016). Dung Beetles along a Tropical Altitudinal Gradient: Environmental Filtering on Taxonomic and Functional Diversity. *Plos One*, *11*(6), e0157442. https://doi.org/10.1371/journal.pone.0157442

Núñez-Bustos, E. O. (2020). *Aspectos de historia natural de las especies de Actinote Hübner (Lepidoptera: Nymphalidae: Heliconiinae: Acraeini) en la Provincia de Buenos Aires, Argentina*. University of Florida. https://doi.org/10.5281/ZENODO.4317587

Oksanen, J., Simpson, G. L., Blanchet, F. G., Kindt, R., Legendre, P., Minchin, P. R., O'Hara, R. B., Solymos, P., Stevens, M. H. H., Szoecs, E., Wagner, H., Barbour, M., Bedward, M., Bolker, B., Borcard, D., Carvalho, G., Chirico, M., Cáceres, M. D., Durand, S., Antoniazi-Evangelista, H. B., Rich-Fitz, J., Friendly, M., Furneaux, B., Hannigan, G., O. Hill, M., Lahti, L., McGlinn, D., Ouellette, M. H., Ribeiro-Cunha, E., Smith T., Stier A., Ter-Braak, C. J. F., & Weedon, J. (2022). *vegan: Community Ecology Package*. Cran. https://CRAN.R-project.org/package=vegan

Olarte-Quiñonez, C. A., Acevedo-Rincón, A. A., Ríos-Málaver, I. C., & Carrero-Sarmiento, D. A. (2016). Diversidad de mariposas (Lepidoptera, Papilionoidea) y su relación con el paisaje de alta montaña en los Andes nororientales de Colombia. *Arxius de Miscel·lània Zoològica*, *14*, 233-255. https://doi.org/10.32800/amz.2016.14.0233

Parmesan, C. (2003). Butterflies as Bioindicators for Climate Change Effects. In C. Boggs, W. Watt & P. Ehrlich (Ed.), *Butterflies: Ecology and Evolution Taking Flight* (pp. 541-560). University of Chicago Press. https://doi.org/10.7208/9780226063195-027

Pires, A. C. V., Barbosa, M., Beiroz, W., Beirão, M. V., Marini-Filho, O. J., Duarte, M., Mielke, O. H. H., Ladeira, F. A., Nunes, Y. R. F., Negreiros, D., & Fernandes, G. W. (2020). Altitudinal variation in butterfly community associated with climate and vegetation. *Anais Da Academia Brasileira de Ciências*, *92*(suppl 2), e20190058. https://doi.org/10.1590/0001-3765202020190058

R Core Team (2023). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing. https://www.R-project.org/

Ramírez-Restrepo, L., Chacón-De Ulloa, P., & Constantino, L. M. (2007). Diversidad de mariposas diurnas (Lepidoptera: Papilionoidea y Hesperioidea) en Santiago de Cali, Valle del Cauca, Colombia. *Revista Colombiana de Entomología*, *33*(1), 54-63. https://doi.org/10.25100/socolen.v33i1.9316

Ríos-Málaver, C. (2007). Riqueza de especies de mariposas (Hesperioidea y Papilionoidea) de la quebrada "El águila" cordillera central (Manizales, Colombia). *Boletín Científico - Centro de Museos - Museo de Historia Natural, 11*(2), 272-291.

Rippstein, G., Escobar, Germán., & Motta, F. M. (2001). *Agroecología y biodiversidad de las sabanas en los Llanos Orientales de Colombia*. CIAT.

Rodríguez, M. A., Angueyra, A., Cleef, A. M., & Van Andel, T. (2018). Ethnobotany of the Sierra Nevada del Cocuy-Güicán: Climate change and conservation strategies in the Colombian Andes. *Journal of Ethnobiology and Ethnomedicine*, *14*(1), 34. https://doi.org/10.1186/s13002-018-0227-6

Rodríguez-Zapata, M. A., & Ruiz-Agudelo, C. A. (2021). Environmental liabilities in Colombia: A critical review of current status and challenges for a megadiverse country. *Environmental Challenges*, *5*, 100377. https://doi.org/10.1016/j.envc.2021.100377

Rosales, J., Suárez, S., & Lasso, C. A. (2010). Descripción del medio natural de la cuenca del Orinoco. Capítulo 3. In C. A. Lasso, J. S. Usma, F. Trujillo & A. Rial (Eds.). *Biodiversidad de la cuenca del Orinoco: Bases científicas para la identificación de áreas prioritarias para la conservación y uso sostenible de la biodiversidad* (pp. 51-

73). Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, WWF Colombia, Fundación Omacha, Fundación La Salle e Instituto de Estudios de la Orinoquía (Universidad Nacional de Colombia). http://repository.humboldt.org.co/handle/20.500.11761/34982

Schaffers, A. P., Raemakers, I. P., Sykora, K. V., & Ter Braak, C. J. F. (2008). Arthropod assemblages are best predicted by plant species composition. *Ecology*, *89*(3), 782-794. https://doi.org/10.1890/07-0361.1

Schirpke, U., Candiago, S., Egarter Vigl, L., Jäger, H., Labadini, A., Marsoner, T., Meisch, C., Tasser, E., & Tappeiner, U. (2019). Integrating supply, flow and demand to enhance the understanding of interactions among multiple ecosystem services. *Science of The Total Environment*, *651*, 928-941. https://doi.org/10.1016/j.scitotenv.2018.09.235

Steigenga, M. J., & Fischer, K. (2009). Fitness consequences of variation in developmental temperature in a butterfly. *Journal of Thermal Biology*, *34*(5), 244-249. https://doi.org/10.1016/j.jtherbio.2009.03.001

Suárez, A., Árias-Arévalo, P. A., & Martínez-Mera, E. (2018). Environmental sustainability in post-conflict countries: Insights for rural Colombia. *Environment, Development and Sustainability*, *20*(3), 997-1015. https://doi.org/10.1007/s10668-017-9925-9

Szewczyk, T., & McCain, C. M. (2016). A Systematic Review of Global Drivers of Ant Elevational Diversity. *Plos One*, *11*(5), e0155404. https://doi.org/10.1371/journal.pone.0155404

Ter Braak, C. J. F., & Schaffers, A. P. (2004). Co-Correspondence Analysis: A new ordination method to relate two community compositions. *Ecology*, *85*(3), 834-846. https://doi.org/10.1890/03-0021

Vallejo, M., Londoño, A., López, R., Galeano, G., Álvarez, E., & Devia, W. (2005). *Establecimiento de parcelas permanentes en bosques de Colombia. Bogotá*. Instituto de Investigaciones de Recursos Biológicos Alexander von Humboldt.

Valtonen, A., Molleman, F., Chapman, C. A., Carey, J. R., Ayres, M. P., & Roininen, H. (2013). Tropical phenology: Bi-annual rhythms and interannual variation in an Afrotropical butterfly assemblage. *Ecosphere*, *4*(3), art36. https://doi.org/10.1890/ES12-00338.1

Vanegas, B. M. Á. (2010). *Efecto de la complejidad del hábitat en la composición de la comunidad de hormigas en bosques premontanos en el área de influencia de la central hidroeléctrica "Porce II"* [Trabajo de Grado]. Universidad Nacional de Colombia sede Medellin. https://repositorio.unal.edu.co/handle/unal/7106

Villareal, H., Álvarez, M., Córdoba, S., Escobar, F., Fagua, G., Gast, F., Mendoza, H., Ospina, M., & Umaña, A. M. (2004). *Manual de métodos para el desarrollo de inventarios de biodiversidad*. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt.

Wagner, D. L. (2020). Insect Declines in the Anthropocene. *Annual Review of Entomology*, *65*, 457-480. https://doi.org/10.1146/annurev-ento-011019-025151

Warrren, A. D., Davis, K. J., Strangeland, E. M., Pelham, J. P., Willmoth|, K. R., & Grishin, N. V. (2023). *North and South American Butterflies. Butterflies of America*. https://www.butterfliesofamerica.com/L/Neotropical.htm

Willig, M. R., & Presley, S. J. (2016). Biodiversity and metacommunity structure of animals along altitudinal gradients in tropical montane forests. *Journal of Tropical Ecology*, *32*(5), 421-436. https://doi.org/10.1017/S0266467415000589

Wilson, R. J., Gutiérrez, D., Gutiérrez, J., & Monserrat, V. J. (2007). An elevational shift in butterfly species richness and composition accompanying recent climate change. *Global Change Biology*, *13*(9), 1873-1887. https://doi.org/10.1111/j.1365-2486.2007.01418.x

Yue, J. C., Clayton, M. K., & Hung, C.-R. (2022). Comparing Nonparametric Estimators for the Number of Shared Species in Two Populations. *Diversity*, *14*(4), 243. https://doi.org/10.3390/d14040243

Zelada, W. H. (2004). Las mariposas diurnas (Lepidoptera: Hesperioidea y Papilionoidea) del Bosque de Cuyas, Ayabaca, Piura, Perú. *Revista Peruana de Entomología*, *44*(1), 37-41.

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Tabla 1. Listado de especies y presencia por altura en el gradiente altitudinal del norte de la Orinoquia colombiana de acuerdo con la propuesta taxonómica de Warren et al. (2023).

Familia/subfamilia	**Especie**	**Altura**				
		132	**300**	**500**	**700**	**980**
Papilionidae / Papilioninae	*Heraclides homothoas* (Rothschild & Jordan,1906)	X				X
	Parides lysander (Cramer, [1775])					X
	Parides eurimedes (Stoll, [1782])					X
Pieridae / Coliadinae	*Eurema albula* (Cramer, [1776])				X	
	Eurema daira (Godart, 1819)		X	X	X	
	Pyrisitia leuce (Boisduval, 1836)	X				
	Pyrisitia venusta (Boisduval, 1836)	X	X			
Pieridae / Pierinae	*Itaballia demophile centralis* Joicey&Talbot, 1928	X				
Nymphalidae / Danainae	*Lycorea halia* (Hübner, 1816)	X	X			
	Ceratinia tutia (Hewitson, 1852)	X				
	Mechanitis menapis Hewitson, 1856			X		
	Mechanitis polymnia (Linnaeus, 1758)	X				X
Nymphalidae / Heliconiinae	*Actinote pellenea* Hübner, [1821]					X
	Actinote stratonice (Latreille, [1813])					X
	Dryas iulia (Fabricius,1775)	X				
	Eueides isabella (Stoll, 1781)					X
	Heliconius antiochus (Linnaeus, 1767)	X				
	Heliconius erato (Linnaeus, 1758)	X	X		X	X
	Heliconius sara (Fabricius, 1793)					X
Nymphalidae / Limenitidinae	*Adelpha alala* (Hewitson, 1847)			X	X	
Nymphalidae / Biblidinae	*Biblis hyperia* (Cramer, 1779)	X				
	Nessaea aglaura (E. Doubleday, [1848])					X
	Eunica anna (Cramer,1780)		X			
	Hamadryas feronia (Linnaeus, 1758)	X		X	X	
	Callicore pitheas (Latreille, [1813])	X				
	Catagramma pyracmon (Godart, [1824])	X				
Nymphalidae / Nymphalinae	*Historis odius* (Fabricius, 1775)				X	
	Colobura dirce (Linnaeus, 1758)					X
	Anartia amathea (Linnaeus, 1758)	X				
	Anartia jatrophae (Linnaeus, 1763)	X	X			X
	Siproeta stelenes (Linnaeus, 1758)					X

	Junonia evarete (Cramer, 1779)	X			X	X
	Castilia ofella (Hewitson, [1864])					X
	Tegosa anieta (Hewitson,1864)				X	
Nymphalidae / Charaxinae	*Hypna clytemnestra* (Cramer, 1777)					X
	Zaretis ellops (Ménétriés, 1855)				X	
	Memphis acidalia (Hübner, [1819])				X	X
Nymphalidae / Satyrinae	*Morpho helenor* (Cramer, 1776)					X
	Morpho deidamia neoptolemus Wood, 1863					X
	Caligo illioneus (Cramer, 1775)		X	X		
	Opsiphanes cassina C. Felder & R. Felder, 1862	X				
	Manataria maculata (Hopffer, 1874)				X	
	Forsterinaria neonympha (C. Felder & R. Felder, 1867)		X			
	Hermeuptychia hermes (Fabricius, 1775)	X	X	X	X	X
	Magneuptychia libye (Linnaeus, 1767)			X		
	Megeuptychia antonoe (Cramer, 1775)					
	Satyrotaygetis iris (C. Felder & R. Felder, 1867)				X	
	Modica fugitiva (Lamas, [1997])				X	
	Pareuptychia ocirrhoe (Fabricius, 1776)				X	X
Riodinidae / Riodininae	*Eurybia elvina* Stichel, 1910				X	
	Mesosemia nyctea (Hoffmansegg, 1818)				X	
	Melanis electron (Fabricius, 1793)	X				
	Calephelis laverna (Godman & Salvin, 1886)	X				
	Rhetus dysonii (Saunders, 1850)					X
Lycaenidae / Theclinae	*Calycopisi sobeon* (A. Butler & H. Druce, 1872)	X				
	Terenthina terentia (Hewitson, 1868)				X	
Hesperiidae / Eudaminae	*Cecropterus* (*Cecropterus*) *zarex* (Hübner, 1818)				X	
	Cecropterus (*Thorybes*) *dorantes* (Stoll, 1790	X				
	Spicauda teleus (Hübner, 1821)	X		X		
	Cogia calchas (Herrich-Schäffer, 1869)	X				
Hesperiidae / Pyrginae	*Eantis thraso* (Hübner, [1807])	X				
	Tiana niger (R. Williams & E. Bell, 1940)	X				
	Burnsius adepta (Plötz, 1884)	X				
	Burnsius oileus (Linnaeus, 1767)	X				
	Burnsius orcus (Stoll, 1780)	X			X	
Hesperiidae / Hesperiinae	*Cumbre* sp.		X			

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First record of *Aglossa caprealis* (Hübner, [1809]) with description of male from India (Lepidoptera: Pyralidae, Pyralinae)

Muzafar Riyaz & Sabreena Ashraf

Abstract

This study documents the first occurrence of *Aglossa caprealis* (Hübner, [1809]) in India, with a specimen collected in the Shopian district of the Kashmir Valley. Based on observations from similar habitats, the species' tentative range includes the Kashmir region, northern Jammu, and potentially extends to Pakistan, Afghanistan, Turkmenistan, and Iran. An IUCN Red List assessment using the GeoCAT tool classifies the species as Least Concern (LC), with an estimated extent of occurrence (EOO) of 207,099,692.893 km². This first confirmed record in the Indian subcontinent highlights a significant range expansion and provides critical insights into its South and Central Asian distribution.

Keywords: Lepidoptera, Pyralidae, Pyralinae, *Aglossa caprealis*, faunistic, species distribution, Kashmir, India.

Primer registro de *Aglossa caprealis* (Hübner, [1809]) con la descripción del macho de la India (Lepidoptera: Pyralidae, Pyralinae)

Resumen

Este estudio documenta la primera aparición de *Aglossa caprealis* (Hübner, [1809]) en la India, con un espécimen recogido en el distrito de Shopian, en el Valle de Cachemira. Según las observaciones realizadas en hábitats similares, el área de distribución provisional de la especie incluye la región de Cachemira, el norte de Jammu y, potencialmente, se extiende hasta Pakistán, Afganistán, Turkmenistán e Irán. Una evaluación de la Lista Roja de la UICN utilizando la herramienta GeoCAT clasifica la especie como «Preocupación menor» (LC), con una extensión estimada de ocurrencia (EOO) de 207 099 692,893 km². Este primer registro confirmado en el subcontinente indio pone de relieve una importante expansión de su área de distribución y proporciona información fundamental sobre su distribución en Asia meridional y central.

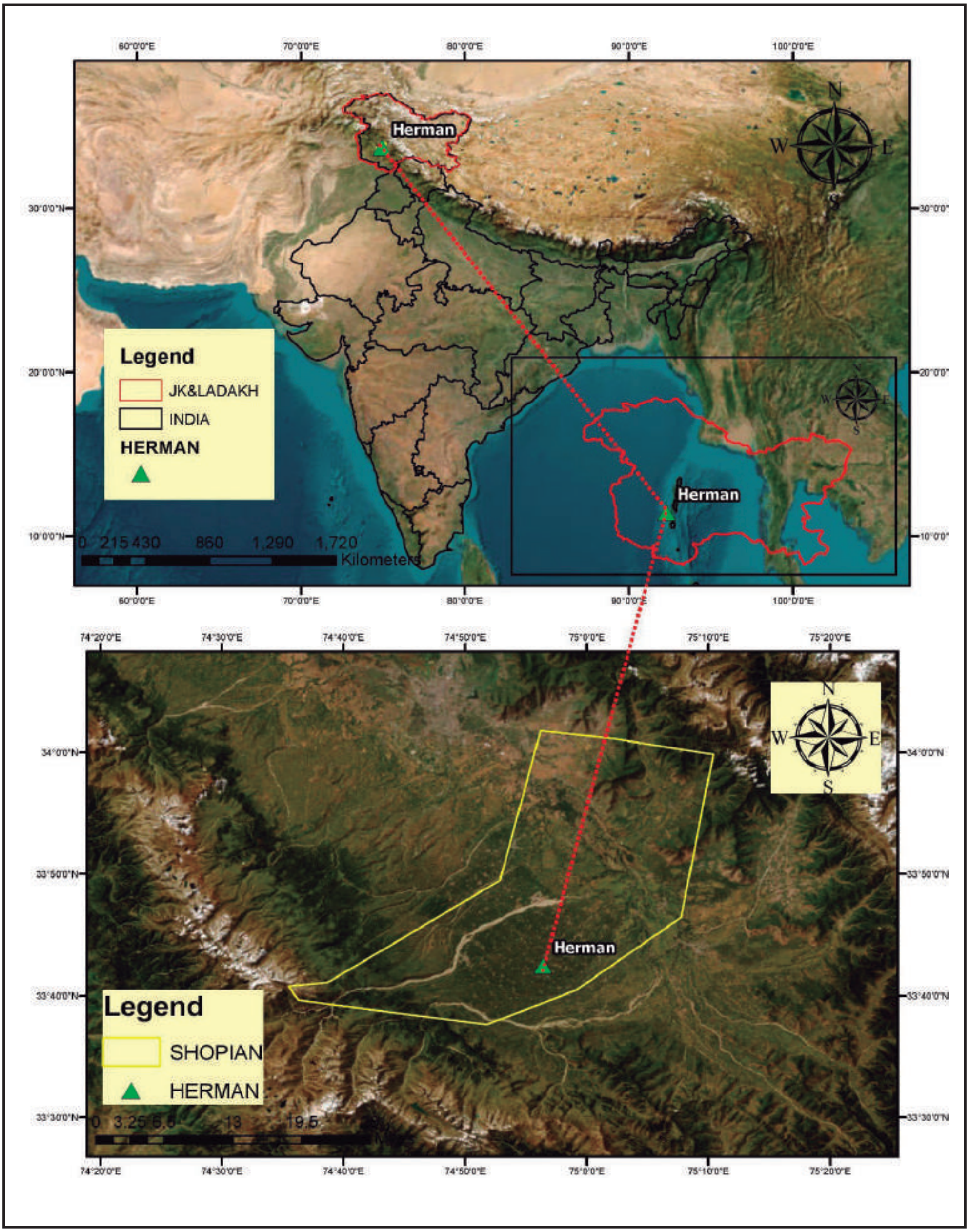
Palabras clave: Lepidoptera, Pyralidae, Pyralinae*, Aglossa caprealis*, faunística, distribución de especies, Cachemira, India.

Introduction

In India, research on the Pyraloidea superfamily began with Hampson's pioneering work in 1896, which was published as part of the *Fauna of British India series*. This early effort documented the distribution and taxonomy of 1,136 species. Since Hampson's contribution, numerous researchers both from India and internationally have periodically added new species and distribution records to the knowledge of Indian Pyraloidea (Rao & Sivaperuman, 2021; Singh et al. 2020; Mathew, 2006; Raha et al. 2017; Murthy et al. 2015). A more recent catalog of Indian Pyraloidea, lists 1,695 species, spread across 509 genera (Singh et al. 2022). Within the Pyralidae family, 518 species are identified, encompassing 182 genera, with the subfamily Pyralinae containing 171 species from 47 genera in India. Five genera -

Endotricha Zeller, 1847, *Hypsopygia* Hübner, [1825], *Pyralis* Linnaeus, 1758, *Sacada* Walker, 1862, and *Stemmatophora* Guenée, 1854 are notably species-rich, each having over ten species, with *Hypsopygia* being the most diverse, including 24 species.

Figure 1. Map of Tehsil Herman, Shopian District, India showing location of collection site.



A recent study by Riyaz et al. (2024) introduced *Pyralis farinalis* (Linnaeus, 1758) as a newly recorded species in India. Moreover, Riyaz & Ignacimuthu (2023) added two new species to the biodiversity records for the Jammu and Kashmir Union Territory: *Pyralis pictalis* (Curtis, 1834), and *Botyodes diniasalis* (Walker, 1859). These discoveries broaden the known range of these moth species in the region, enhancing the country's biodiversity records. Among the various genera, *Aglossa* Latreille, 1796 stands out, with several species documented in India. Noteworthy species include *Aglossa asiatica* Erschoff, 1872, found in the Northwest Himalayas, and *Aglossa dimidiatus* (Haworth, 1809), distributed in the Nilgiris and South India. Other species such as *Aglossa pinguinalis* (Linnaeus, 1758) are also present in the Northwest Himalayas, while *Aglossa tanya* Corbet & Tams (1943) is reported only in India (Singh et al. 2022).

Materials and Methods

An adult male specimen of *Aglossa caprealis* was photographed and collected indoors on August 19, 2024, at an elevation of 1,596 meters in Tehsil Herman (33º42'18"N, 74º56'23"E), located in the Shopian district of the Kashmir Division, Jammu & Kashmir Union Territory, India (Figure 1). The specimen was captured at night using a ProTac HL headlamp and ethyl acetate vials wrapped in cotton. It was photographed with a Xiaomi Redmi Note 8 Pro smartphone equipped with a 20 mm macro lens. The specimen was obtained during the author's exploration of the diverse insect life in Kashmir Valley. Subsequent taxonomic analyses, including the dissection and preparation of the genitalia, were carried out. The abdomen of the specimen was treated with KOH at 135ºC for several minutes, cleaned, and the genitalia were then prepared. After rinsing in distilled water, the genitalia were preserved in glycerin for further examination. The region, predominantly rural with large agricultural areas, receives an annual precipitation of 660 mm and maintains an average temperature of 25ºC (Riyaz et al. 2021; 2022; 2023; 2024; Riyaz & Reshi, 2021; Shiekh & Mishra, 2023). Both the specimen and its genitalia have been deposited in the insect museum of the Xavier Research Foundation at St. Xavier's College, Palayamkottai, India, under voucher number XRF-KMR-277. The identification of Aglossa caprealis was confirmed by examining the male specimen's morphological features and genitalia, utilizing online platforms like Pathpiva (https://pathpiva.fr/aglossa-caprealis/) and Lepiforum (https://lepiforum.org/wiki/page/Aglossa_caprealis), as well as relevant literature, including Solis & Shaffer (1999), Watt (1965), Trematerra (1987), and Goater et al. (2023).

Results

Taxonomical position

Superfamily Pyraloidea Latreille, 1809
Family Pyralidae Latreille, 1809
Subfamily Pyralinae Latreille, 1809
Tribe Pyralini Latreille, 1809

Aglossa Latreille, 1796. *Précis Charact. Gen. Ins*., 145
TS: *Pyralis pinguinalis* Linnaeus, 1758. *Syst. Nat.* (Ed. 10), 533, by subsequent monotypy

Aglossa caprealis (Hübner, [1809])
Pyralis caprealis Hübner, [1809]. *Samml. Eur. Schmett.,* pl. 23, fig. 153
LT: Europe

Species Description

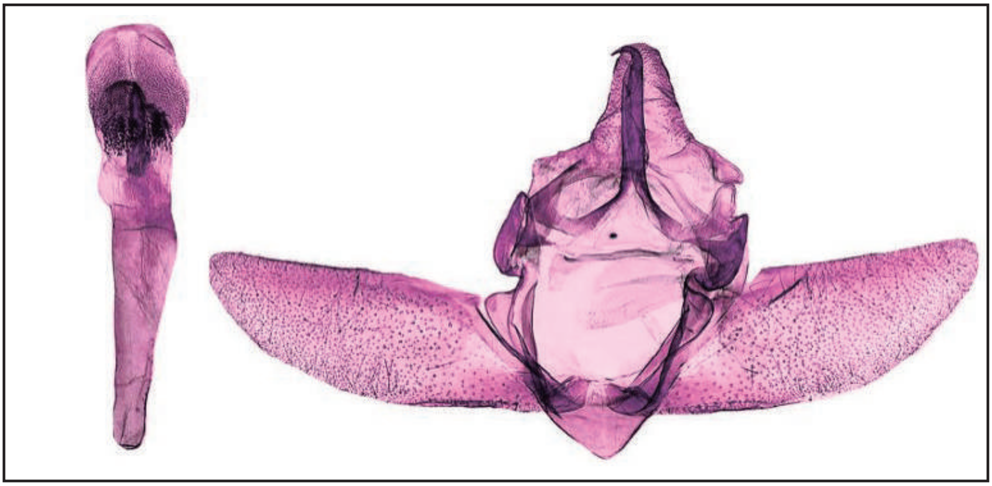
Adult: Wingspan: 25 mm; head and neck dorsally dark-colored; forewings exhibit a shiny brownish-gray ground color interspersed with pale yellowish markings and lines; reniform spot distinct, dark, circular, and encircled by a pale ring; antemedial (AM) line prominent, thick, sharply angled, forming a shallow zigzag pattern; subterminal (ST) line broad, straight at the costa and inner margin, with the central section forming a thin, jagged U-shaped curve.

Male Genitalia: Uncus slender, tapering slightly towards the apex but of near-uniform width throughout, with no spine clusters present ventrally; the structure is slightly curved, moderately sclerotized, and smooth.

Figure 2. Mounted Adult male *Aglossa caprealis*.

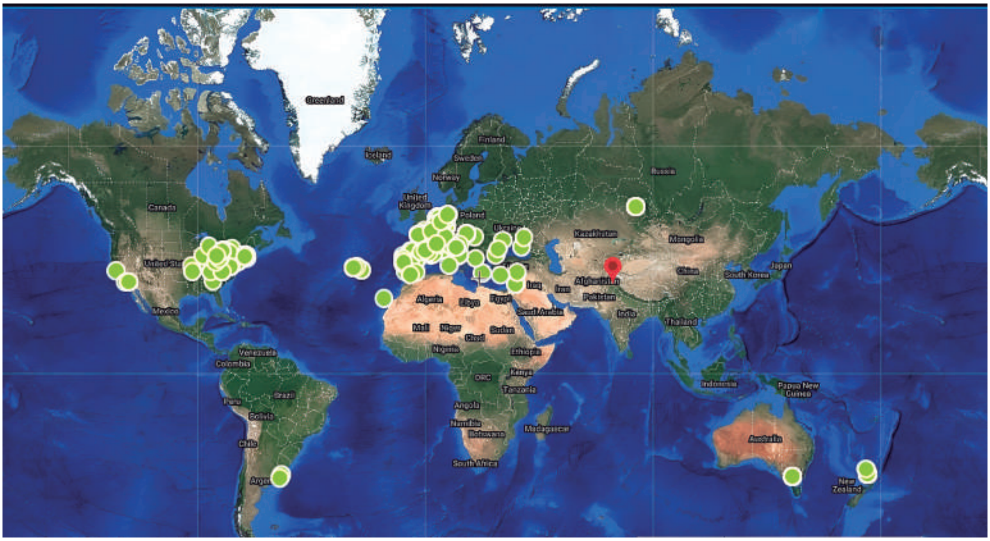
Tegumen is highly sclerotized and broad; vinculum well developed, connecting strongly with the tegumen: Juxta simple, small, and minimally sclerotized. Valvae symmetrical, broad, and relatively simple in form, with the ventral surface bearing fine hairlike setae, though not arranged in radiating rows; costal setae are absent. Aedeagus elongated and cylindrical, with the vesica bearing spinelike cornuti and showing heavy sclerotization. The vesica is slightly reflexed and moderately spined, contributing to the functional morphology of the genitalia.

Figure 3. Male genitalia of *Aglossa caprealis*.



Based on previous observations in similar ecological habitats, the authors suggest a tentative distribution range for this species encompassing the entire Kashmir region and northern areas of the Jammu division within the state of Jammu and Kashmir, India. Additionally, the authors propose the potential occurrence of the species in northern regions of Pakistan, Afghanistan, Turkmenistan, and Iran, which are geographically connected to the current known location. According to the IUCN Red List assessment using the GeoCAT tool, based on current and historical records, the species is classified as *Least Concern* (LC) with an estimated extent of occurrence (EOO) of 207,099,692.893 km² (Figure 4). This record is particularly significant as it represents the first confirmed evidence of *Aglossa caprealis* in the Indian subcontinent, marking a noteworthy range extension of the species into India's political boundaries. The discovery of this species in this region holds substantial biogeographical importance and adds to our understanding of its broader distribution across South and Central Asia.

Figure 4. IUCN Red List assessment of *Aglossa caprealis* using the GeoCAT



Conclusion

The Pyraloidea is a vast superfamily of moths within the order Lepidoptera, comprising more than 16,000 species globally, with the Pyralidae family accounting for 6,000 species and the Crambidae family for 11,000 species. These species occupy a variety of habitats, ranging from forests to deserts and from lowland areas to high-altitude regions. While many Pyraloidea species are notorious agricultural pests that can inflict substantial damage on crops, others serve beneficial roles as biological control agents against harmful insect pests. Pyraloidea are typically small to medium in size, often recognizable by their elongated snouts and triangular forewings.

In the Kashmir Valley, a key biodiversity hotspot within the Himalayas, the revision and documentation of insect species, especially moths, has been relatively sparse. Despite existing records, the region's full diversity remains underexplored, with many species still awaiting formal documentation. This study marks an important addition, confirming the first record of *Aglossa caprealis* from the Indian subcontinent. The record emphasizes the need for further entomological surveys and research in the region, which could uncover additional species and provide insights into the biogeographical distribution of these moths. With rapid environmental changes and threats to biodiversity, it is crucial to expand knowledge of the insect fauna in areas like the Kashmir Valley to inform conservation efforts and enhance our understanding of distributions across South Asia.

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Conflict of Interest

The authors declare that they have no known financial interests or personal relationships that could have influenced the work presented in this article.

References

Goater, B., Senior, G., & Dyke, R. (2023). *British pyralid moths*. Brill.

Hübner, J. (1796-[1836]). *Sammlung europäischer Schmetterlinge. Achte Horde. Die Schaben; nach der Natur geordnet, beschrieben und vorgestellt*. Augsburg.

Latreille, P. A. (1796). *Précis des caractères génériques des insectes, disposés dans un ordre naturel*. Prévôt & Bordeaux. https://doi.org/10.5962/bhl.title.58411

Linnaeus, C. (1758). *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Laurentii Salvii, Holmiae. https://doi.org/10.5962/bhl.title.542

Mathew, G. (2006). An inventory of Indian Pyralids (Lepidoptera: Pyralidae). *Zoos' Print Journal, 21*(5), 2245-2258. https://doi.org/10.11609/JoTT.ZPJ.667.2245-58

Murthy, M. S., Nagaraj, S. K., & Prabhuraj, A. (2015). Agriculturally important Pyraloidea (Lepidoptera) of India: Key to subfamilies, current taxonomic status and a preliminary checklist. *Entomon, 40*(1), 23-62. https://doi.org/10.33307/entomon.v40i1.65

Raha, A., Sanyal, A. K., Majumder, A., & Chandra, K. (2017). An inventory of Pyraloidea Latreille, 1809 (Lepidoptera: Heterocera) from Chhattisgarh. *National Journal of Life Science, 14*(1), 41-45.

Rao, B. S. K., & Sivaperuman, C. (2021). New records of pyraloid moths (Lepidoptera: Pyraloidea) in the Andaman and Nicobar Islands, India. *Zoosystematica Rossica, 30*(2), 215-221. https://doi.org/10.31610/zsr/2021.30.2.215

Riyaz, M., & Reshi, M. A. (2021). First record of *Myrmeleon trivialis* (Gerstaecker, 1885) (Neuroptera: Myrmeleontidae) from the J & K UT (Kashmir Valley, India). *Egyptian Academic Journal of Biological Sciences à Entomology, 14*(3), 59-64. https://doi.org/10.21608/eajbsa.2021.193051

Riyaz, M., & Sivasankaran, K. (2022). First record of Xanthia (Cirrhia) icteritia (Hufnagel, 1766) (Noctuidae: Xyleninae) from India. *Journal of Threatened Taxa, 14*(8), 21745-21748. https://doi.org/10.11609/jott.7846.14.8.21745-21748

Riyaz, M., & Ignacimuthu, S. (2023). Taxonomy of Pyraloidea with new distributional records from northwestern Himalayas, Kashmir-India. *Munis Entomology & Zoology, 18* (suppl.), 1965-1971.

Riyaz, M., & Ignacimuthu, S. (2024). Plusiinae of Kashmir: Taxonomy, distribution and new faunistic records (Lepidoptera: Noctuoidea). *SHILAP Revista de lepidopterología*, *52*(206), 375-383. https://doi.org/10.57065/shilap.919

Riyaz, M., Mathew, P., Shiekh, T., Ignacimuthu, S. & Sivasankaran, K. (2021). First record of the Afghan Poplar Hawkmoth Laothoe witti Eitschberger et al., 1998 (Sphingidae: Smerinthinae) from India: A notable range extension for the genus. *Journal of Threatened Taxa, 13*(7), 18943-18946. https://doi.org/10.11609/jott.6400.13.7.18943-18946

Singh, N., Kirti, J. S., Ranjan, R., Chandra, K., & Speidel, W (2020). On the taxonomy of the genus *Sacada* Walker, 1862 from India, with descriptions of a new genus and two new species (Pyralinae, Pyralidae, Lepidoptera). *ZooKeys, 962*, 139-163. https://doi.org/10.3897/zookeys.962.51194 PMid:32904399 PMCid:PMC7452911

Singh, N., Ranjan, R., Talukdar, A., Joshi, R., Kirti, J. S., Chandra, K., & Mally, R. (2022). A catalogue of Indian Pyraloidea (Lepidoptera). *Zootaxa, 5197*(1), 1-423. https://doi.org/10.11646/zootaxa.5197.1.1 PMid:37045059

Trematerra, P. (1987). Biological notes on *Aglossa caprealis* (Hübner) (Lepidoptera, Pyralidae). *Proceedings of the Fourth International Working Conference on Stored-Product Protection, Tel Aviv, Israel, 21-26 September, 1986., 1987*, 478-484 ref. 18.

Watt, M. (1965). A note on "*Aglossa caprealis*" (Hübner) (Lep., Pyralidae) a minor household pest. *Journal of the Entomological Society of Australia (N. S. W.), 2*, 57-58.

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Catalogue of the Castniidae in the National Museum of Ireland - Natural History, Dublin, with general comments on the history of the collection (Insecta: Lepidoptera)

Jorge M. González & Aidan O'Hanlon

Abstract

The material representing 35 specimens with 21 species and a total of 24 taxa belonging to the Castniidae (Lepidoptera) deposited in the National Museum of Ireland - Natural History, Dublin, Ireland, was studied. A brief comment on the history of the Natural History Museum and the origin of this small collection of Neotropical and Australian species is provided. General comments on natural history, distribution and other details for each mentioned species and subspecies are also included.

Keywords: Insecta, Lepidoptera, Castniidae, Neotropics, Australia.

Catálogo de los Castniidae en el Museo Nacional de Irlanda - Historia Natural, Dublín, con comentarios generales sobre la historia de la colección (Insecta: Lepidoptera)

Resumen

Se ha estudiado el material representado por 35 ejemplares, pertenecientes a 21 especies y un total de 24 taxones de Castniidae (Lepidoptera) depositados en el Museo Nacional de Irlanda - Historia Natural, Dublín, Irlanda. Se ofrece un breve comentario sobre la historia del Museo de Historia Natural y el origen de esta pequeña colección de especies de Castniidae neotropicales y australianas. También se incluyen comentarios generales sobre la historia natural, la distribución y otros detalles de cada una de las especies y subespecies mencionadas.

Palabras clave: Insecta, Lepidoptera, Castniidae, Neotrópico, Australia.

Introduction

The Natural History Division of the National Museum of Ireland (NMI) cares for the national collections in the scientific disciplines of Zoology and Geology. The Museum's origin dates back to the mid-18th century collections of the Royal Dublin Society (RDS) which was formerly lodged in Leinster House. The Natural History Museum was built as an extension to Leinster House in 1856 to accommodate the expanding RDS collections. The Museum's collections were transferred into state ownership in 1877 as the Museum of Science and Art, Dublin and again in 1921 as the National Museum of Ireland (O'Riordan, 1983). Following the Anglo-Irish War (1919-1921) Leinster House was transformed into the site of the Oireachtas (Irish Parliament) in 1922. Meanwhile, the Natural History Museum, originally an annex to Leinster House, has remained largely unchanged since opening to the public 169 years ago. It stands today as an "intact example of a nineteenth-century natural science collection" (Adelman, 2005; Murphy, 2021; Gan & Low, 2024), often referred to in Ireland as a "museum of a museum". Stephen Jay Gould fondly described the Museum's "cabinet-style" layout, calling it 'quintessentially Victorian' (Gould, 1994, 1995) (Figures 1.1 - 1.3).

Figure 1. Inside the National Museum of Ireland - Natural History, showing the typical Victorian arrangement of organisms, covering all available space. **1-3**. Galleries as seen from the upper floor. **2.** Two male giant Irish deer (center and right) and a female (left) (*Megaloceros giganteus*) at the entrance of the Irish Room, ground floor. **4-6.** Collection drawers showing the 35 Castniidae owned by the Museum as arranged during the late 1800s. **5**. William Forsell Kirby (1944-1912), assistant naturalist and curator to the Royal Dublin Society and Later to the Museum of Science and Art, precursors of the Natural History Museum.

Of the estimated two million specimens in the NMI Natural History Division's holdings, around 10,000 are on display, with the remainder maintained as a reference collection for scientific research. Approximately half of the Natural History collections consist of insects. The main area of active acquisition has been of Irish material, which consequently represents the majority of specimens in the museum. However, NMI also holds significant collections from beyond Ireland.

The entomology collection is particularly rich in Type material, and includes specimens from around the world, collected by famous naturalists like Johann Friedrich Gmelin (1748-1804), Charles Robert Darwin (1809-1882), Alfred Russell Wallace (1823-1913), and many other names familiar to modern taxonomists (Kirby, 1869; Monaghan, 2005).

Among its holdings are numerous South American Lepidoptera. Within the Castniidae, we were able to find 35 specimens in two drawers (Figures 1.4, 1.6). Thirty-three of them are Neotropical Castniinae, and two are Australian *Synemon* Doubleday, 1846 species. The number of specimens found in these two drawers coincides (with a couple of exceptions) with a catalogue of the Lepidoptera collection in the museum published by Kirby (1880). Unfortunately, most specimens lack any labels. Some of them appear to be quite old, possibly dating from the late 1700s and originating from the Leske collection. Nathanael Gottfried Leske (1751-1786) maintained an extensive cabinet of minerals and natural history, receiving specimens from European naturalists like Johann Friedrich Gmelin (1748-1804) (Kirby, 1869). The Royal Dublin Society acquired the Leskean Cabinet in 1792, later passing it to the Museum (Berry, 1915; Adelman, 2005).

Some labels bear numbers that might correspond to the Leske catalogue, but no definitive matches have been found (see Karsten, 1789; O'Reilly, 1813). Similarly, they do not align with William Forsell Kirby's catalogues. The Castniidae specimens were initially curated and arranged by British entomologist William Forsell Kirby (1844-1912) (Figure 1.5), who worked at the Museum from 1867 to 1879, with later additions by George Herbert Carpenter (1865-1939), another British entomologist employed there in the late 19th century. The arrangement has remained otherwise unchanged since the 1880s-1890s, aside from a few additions in the early 1900s.

Despite the absence of any provenance data from most of the Castniidae material, several specimens do bear labels and collector names of interest. For instance, some originate from Edward Bartlett (1844-1908) and Colonel Henry "Harry" Joseph Kelsall (1867-1950). Bartlett, a British ornithologist and herpetologist, also collected insects in the Amazon Basin and Peru between 1865 and 1869 (Palmer, 1944; Lamas, 1981: Bauer & Das, 2024). Kelsall, an officer in the Royal Artillery, was stationed in various locations worldwide (Gan & Low, 2024). He donated collections to the Dublin Natural History Museum and live animals to the Dublin Zoo (Anonymous, 1911, 1912). Some specimens originate from English zoologist and entomologist Robert Henry Fernando Rippon (c.1836-1917), whose collections were dispersed across multiple museums (Kirk-Spriggs, 1995; Nelson, 2017). Additional specimens came to the Museum as part of a collection of 130 Lepidoptera specimens purchased from a Mr. H. Lincoln of Dublin.

Materials and methods

Thirty-five specimens were found in two museum drawers. They belong to 21 species and represent 24 different taxas. This annotated list was organized roughly following the taxonomic arrangements of Moraes & Duarte (2009, 2014) (for Castniinae: Castniini) (with some exceptions) and Edwards (1996) (for Castniinae: Synemonini). The genera have been ordered phylogenetically, loosely following Lamas (1995) and Miller (1995). Species are organized alphabetically. For practical reasons, we also consider the separation of the several specimens into three subtribes.

Each species is presented with a brief comment. The "Material examined" section contains the sex of every studied specimen, as well as the data contained in its labels. Comments, additions, or corrections are added within brackets.

Results and discussion

Annotated list of species and label information of examined specimens of Castniidae hosted in the insect collection of the National Museum of Ireland - Natural History, Dublin

CASTNIIDAE Blanchard, 1840

Castniinae Blanchard, 1840

Castniini Blanchard, 1840

Lapaeumides ctesiphon (Hübner, [1820]) (Figure 2.1)
Eupalamides ctesiphon Hübner, [1820]. *Samml. exot. Schmett, 2,* pl. [141]

A large, beautiful and very rare species, with not many specimens in collections worldwide, most of which are quite old (Miller, 1986). The species is restricted to southern Brazil (Miller, 1986). It is probably associated with lowland tropical forest, but other than that, nothing is known about its biology (Miller 1986). This species and the next one (*L. zerynthia*) were listed under *Synpalamides* Hübner, [1823] by Moraes & Duarte (2014), we are placing them back in *Lapaeumides* Oiticica, 1955 out of convenience. Both species are very close morphologically and have almost identical and unique wings that differ from typical *Synpalamides*, allowing us to place them together back in the genus *Lapaeumides*. They are the only taxa within the latter genus, and they are both possibly extinct (see Lamas, 1995; Miller, 1986, 1995).

Material examined: 1 ♂, *Castnia latreilli*, [sic.] Brazil, ["279" label of unknown meaning].

Lapaumides zerynthia (Gray, 1838) (Figure 2.2)
Castnia zerynthia Gray, 1838. *Trans. ent. Soc. Lond., 2*, 144

The species appears to be restricted to Southeast Brazil, but some old classic authors have mentioned its presence in Bolivia (Westwood, 1877; Strand, 1913; Houlbert, 1918). Despite being a large and showy species, it is rare and poorly represented in colledtions, probably because local population numbers are very low, or possibly extinct (Miller 1986). As in the case of *L. ctesiphon* (Hübner, [1820]), all known specimens are quite old (Miller 1986). Nothing is known about its biology (Miller, 1986; González et al. 2010).

Material examined: 1 ♂, no data. [Brazil?].

Hista fabricii (Swainson, 1823) (Figure 2.5)
Castnia fabricii Swainson, 1823. *Zool. Illustr.,* (1)*3,* pl. 149

A common species in southeastern Brazil, however very little is known about its biology (Moraes et al. 2010). The phenotypic variability of the species is quite remarkable, allowing Moraes et al. (2010) to synonymize up to ten names under the one described by Swainson (1823). Its larvae have been found feeding on *Tillandsia aeranthos* (Loisel.) L. B. Sm. (Bromeliaceae) (Biezanko, 1961; González & Stüning, 2007; Moraes et al. 2010). Miller (1986) stated that the species could pupate on the ground or among grass at the base of trees where the host plant is located.

This species and the following (*H. hegemon* (Kollar, 1839)) were originally placed in the genus *Hista* (see Lamas, 1995; Miller, 1995; Moraes et al. 2010) but later, Moraes & Duarte (2014) synonymized them under *Synpalamides*. However, the close phylogenetic relationship of *Synpalamides* and *Hista* seems to be quite doubtful (R. Worthy, pers. comm.). Thus, we prefer to keep this and the following species under *Hista* Oiticica, 1955.

Material examined: 1 ♂, Brazil.

Hista hegemon (Kollar, 1839)
Castnia hegemon Kollar, 1839. *Ann. wien. Mus. Naturg., 2* (2), 217, pl. 13, f. 2

The species has been found in south and southeastern Brazil, with records for the states of Espírito Santo, Rio de Janeiro, São Paulo, and Santa Catarina (Moraes et al. 2010). It is a sexually dimorphic species, with the very rare females larger than males, and both sexes having different color pattern on the discal cell region of the hindwing (Moraes et al. 2010). Unfortunately, almost nothing is known about its behavior and ecology (Moraes et al. 2010; Rodríguez-Ramírez et al. 2020). Miller (1986) reported that it has been observed flying around trees similarly to various Sphingidae and that it flies between 11:30 and 13:00 hours, overlapping in activity with the sympatric *H. fabriicii*. Both species are closely associated. Even though Moraes et al. (2010) kept them both in the genus *Hista* (following Lamas, 1995, and Miller, 1995), Moraes & Duarte (2014) synonymized the genus under *Synpalamides*. Curiously, Moraes & Duarte (2014) noted that the wing pattern of *S. hegemon* is very similar to that of *Lapaeumides zerynthia*. Also, *Lapaeumides* and *Hista* might be closer to each other than *Hista* and *Synpalamides*. Thus, we keep this and the previous species within the genus *Hista*.

Material examined: 1 ♂, no data [Brazil?].

Yagra fonscolombe (Godart, [1824])
Castnia fonscolombe Godart, [1824]. *Encycl. méthod., 9*(2), 799

One of the few species in the family, with long series found in several collections worldwide (Moraes et al. 2011). The species is known from southeastern Brazil and Northeastern Argentina, and suspected to be in Paraguay, at least close to the border areas with the above-mentioned countries (Penco, 2011; Ríos & González, 2011; Rodríguez-Ramírez et al. 2020). Both sexes are represented in the museum, allowing them to appreciate their sexual dimorphism. Females are larger than males and have few creamy spots along the submarginal region as well as in the discal cell on their forewings, also the submarginal band of the hind wings has more spots than in males (Moraes et al. 2011).

Material examined: 1 ♂, ["99" label of unknown meaning] [Brazil?]; 1 ♂, no data [Brazil?].

Imara pallasia (Eschscholtz, 1821)
Castnia pallasia Eschscholtz, 1821, *in* Kotzebue. *Entdeck. Reise Süd-See, 3*(App. 5), 217, pl. 6, f. 27

A species of cloud forest ecosystems from southeasterm Brazil where it lives sympatrically with the congeneric *I. satrapes* (Kollar, 1839) (González & Stüning, 2007; González et al. 2010, 2013b). According to Miller (1986) the species appears to be a visual mimic of *Parides ascanius* (Cramer, 1775) (Papilionidae). She also reported the species hilltopping with some *Morpho* spp. (Nymphalidae) (Miller, 1986).

Material examined: 1 ♂, no data, [Brazil?]; 1 ♂, Brazil.

Synpalamides amycus (Cramer, [1779])
Papilio amycus Cramer, [1779]. *Uitl. Kapellen, 3*(17-21), 60, pl. 227, f. D, E;

A highly variable and relatively common species in eastern Brazil, but has been reported also from Argentina, Uruguay, Venezuela, Guyana, and Trinidad & Tobago (Miller, 1986; González & Fernández-Yépez, 1993, 2010; González, 1999; Sandoval et al. 2008; Penco, 2011). Even though nothing is known about its biology, it is possible that the species is associated to bromeliads (Bromeliaceae) (González & Cock, 2004).

Material examined: 1 ♂, no data. [Brazil?].

Synpalamides orestes (Walker, 1854) (Figure 2.3)
Castnia orestes Walker, 1854. *List Spec. Lepid. Insects Colln Br. Mus., 1***,** 26

A species commonly found in southeastern Brazil, but it is not as common in collections worldwide (González et al. 2010, Miller, 1986). A specimen is known in the Natural History Museum, London (NHMUK), from Johann Joseph Maria Becker's (1788-1859) collection, and was supposedly collected in "Venezuela" (Houlbert 1918). However, such locality is improbable, and the specimen might have been mislabeled (González et al. 2010).

Material examined: 1 ♂, Brzl [Brazil].

Synpalamides phalaris (Fabricius, 1793)
Papilio phalaris Fabricius, 1793. *Ent. Syst., 3*(1), 45

This highly variable species was originally described from Brazil, but it is known from most of Sout America, including Venezuela, Trinidad, Paraguay, Uruguay, Bolivia and Argentina (Miller, 1986; González & Cock, 2004; González & Stüning, 2007; González et al. 2010, 2013a; Penco, 2011; Ríos & González, 2011; González & Worthy, 2017). Little is known about its natural history, but females have been observed depositing their eggs on bromeliads in the genera *Guzmania* Ruiz & Pav. and *Bromelia* L. (Bromeliaceae) (Miller, 1986; González & Worthy, 2017). Adults have been observed flying around *Bromelia balansae* Mez and *Pseudananas sagenarius* (Arruda) Camargo and have been associated with pineapple crops (*Ananas* sp.) (Bromeliaceae) and bananas (*Musa* spp., Musaceae) (Jörgensen, 1930; Penco, 2011; Ríos & González, 2011).

Material examined: 1 ♂, no data; 1 ♂, S. [South] America. [Brazil?].

Castnia invaria penelope Schaufuss, 1870
Castnia penelope Schaufuss, 1870. *Nunq. Otios., 1*(1), 9, pl. 1

This is a variable species commonly associated with wild and ornamental Bromeliaceae and is considered a minor pest of pineapple (*Ananas comosus* (L.) Merr., Bromeliaceae) throughout most of its distribution (Miller 1986; González & Fernández-Yépez 1993; González, 2003; González & Cock 2004). This subspecies is present in Brazil, south of the Amazon, Argentina, Paraguay and Bolivia (Lamas, 1995; Penco, 2011; Ríos & González, 2011; Rodríguez-Ramírez et al. 2020). Its coloration is highly variable throughout its distribution area, which is reflected in the existence of a high number of synonyms (Lamas, 1995). The specimen in the museum is not well spread and its wing margins were cut. It differs from two specimens of *C. invaria trinitatis* (Lathy, 1925) also preserved in the museum (see below).

Material examined: 1 ♂, no data, [Brazil?].

Castnia invaria trinitatis Lathy, 1925 (Figure 2.4)
Castnia icarus trinitatis Lathy, 1925. *Ann. Mag. nat. Hist.*, (9)*16*, 242-243

This subspecies is only found in Trinidad and Tobago, where it seems to be rare (González & Cock, 2004; Cock et al. 2024). Lathy (1925) named the subspecies based on slightly variant color patterns different "from the typical form … and … resembling the race *penelope*, … and … having hindwing above as typical *icarus* …" Even though only one of these specimens (the female) in the museum was labelled, they both fit

Lathy's description. Also, since the male was mounted together with the female, it is possible that they were collected at the same time and place.

Material examined: 1 ♂, no data [Trinidad & Tobago?]; 1 ♂, Trinidad, Coll. Kelsall, (NMINH:1902.313) [Trinidad & Tobago].

Telchin atymnius drucei (Schaus, 1911) (Figure 2.6)
Castnia drucei Schaus, 1911. *Ann. Mag. nat. Hist.,* (8)*7*(38), 191

A typical Central American subspecies originally described from Costa Rica (as *Castnia drucei*) based on males and females from four different locations in the Country (Schaus, 1911; González, 2024; García et al. 2024). The species has been reported from Brazil, Colombia, Panama and Costa Rica; however, the South American records might be related to similar and very reddish *drucei*-like specimens of *Telchin atymnius humboldti* (Boisduval, [1875]), or incorrect labeling (García et al. 2024). For certain, the subspecies is found in the Pacific slope of the country, and in northern Panama, and might even reach northwestern South America and, as far as we know, it has not been recorded from other central American countries north of Costa Rica (González & Salazar, 2003, González et al. 2010; González & Domagała, 2019; Van den Berghe et al. 2020; Maes & González, 2022; García et al. 2024). The larvae of this subspecies are known to feed on various species of *Heliconia* plants (Heliconiaceae) and is regarded as a pest of sugarcane (*Saccharum officinarum*, Poaceae) (Salazar-Blanco et al. 2018; Cadet-Piedra et al. 2019; García et al. 2024).

Material examined: 1 ♂, Costa Rica.

Telchin atymnius humboldti (Boisduval, [1875])
Castnia humboldti Boisduval, [1875]. *Hist. nat. Ins., Spec. gén. Lépid. Hétérocères, 1*, 528

A subspecies commonly found in parts of northern South America, in Colombia, and Venezuela (Miller 1986; Constantino, 1998; Salazar, 1999). Like other subspecies in the species, it is frequently associated with bananas (*Musa* spp., Musaceae) and heliconia plants (*Heliconia* spp.: Heliconiaceae) (Miller, 1986; Constantino, 1998).

Material examined: 1 ♂, Colombia.

Telchin evalthe (Fabricius, 1775)
Papilio evalthe Fabricius, 1775. *Syst. Ent.*, 480

This species is widely distributed from southern Mexico to southern Brazil (Miller, 1986). It appears that the species could be associated with bromeliads (Bromeliaceae) or heliconia plants (*Heliconia* spp., Heliconiaceae), based mainly on potential host plants in areas where the species has been collected (Moss, 1945; Miller, 1986; González & Cock, 2004; González et al. 2010, 2017; González & Domagała, 2019; Aya et al. 2022; García-Díaz, 2023; García-Díaz et al. 2024). Several subspecies have been described; however, the species deserves a thorough morphological and molecular review to clarify its taxonomy. The specimen in the museum is a female; it resembles *T. evalthe quadrata* (Rothschild, 1919) described from Peru and Ecuador, which differs slightly from other subspecies (Rothschild, 1919; Lamas, 1995; González & Domagała, 2021).

Material examined: 1 ♂, Coll. By E. [Edward] Barlett, Chyavitas [Chayahuitas, 316 m, 05º25'S, 76º50'W], 1866, Peruvian Amazons, Castnia Evalthe. Loreto, [Peru].

Telchin licus (Drury, 1773)
Papilio licus Drury, 1773. *Illust. Nat. Hist. Exot. Insects, 2*, 30, pl. 16, f. 1

An extremely common and highly variable species throughout its distribution in Central and South America, where several subspecies are known (Miller, 1986; Rodríguez-Ramírez et al. 2020). Several of its subspecies have been reported as pests of relevant crops and ornamentals such as sugarcane (*Saccharum officinarum* L., Poaceae), bananas and plantains (*Musa* spp., Musaceae) and heliconia plants (Heliconiaceae) (González & Fernández-Yépez, 1993; González & Stüning, 2007; González et al. 2013a; Silva-Brandão et al. 2013; Aya et al. 2022). Although some subspecies present in Brazil and Colombia have been distinguished through molecular studies, the taxonomy of the species is still unclear (González & Cock, 2004; González et al. 2010; Silva-Brandão et al. 2013; Aya et al. 2022).

Material examined: 1 ♂, Rippon, Bogota. Castnia licus, Bogota, For Bengal Society, [Colombia]

Telchin licus insularis (Houlbert, 1918) (Figures 2.7 & 2.8)
Castnia licoides f. *insularis* Houlbert, 1918. *Etud. Lépid. Comp., 15*, 235

Individuals of this subspecies are "the most common and widespread castniids in Trinidad" according to González & Cock (2004). Known as the giant moth borer or large moth borer, it is an important pest of sugarcane, *Saccharum officinarum* L. (Poaceae) (Urich, 1912; Wolcott, 1913; Myers, 1931; Cock, 1985). However, this subspecies is known to attack *Heliconia* plants (Heliconiaceae), as well as bananas (Musaceae) and possibly other monocots (Myers, 1932; González & Cock, 2004).

Material examined: 1 ♂, Trinidad, Prevost [Trinidad & Tobago]; 1 ♂, Trinidad [Trinidad & Tobago]; 2 ♂, 1 ♀, Trinidad, Coll. Kelsall., (NMINH:1902.313) [Trinidad & Tobago].

Telchin syphax (Fabricius, 1775)
Papilio syphax Fabricius, 1775. *Syst. Ent.*, 480

The species is widely distributed in southern Venezuela, Trinidad, the Guianas and lower Amazon, in Brazil (González, 1999; González & Cock, 2004; González et al. 2010, 2013a). However, although many specimens are known and exist in numerous private and institutional collections, very little is known about its biology (Miller, 1986; González, 1999; González & Cock, 2004; González et al. 2010, 2013a).

Material examined: 1 ♂, no data [Brazil?]

Geyeria decussata (Godart, [1824])
Castnia decussata Godart, [1824]. *Encycl. Méthod., 9*(2), 799

This is a highly variable species which led several authors to consider them as different subspecies depending on the place of collection within a geographic range in eastern Brazil, from at least Pernanbuco to Rio Grande do Sul (Miller, 1986; Lamas, 1995).

Some adults are known to feed on the nectar of flowers of *Aechmea nudicaulis* Griseb. (Bromeliaceae), and larvae have been found in the bromeliad *Wittrockia superba* Lindman, in Santa Catarina Island, Brazil (Albertoni et al. 2012).

Material examined: 1 ♂, *Castnia decussata*, Brazil.

Gazerini Houlbert, 1918

Ceretes marcelserres (Godart, [1824])
Castnia marcel-serres Godart, [1824]. *Encycl. Méthod., 9*(2), 800

This species has a marked sexual dimorphism, a characteristic shared with the other species in the genus, *C. thais* (Drury, 1782), and quite unique in the family (Miller, 1986; Moraes & Duarte, 2014; Ríos et al. 2015). It is widely distributed in middle-south South America including East Bolivia, Southeast Brazil, Mid-East Paraguay and North-East Argentina (Penco 2011; Ríos & González, 2011; Ríos-Díaz et al. 2015). Jörgensen (1930) reported larvae of the species feeding on *Miltonia flavescens* Lindl. (Orchidaceae), which is abundant in the region where *C. marcelserres* flies in Paraguay (Ríos-Díaz et al. 2015).

Material examined: 1 ♂, S. [South] America, [Brazil?].

Ceretes thais (Drury, 1782) (Figure 2.9)
Papilio thais Drury, 1782. *Illust. Nat. Hist. Exot. Insects, 3*, 21, index [1], pl. 16, f. 4

Distributed in southern Brazil, reaching Bolivia and Argentina (Miller, 1986, Ríos & González, 2011). As in *C. marcelserres*, this species exhibits a striking sex dimorphism (González et al. 2010; González & Domagała, 2019). The ground color of the forewings is slightly similar in males and females, but paler with reduced markings in the latter. The ground-color of the female hindwings is orange-fulvous with two postmedian bands that are very dark, black, with an additional extradiscal spot band (Miller, 1986; González et al. 2010; Ríos & González, 2011). The hindwings od the males are colorful (blue-purple, with an orange band at the apex of the costal margin, extending to near the middle of the external margin. A yellow-orange spot is at the costal margin, without touching it, and stands alone, before the beginning of the orange band.

Material examined: 1 ♂, Brazil; 1 ♂, *Castnia thais*, [Brazil?].

Gazera heliconioides obidonus (Rothschild, 1919) (Figure 2.10)
Castnia (Cabirus) linus obidonus Rothschild, 1919. *Novit. Zool., 26*(1), 24

We keep this and the following taxon under the genera assigned by Lamas (1995) and Miller (1986, 1995), since we do not see them clearly matching the genus Prometheus Hübner, [1824] to which they were assigned by Moraes & Duarte (2014) (Worthy & González, in prep.). The subspecies of *G. heliconioides* are several and too similar, but this subspecies might be distinguished from others by its size and the hindwing submarginal spots (Rothschild, 1919; Miller, 1986)

Material examined: 1 ♂, Coll. by E. [Edward] Barlett, Ucayali [Lower River Ucayali, Loreto; either the mouth of the river, 04º26'S, 73º27'W, 110 m; or close to Nauta, 04º30'S, 73º35'W], 1865. Peruvian Amazons, *Castnia linus*, [Peru].

Duboisvalia ecuadoria pellonia (H. Druce, 1890)
Castnia pellonia Druce, 1890. *Ent. mon. Mag., 2*(310), 7

As in the previous taxon, we keep this subspecies under the genus assigned by Lamas (1995) and Miller (1995). Most representatives within this genus mimic *Heliconius* butterflies (Nymphalidae) (Miller, 1986). This taxon was originally designated as the type species of *Duboisvalia* Oiticica, 1955 and probably would be reinstated as a valid species (Miller 1986; Worthy & González, in prep.).

Material examined: 1 ♂, no data [Ecuador?]

SYNEMONINI Common, 1990

Synemon laeta Walker, 1854 (Figure 2.12)
Synemon laeta Walker, 1854. *Cat. Lep. Het. Brit. Mus, 1*, 36

An interesting Australian species with a wide distribution in Australia (Murphy, 2015, 2020). It is known to feed inside the culm of the Asparagaceae species *Lomandra longifolia* Labill. instead of the roots of their host as other species in this genus. It is a common species in its area of distribution (Guest, 1882).

Material examined: 1 ♂, 906 [original auctioneers' number?], (NMINI:1897.7.21.33) [Australia]

Synemon theresa Doubleday, 1846 (Figure 2.11)
Synemon theresa Doubleday, 1846, *in* Stokes. *Discov. Australia Append., 1*, 517, pl. 3, f. 6

Found in Victoria and South Australia, it is critically endangered, possibly extirpated in some areas, due to urban expansion, and the proliferation of exotic grasses and weeds (Douglas & Marriott, 2003; Marriott, 2003; Young & Hunt, 2005; Douglas, 2008). Their larvae feed amongst the roots of *Rytidosperma racemosum* (R. Br.) H. OP. Linder or *R. caespitosum* (Gaudich.) Connor & Edgar (Poaceae) and females have been observed laying eggs on *Themeda triandra* Forssk. (Poaceae) (Young & Hunt, 2005; Douglas, 2008). Adults lack feeding proboscis and last only for a few days living off body fat acquired as larvae (Douglas, 2008).

Material examined: 1 ♂, 906 [original auctioneer's number?], (NMINI:1897.7.21.17) [Australia]

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Conflict of Interest

The authors declare that they have no known financial interest or personal relationship that could have influenced the work presented in this article.

References

Adelman, J. (2005). Evolution on display: promoting Irish natural history and Darwinism at the Dublin Science and Art Museum. *British Journal for the History of Science*, *38*(4), 411-436. https://doi.org/10.1017/S0007087405007351

Albertoni, F. F., Moraes, S. S., Steiner, J., & Zillikens, A. (2012). Description of the pupa and redescription of the imagines of *Geyeria decussata* and their association with bromeliads in Southern Brazil (Lepidoptera: Castniidae). *Entomologia Generalis*, *34*(1-2), 61-74. https://doi.org/10.1127/entom.gen/34/2012/61

Anonymous (1911). Irish Societies. *The Irish Naturalist*, *20*(10), 181-184.

Anonymous (1912). Irish Societies. *The Irish Naturalist*, *21*(3), 57–62.

Aya, V. M., Pabón, A., González, J. M., & Vargas, G. (2022). Morphological and molecular characterization of Castniidae (Lepidoptera) associated to sugarcane in Colombia. *Bulletin of Entomological Research*, *112*(3), 399-410.

Bauer, A. M., & Das, I. (2024). *Edward Bartlett (1844-1908). Biography, bibliography and contributions to the herpetology of Borneo*. Society for the Study of Amphibians and Reptiles.

Berry, H. F. (1915). *A History of the Royal Dublin Society*. Kessinger Publishing. https://doi.org/10.5962/bhl.title.28459

Biezanko, C. M. (1961). Castniidae, Zygaenidae, Dalceridae, Eucleidae, Megolopygidae, Cossidae et Hepialidae da Zona Missioneira do Rio Grande do Sul. *Arquivos de Entomologia. Escola de Agronomia "Eliseu Maciel"*, *(B), 14*, 1-12.

Cadet-Piedra, E., Salazar-Blanco, J. D., & Oviedo-Alfaro, R. (2019). Monitoreo y manejo del barrenador gigante del tallo de la caña de azúcar (*Telchin atymnius* Lepidoptera: Castniidae) en Costa Rica. *Boletín Agroclimático*, *1*(12), 5-8.

Cock, M. J. W. (ed.) (1985). *A review of biological control of pests in the Commonwealth Caribbean and Bermuda up to 1982*. Commonwealth Institute of Biological Control, Technical Communication 9.

Cock, M. J. W., Mejias, C., Deacon, A. E., Deo, R. N., Kelly, M., & Pandey, D. R. W. (2024) More than 100 new records of moths and butterflies (Lepidoptera) from Tobago, West Indies, with a new synonym in Crambidae. *Living World*, *2024*, 52-100.

Constantino, L. M. (1998). Butterfly life history studies, diversity, ranching and conservation in the Chocó rainforests of Western Colombia (Insecta: Lepidoptera). *SHILAP Revista de lepidopterología*, *26*(101), 19-39.

Douglas, F. (2008). *The Sun-moths (Lepidoptera: Castniidae) of Victoria, with a detailed study of the pale Sun-moth* (*Synemon selene* Klug, 1850) [Master of Applied Science Thesis, University of Ballarat].

Douglas, F., & Marriott, P. (2003). Some notes on the Sun-moths, Lepidoptera: Castniidae. *Victorian Entomologist*, *33*(6), 90, 95.

Edwards, E. D. (1996). Castnioidea. In E. S. Nielsen, E. D. Edwards & T. V. Rangsi (Eds.). Checklist of the Lepidoptera of Australia. *Monographs on Australian Lepidoptera* (Vol. 4, pp. 138-351). CSIRO.

Gan, L. X., & Low, M. E. Y. (2024). *Singapore at the Dead Zoo: Celebrating Fifty Years of Ireland-Singapore Ties*. Lee Kong Chian Natural History Museum.

García-Díaz, J. J. (2023). Notes on *Telchin evalthe viryi* (Boisduval, [1875]) (Castniidae: Castniinae) in Mexico. *Tropical Lepidoptera Research*, *33*(1), 64-69.

García-Díaz, J. J., Espinoza-Sanabria, B. A., Worthy, R., González, J. M., Janzen, D. H., & Hallwachs, W. (2024). Synopsis of the Castniidae (Lepidoptera) of Costa Rica. *Zootaxa*, *5481*(2), 151-202.

González, J. M. (1999). Castniinae (Lepidoptera; Castniidae) from Venezuela. III: Genera represented by only one known species. Diagnosis and comments. *Ciencia (Maracaibo)*, *7*(3), 229-235.

González, J. M. (2003). Castniinae (Lepidoptera: Castniidae) from Venezuela. V: *Castnia* Fabricius and *Telchin* Hübner. *Boletín del Centro de Investigaciones Biológicas (Maracaibo)*, *37*(3), 191-201.

González, J. M. (2024). Types of Castniidae (Lepidoptera) in the Smithsonian Entomology Collection, National

Museum of Natural History (Washington, D.C.). *Colligo*, *7*(1), 3-13. https://revue-colligo.fr/?id=93

González, J. M., Boone, J. H., Brilmyer, G. M., & Le, D. (2010). The Giant Butterfly-moths of the Field Museum of Natural History, Chicago, with notes on the Herman Strecker collection (Lepidoptera: Castniidae). *SHILAP Revista de lepidopterología*, *38*(152), 385-409.

González, J. M., & Cock, M. J. W. (2004). A synopsis of the Castniidae (Lepidoptera) of Trinidad and Tobago. *Zootaxa*, *762*, 1-19. https://doi.org/10.11646/zootaxa.762.1.1

González, J. M., & Domagała, P. J. (2019). A catalog of the Castniidae (Lepidoptera) in the California Academy of Sciences with general and historical comments. *Annals of the Upper Silesian Museum in Bytom, Entomology*, *28*, 1-24. https://doi.org/10.5281/zenodo.2587666

González, J. M., & Domagała, P. J. (2021). Castniidae of the Museum of Natural History of the University of Wrocław: new findings from Friedrich Wilhelm Niepelt's collection with comments on Karl Adolf Georg Lauterbach and August Weberbauer. *Nota lepidopterologica, 44*, 123-132.

González, J. M., Domagała, P., Czaderma, R., & Wanat, M. (2013a). The Giant Butterfly-moths of the Natural History Museum of Wrocław University, Poland, with comments about Friedrich Wilhelm Niepelt and his insect collection (Lepidoptera: Castniidae). *Genus*, *24*(3-4), 275-290.

González, J. M., Domagała, P., & Larysz, A. (2013b). The Giant Butterfly-Moths (Lepidoptera: Castniidae) of the Upper Silesian Museum (Muzeum Górnośląskie) in Bytom, Poland, with notes on the history of the Museum. *Biodiversity Journal*, *4*(1), 219-228.

González, J. M., & Fernández-Yépez, F. (1993). Lista preliminar de las especies de Castniinae (Lepidoptera: Castniidae) del Parque Nacional "Henri Pittier", Venezuela. Diagnosis y comentarios. *Memorias de la Sociedad de Ciencias Naturales La Salle*, *53*(139), 47-53.

González, J. M., & Salazar, J. A. (2003). Adición a la lista de Castnidos (Lepidoptera: Castniidae: Castniinae) conocidos de Colombia. *Boletín Científico del Museo de Historia Natural, Manizale*s, *7*, 47-56.

González J. M., & Stüning, D. (2007). The Castniinae at the Zoologisches Forschungsmuseum Alexander Koenig, Bonn (Lepidoptera: Castniidae). *Entomologische Zeitschrift*, *117*(2), 89-93.

González, J. M., & Worthy, R. (2017). First records of *Synpalamides phalaris* (Fabricius, 1793) (Lepidoptera: Castniidae) in Venezuela, with comments on its natural history. *Check List*, *13*(4), 177-183. https://doi.org/10.15560/13.4.177

Gould, S. J. (1994). Cabinet museums revisited. *Natural History Magazine, 103*(1), 12-20.

Gould, S. J. (1995). *Cabinet museums: Alive, Alive, O!* In S. J. Gould. *Dinosaur in a Haystack. Reflections in Natural History* (pp. 238-247). Harmony Books. https://doi.org/10.4159/harvard.9780674063426.c27

Guest, E. (1882). List of diurnal Lepidoptera about Balhannah, Co. Adelaide, with descriptions of new or little-known species. *Transactions and Proceedings and Report of the Royal Society of South Australia*, *5*, 34-37

Houlbert, C. (1918). Révision monographique de la sous-famille des Castniinae. *Études de Lépidoptérologie Comparée*, *15*, 1-730.

Jörgensen, P. (1930). Las especies de Castniidae de la Argentina y Paraguay. *Revista de la Sociedad Entomológica Argentina*, *3*(14), 175-180.

Karsten, G. (1789). *Museum Leskeanum. Regnum Animale* (Vol. I). G. Müller. https://www.biodiversitylibrary.org/item/129768#page/417/mode/1up

Kirby, W. F. (1869). On the Diurnal Lepidoptera described in Gmelin's Edition of the Systema Naturae. *Transactions of the Royal Entomological Society of London*, *1869*(5), 355-362. https://doi.org/10.1111/j.1365-2311.1869.tb01111.x

Kirby, W. F. (1880). Catalogue of the Lepidoptera (Rhopalocera, Sphingidae, Castniidae and Uraniidae) in the Museum of Science and Art, Dublin, with remarks on new or interesting species. *Scientific Proceedings of the royal Dublin Society (New Series)*, *2*(5), 292-340

Kirk-Spriggs, A. H. (1995). Robert Henry Fernando Rippon (ca 1836-1917), naturalist and zoological illustrator. *Archives of Natural History*, *22*(1), 97-118. https://doi.org/10.3366/anh.1995.22.1.97

Lamas, G. (1981). Introducción a la historia de la Entomología en el Perú. II. Período de los viajeros, colectores y estudiosos especializados. *Revista Peruana de Entomología*, *23*(1), 25-31.

Lamas, G. (1995). A critical review of J. Y. Miller's Checklist of the Neotropical Castniidae (Lepidoptera). *Revista Peruana de Entomología*, *37*, 73-87.

Lathy, P. I. (1925). The Castniidae (Lepidoptera) of Trinidad and Tobago. *Annals and Magazine of Natural History*, (9)*16*(92), 242-243.

Maes, J.-M., & González, J. M. (2022). Ampliación geográfica de *Corybantes veraguana veraguana* (Westwood, 1877) y *Athis clitarcha* (Westwood, 1877) para la fauna de Nicaragua (Lepidoptera: Castniidae). *Revista Nicaragüense de Entomología*, *274*, 1-13.

Marriott, P. (2003). Victorian Sun-moths Lepidoptera: Castniidae. *Victorian Entomologist*, *33*(6), 91-94.

Miller, J. Y. (1986). *The taxonomy, phylogeny, and zoogeography of the Neotropical Castniinae (Lepidoptera: Castnioidea: Castniidae)* [Thesis Ph. D., University of Florida]. Colecciones Digitales, Bibliotecas George A. Smathers. https://ufdc.ufl.edu/aa00058516/00001

Miller, J. Y. (1995). Castniidae. In J. B. Heppner (Ed.). Checklist: Part 2. Hyblaeoidea-Pyraloidea-Tortricoidea. *Atlas of Neotropical Lepidoptera* (pp. 133-137, 176-177). Association for Tropical Lepidoptera/Scientific Publishers.

Monaghan, N. T. (2005). *Guide to the National Museum of Ireland - Natural History*. National Museum of Ireland.

Moraes, S. S., Duarte, M., & González, J. M. (2010). Revision of *Hista* Oiticica (Lepidoptera: Castniidae) and discussion on the validity of its subspecies. *Zootaxa*, *2421*, 1-27. https://doi.org/10.11646/zootaxa.2421.1.1

Moraes, S. S., & Duarte, M. (2009). Morfologia externa comparada das três espécies do complexo *Telchin licus* (Drury) (Lepidoptera, Castniidae) com uma sinonímia. *Revista Brasileira de Entomologia*, *53*(2), 245-265.

Moraes, S. S., & Duarte, M. (2014). Phylogeny of Neotropical Castniinae (Lepidoptera: Cossoidea: Castniidae): testing the hypothesis of the mimics as a monophyletic group and implications for the arrangement of the genera. *Zoological Journal of the Linnean Society*, *170*(2), 362-399.

Moraes, S. S., Duarte, M., & Miller, J. Y. (2011). Revision of the Neotropical genus *Yagra* Oiticica (Lepidoptera: Castniidae). *Journal of Natural History*, *45*(25-26), 1511-1531. https://doi.org/10.1080/00222933.2011.559593

Moss, A. M. (1945). The *Castnia* of Pará, with notes on others (Lep. Castniidae). *Proceedings of the Royal Entomological Society of London, (B)*, *14*(3-4), 48-52. https://doi.org/10.1111/j.1365-3113.1945.tb00016.x

Murphy, M. J. (2015). First records of the sun moth *Synemon laeta* Walker, 1854 (Lepidoptera: Castniidae) from New South Wales. *The Victorian Naturalist*, *132*(2), 44-46.

Murphy, M. J. (2020). Additional records of the sun moth *Synemon laeta* Walker, 1854 (Lepidoptera: Castniidae) from the Pilliga Forest in northern inland New South Wales. *The Victorian Naturalist*, *137*(4), 110-113

Murphy, S. (2021) *"The First National Museum": Dublin's Natural History Museum in the mid-nineteenth century*. Cork University Press.

Myers, J. G. (1931). *A preliminary report on an investigation into the biological control of West Indian insect pests*. His Majesty's Stationery Office.

Myers, J. G. (1932). The original habitat and hosts of three major sugar-cane pests of tropical America. (*Diatraea*, *Castnia* and *Tomaspis*). *Bulletin of Entomological Research*, *23*(2), 257-271. https://doi.org/10.1017/S0007485300004181

Nelson, E. C. (2017). Robert Henry Fernando Rippon: Some additional biographical notes. *Archives of Natural History*, *44*(1), 176-178. https://doi.org/10.3366/anh.2017.0427

O'Reilly, B. (1813). *Catalogue of the subjects of natural history in the museum of the right hon and hon. The Dublin Society, systematically arranged, also of the antiquities &c.* Graisberry and Campbell.

O'Riordan, C. E. (1983). *The Natural History Museum, Dublin*. The Stationery Office.

Palmer, T. S. (1944). Edward Bartlett. *The Auk*, *61*, 504-505. https://doi.org/10.2307/4079545

Penco, F. C. (2011). *Lepidoptera Argentina. Catálogo ilustrado y comentado de las mariposas de Argentina. Parte I: Castniidae*. Autor.

Ríos, S. D., & González, J. M. (2011). A synopsis of the Castniidae (Lepidoptera) of Paraguay. *Zootaxa*, 3*055*(1), 43-61. https://doi.org/10.11646/zootaxa.3055.1.3

Ríos-Díaz, S. D., Smith, P., Penco, F. C., & González, J. M. (2015). Registros recientes de *Ceretes marcelserres* (Godart, 1824) (Lepidoptera: Castniidae). *Boletín del Museo Nacional de Historia Natural del Paraguay*, *19*(1), 29-34.

Rodríguez-Ramírez, J., Ríos, S. D., Moraes, S., Penco, F. C., & González, J. M. (2020). Catálogo de los Castniidae (Lepidoptera) del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires: descripción de tipos y notas generales e históricas. *Revista del Museo Argentino de Ciencias Naturales*, *22*(2), 173-190. https://doi.org/10.22179/REVMACN.22.686

Rothschild, W. (1919). Supplementary notes to the review of Houlbert and Oberthür's monograph of Castniinae by Talbot and Prout. *Novitates Zoologicae, 26*(1), 1-27.

Salazar, J. A. (1999). Datos de recolección para 16 especies de castnidos colombianos (Lepidoptera: Castniidae). *Boletín Científico del Museo de Historia Natural, Manizales*, 3, 43-51.

Salazar-Blanco, J. D., Cadet-Piedra, E., Oviedo-Alfaro, R., Berrocal-Kopper, R., & Araya-Vindas, A. (2018). Monitoreo y manejo del barrenador gigante del tallo de la caña de azúcar (*Telchin atymnius,* Lepidoptera: Castniidae) en Costa Rica. *Resumen XI Congreso ATALAC - TECNICAÑA, Cali, Colombia, 26-28 de*

Setiembre de 2018.

Sandoval, M. F., Fernández-Badillo, A., & González, J. M. (2008). Mariposas (Insecta: Lepidoptera) del Parque Nacional Henri Pittier, Venezuela: lista, distribución y algunas notas sobre su historia natural. *Revista de la Facultad de Agronomía, Alcance 70*, 1-140.

Schaus, W. (1911). New species of Heterocera from Costa Rica. V. *Annals and Magazine of Natural History*, (8) *7* (38), 173-193. https://doi.org/10.1080/00222931108692920

Silva-Brandão, K. L., Almeida, L. C., Moraes, S. S., & Cônsoli, F. L. (2013). Using population genetic methods to identify the origin of an invasive population and to diagnose cryptic subspecies of *Telchin licus* (Lepidoptera: Castniidae). *Bulletin of Entomological Research*, *103*(1), 89-97. https://doi.org/10.1017/S0007485312000430 PMid:22971459

Strand, E. (1913). Gattung: *Castnia* F. (pp. 7-17), In A. Seitz (Ed.). *Die Gross-Schmetterlinge der Erde* (Vol. 6). A. Kernen.

Swainson, W. ([1822]-1823). *Zoological illustrations or original figures and descriptions of new, rare or interesting animals, selected chiefly from the classes of ornithology, entomology and conchology, and arranged on the principles of Cuvier and other modern zoologists* (Vol. 3). Baldwin, Cradock and Joy & W. Wood.

Urich, F. W. (1912). Sugar-cane insects in Trinidad. *West Indian Bulletin*, *12*(3), 388-391.

Van den Berghe, E., Maes, J.-M., Hernández-Baz, F., & González, J. M. (2020). Synopsis of the Castniidae (Lepidoptera) from Honduras and Nicaragua, Central America. *Zootaxa*, *4895*(2), 272–284. https://doi.org/10.11646/zootaxa.4895.2.6 PMid:33756905

Westwood, J. O. (1877). A monograph of the lepidopterous genus *Castnia* and some allied groups. *Transactions of the Linnean Society of London, Zoology*, (2)*1*(4), 155-207. https://doi.org/10.1111/j.1096-3642.1877.tb00437.x

Wolcott, G. N. (1913). Report on a trip to Demerara, Trinidad and Barbados during the winter of 1913. *Journal of Economic Entomology*, *6*(6), 443-457. https://doi.org/10.1093/jee/6.6.443

Young, D. A., & Hunt, L. F. (2005). The rediscovery of the Sun-moth, *Synemon theresa* (Doubleday, 1946). *Victorian Entomologist*, *35*(3), 48-51.

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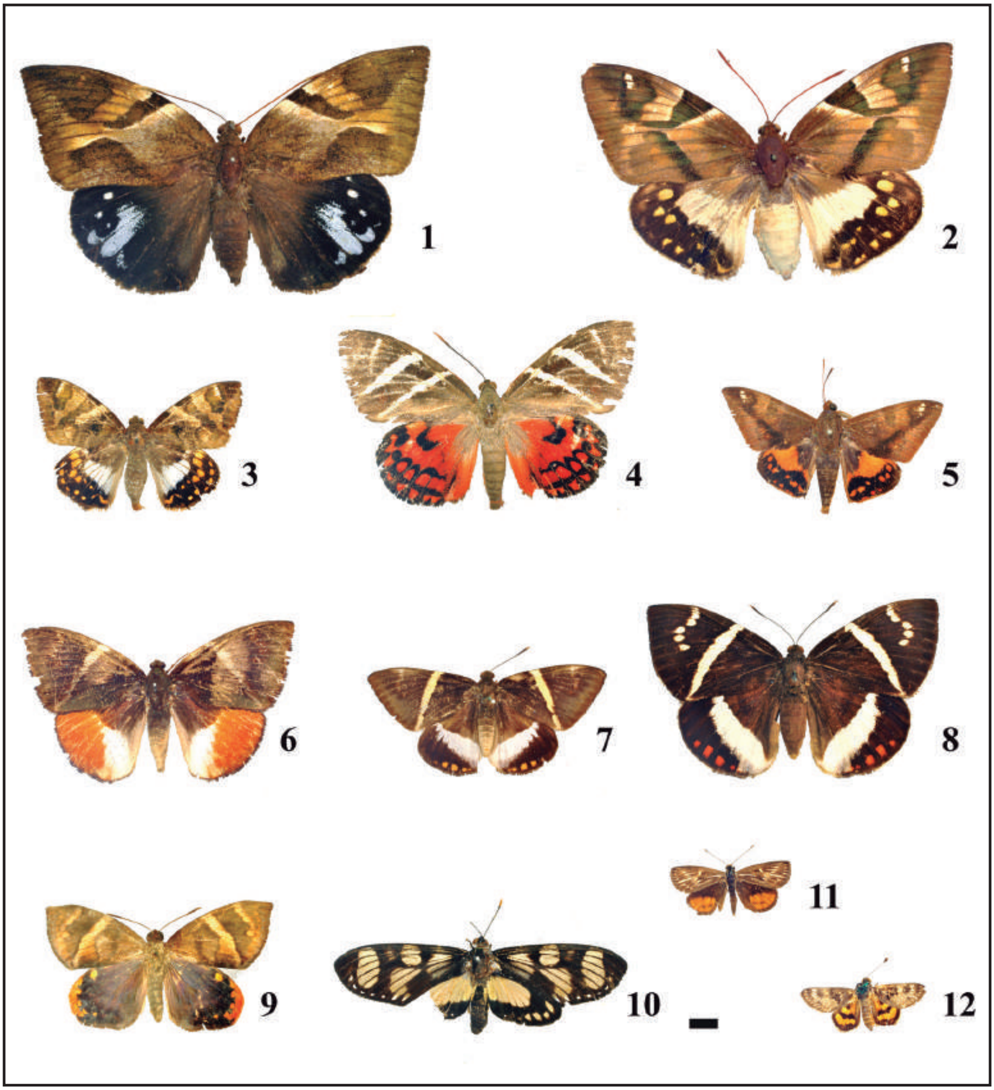
Figure 2. Castniidae (Lepidoptera) from the Insect Collection of the National Museum of Ireland - Natural History. **1.** *Lapaumides ctesiphon*, ♂, Brazil. **2.** *Lapaumides zerinthia*, ♂, Brazil. **3.** *Synpalamides orestes*, ♂, Brazil. **4.** *Castnia invaria trinitatis*, ♂, Trinidad & Tobago. **5.** *Hista fabricii*, ♂, Brazil. **6.** *Telchin atymnius drucei*, ♂, Costa Rica. **7-8.** *Telchin licus insularis*, ♂ and ♂, Trinidad & Tobago. **9.** *Ceretes thais*, ♂, Brazil. **10.** *Gazera heliconioides obidona*, ♂, Peru. **11.** *Synemon theresa*, ♂, Australia. **12.** *Synemon laeta*, ♂, Australia. Scale 1 cm.



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Integrative Taxonomic Characterization and first DNA Barcoding of *Chrysozephyrus syla* (Kollar, [1844]) and *C. birupa* (Moore, 1877) for Indian species (Lepidoptera: Lycaenidae)

Diksha Chopra, Gurinder Kaur Walia & Avtar Kaur Sidhu

Abstract

Genus *Chrysozephyrus* Shirôzu & Yamamoto, 1956 (Tribe: Theclini) contains species with high morphological plasticity, often complicating accurate identification. This study provides an integrative taxonomic assessment of *C. syla* (Kollar, [1844]) and *C. birupa* (Moore, 1877) based on specimens from the Himachal Pradesh region of the Indian Himalayas. Significantly, this investigation provides the first formal description and illustration of the female genitalia of *C. birupa*, alongside the first comprehensive illustrations of both male and female genitalia for *C. syla*. To supplement these morphological findings, mitochondrial cytochrome c oxidase I (COI) sequences were generated, representing the first global DNA barcoding data for these species. Molecular analysis revealed a characteristic A + T bias (average 70.3%), consistent with Lepidoptera mitochondrial evolution. Preliminary phylogenetic reconstruction using Maximum Likelihood confirms the placement of these Indian taxa within the Theclini clade, showing low intergeneric genetic distances (5.0-6.5%) that align with recent genomic hypotheses suggesting potential synonymy within the *Hypaurotis* Scudder, 1876 group. These findings provide essential morphological and molecular baselines for rare high-altitude Lycaenidae and underscore the importance of integrating genital morphology with molecular tools for resolving the complex systematics of the tribe.

Keywords: Lepidoptera, Lycaenidae, Theclini, *Chrysozephyrus*, DNA Barcoding, COI, genitalia, Integrative Taxonomy, India.

Caracterización taxonómica integradora y primer código de barras de ADN de *Chrysozephyrus syla* (Kollar, [1844]) y *C. birupa* (Moore, 1877) para especies indias (Lepidoptera: Lycaenidae)

Resumen

El género *Chrysozephyrus* Shirôzu & Yamamoto, 1956 (tribu: Theclini) contiene especies con una gran plasticidad morfológica, lo que a menudo complica su identificación precisa. Este estudio ofrece una evaluación taxonómica integradora de *C. syla* (Kollar, [1844]) y *C. birupa* (Moore, 1877) basada en especímenes de la región de Himachal Pradesh, en el Himalaya indio. Cabe destacar que esta investigación ofrece la primera descripción formal e ilustración de la genitalia de la hembra de *C. birupa*, junto con las primeras ilustraciones completas de la genitalia del macho y de la hembra de *C. syla*. Para complementar estos hallazgos morfológicos, se generaron secuencias de citocromo c oxidasa I (COI) mitocondrial, lo que representa los primeros datos globales de códigos de barras de ADN para estas especies. El análisis molecular reveló un sesgo característico de A + T (70,3 % de media), en consonancia con la evolución mitocondrial de los Lepidoptera. La reconstrucción filogenética preliminar utilizando la máxima verosimilitud confirma la ubicación de estos taxones indios dentro del clado Theclini, mostrando bajas distancias genéticas

intergenéricas (5,0-6,5 %) que se alinean con las hipótesis genómicas recientes que sugieren una posible sinonimia dentro del grupo *Hypaurotis* Scudder, 1876. Estos hallazgos proporcionan bases morfológicas y moleculares esenciales para los Lycaenidae raros de gran altitud y subrayan la importancia de integrar la morfología genital con herramientas moleculares para resolver la compleja sistemática de la tribu.
Palabras clave: Lepidoptera, Lycaenidae, Theclini, *Chrysozephyrus*, código de barras de ADN, COI, genitalia, taxonomía integrativa, India.

Introduction

The ecological diversity and functional roles of Papilionoidea serve as crucial indicators of biodiversity change (Lomov et al. 2006). However, documenting this diversity is often hindered by identification challenges arising from complex life cycles, polymorphism, and regional phenotypic variations. The tribe Theclini Swainson, 1831, is predominantly distributed across East Asia, comprising nearly 200 species situated within the ecotonal regions of the Eastern Palaearctic and Northern Oriental realms (Fujioka, 1993; Koiwaya, 1999). In India, the tribe is represented by 33 species across 13 genera (Varshney & Smetacek, 2015). Among these, the genus *Chrysozephyrus* Shirôzu & Yamamoto, 1956, exhibits the highest species richness, with over 50 formally described taxa (Koiwaya, 2007).

Species within *Chrysozephyrus* show remarkable interspecific morphological similarity in external wing patterns, necessitating the examination of genital structures for accurate identification (Huang, 2021). Historically, Howarth (1957) utilized external forewing characteristics to categorize the *Chrysozephyrus birupa* group, including *C. syla* (Kollar, [1844]) and *C. birupa* (Moore, 1877). While both species share overlapping distributions across the Himalayas from Himachal Pradesh to Uttarakhand and exhibit similar metallic violet-green reflections in males, their internal diagnostic features remained under-documented, particularly for female taxa.

The taxonomic placement of these species has undergone significant revision. Varshney and Smetacek (2015) initially assigned *C. birupa* and *C. syla* to the genera *Shirozuozephyrus* Koiwaya, 2008 and *Inomataozephyrus* Koiwaya, 2007, respectively. These were later synonymized under *Chrysozephyrus* by Saito & Hasegawa (2016). More recently, Zhang et al. (2020) proposed a broader synonymization of several genera, including *Chrysozephyrus*, under *Hypaurotis* Scudder, 1876, based on genomic evidence. Additionally, Garlani (2024) documented the presence of these two species within Himachal Pradesh.

To address these taxonomic complexities, integrative approaches combining morpho taxonomy with DNA barcoding have become essential (Wahlberg et al. 2005; Prieto et al. 2018). The mitochondrial cytochrome oxidase I (COI) gene remains the standard molecular marker for species delimitation due to its conserved nature and efficacy in resolving taxonomically challenging insect groups (Hebert et al. 2003).

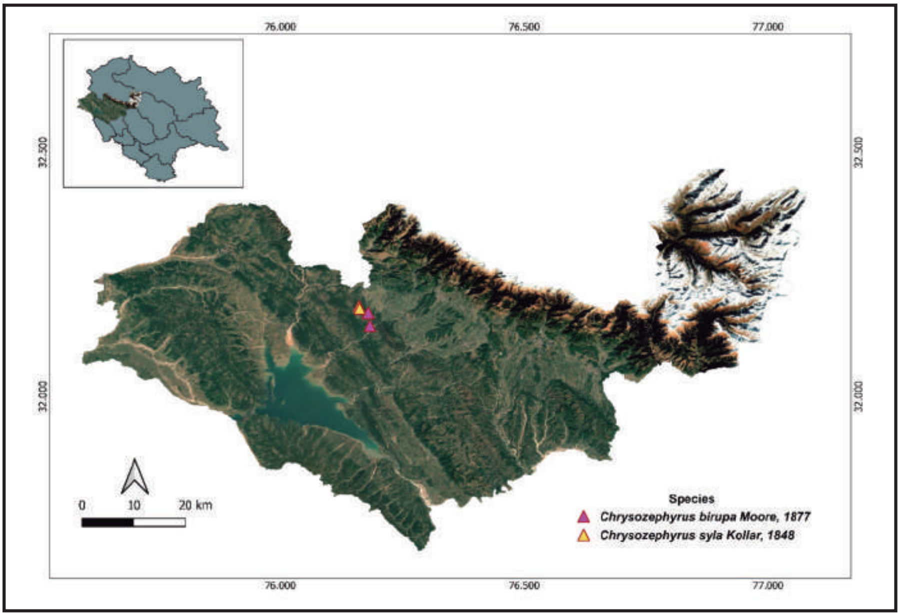
In the present study, we address existing knowledge gaps by providing the first formal description of the female genitalia of *C. birupa* and comprehensive genital illustrations for both sexes of *C. syla*. Furthermore, we present the first COI-based DNA barcodes for these species from the Indian Himalayas. By integrating detailed morphological dissections with preliminary molecular data, this study aims to clarify the diagnostic characteristics of these high-altitude Lycaenidae and contribute essential data to the ongoing systematic re-evaluation of the tribe Theclini.

Materials and Methods

Collection and Preservation: In the present study, four samples of the genus *Chrysozephyrus* were collected by sweeping net from various locations in Kangra, Himachal Pradesh (India), from 2022-2024. Wings were detached and placed in envelopes as vouchers. The bodies of the samples were placed in glass vials containing 100% ethanol. All ethanol-preserved samples were also stored at -20ºC until further use.

Morphological and Genitalia Examination: Specimen identification was conducted based on wing morphology and colouration patterns, following the methods of Evans (1932); Wynter-Blyth (1957), Cantile (1963) and Kehimkar (2016), supplemented by data from (http://www.ifoundbutterflies.org). Genitalia dissections were prepared via Robinson (1976) protocol for Microlepidoptera, with nomenclature standardized according to Klots (1970). Imaging and documentation were performed using a Leica image processing unit. Mapping was performed via QGIS software (Figure 1).

Figure 1. Map indicating the locations within Kangra district of Himachal Pradesh.



DNA Extraction and COI Amplification: Genomic DNA was extracted from ethanol-preserved samples, specifically from the legs and abdominal musculature. Extraction was performed via Qiagen DNA extraction kit. Agarose gel electrophoresis was used to check the integrity of the extracted DNA. For COI gene amplification, universal forward and reverse primers (Folmer et al. 1994) were used (LCO-1490-5'GGTCAACAAATCATAAAGATATTGG3' and HCO-2198- 5'TAAACTTCAGGGTGACCAAAAAATCA3'). Amplification was performed in a total volume of 28 µl, containing 8 µl of PCR water, 14 µl of Master Mix, 1.5 µl of each primer (LCO-1490 and HCO-2198), 1 µl of BSA and 2 µl of DNA. The thermal cycling program of the PCR procedure was as follows: 1 cycle for initial denaturation at 95ºC for 5 minutes; 35 cycles for denaturation at 95ºC for 1 minute, annealing at 45ºC for 1 minute, and extension at 72ºC for 1 minute; and 1 cycle for a final extension at 72ºC for 5 minutes. All the PCR products were visualized via 1% agarose gel electrophoresis with ethidium bromide (EtBr) staining under UV light via a gel documentation system to confirm successful DNA amplification. The amplification of the COI gene was performed. Amplified products were sent to the Research Lab Biology, New Delhi, for sequencing via the Sanger dideoxy sequencing method. The obtained sequences were approximately 600-680 bp in length and were submitted to the NCBI database, and accession numbers were obtained. The NCBI BLAST search engine was employed to identify conspecific sequences by analysing genetic similarities. Four COI (cytochrome oxidase I) gene sequences, representing two species, were submitted to the NCBI GenBank database. Unique accession numbers were assigned to these sequences, making them accessible for future research and comparative analysis.

Sequence alignment, accession numbers, genetic distance analysis and phylogenetic analysis: Corresponding COI sequences of conspecific samples deposited by other workers were downloaded from GenBank via a BLAST search. The raw sequences were aligned, edited and trimmed manually via ClustalW in MEGA XII software. Interspecific genetic distances and conserved, variable and parsimony informative sites of the COI gene fragments of all the species were recovered via MEGA XII. A phylogenetic tree was constructed via the maximum likelihood method and the Tamura (1992) model for all the species and *Thecla betulae* (Linnaeus, 1758) of the subfamily Theclinae designated as the outgroup (Table 1)**.**

Table 1. Accession numbers, voucher numbers, sequence lengths, localities and references of the species used in the phylogenetic analysis.

Reference	Species	Sequence Length (bp)	Voucher Number	Accession number	Locality
Odagiri, 2004	*Chrysozephyrus smaragdinus* Shirôzu & Yamamoto, 1956	507	98ZE32	AB195511	Japan
Odagiri, 2004	*Favonius cognata* (Staudinger, 1892)	507	98ZE45	AB195541	Japan
Odagiri, 2004	*Favonius jezoensis* (Matsumura, 1915)	507	98ZE05	AB195538	Japan
Odagiri, 2004	*Favonius korshunovi* Dubatolov & Sergeev, 1982	579	98ZE39	AB195536	Japan
Odagiri, 2004	*Favonius leechina* Lamas, 2008	579	98ZE51	AB195531	Japan
Odagiri, 2004	*Favonius orientalis* (Murray, 1875)	579	98ZE13	AB195530	Japan
Odagiri, 2004	*Favonius saphirina* (Staudinger, 1887)	579	98ZE40	AB195522	Japan
Odagiri, 2004	*Favonius taxila* (Bremer, 1861)	579	98ZE03	AB195526	Japan
Odagiri, 2004	*Favonius ultramarine* (Fixsen, 1887)	579	98ZE18	AB195544	Japan
Odagiri, 2004	*Favonius yuasai* Shirôzu, 1948	579	98ZE36	AB195534	Japan
Odagiri, 2004	*Hypaurotis crysalus* (Edwards, 1873)	507	98ZE31	AB195512	Japan
Odagiri, 2004	*Neozephyrus japonica* (Murray, 1875)	507	97ZE20	AB195513	Japan
Odagiri, 2004	*Sibataniozephyrus fujisanus* (Matsumura, 1910)	507	98ZE33	AB195514	Japan
Kim et al. 2010	*Neozephyrus koreanus* (Riley, 1939)	603	NA	GU372574	Korea
Hausmann et al. 2011	*Quercusia quercus* (Linnaeus, 1758)	579	BC ZSM Lep 30684	HM393195	Germany
Dinca et al. 2021	*Hypaurotis quercus* (Linnaeus, 1758)	579	RVcoll1 5F391	MW503561	Portugal
Nakabayashi & Ohshima, 2024	*Hypaurotis orientalis* (Murray, 1875)	507	YT-048	OP443378	Japan
Lukhtanov et al. 2009	*Thecla betulae* (Linnaeus, 1758)	534	2005-LOWA-736	FJ664048	Russia
Current study	*Chrysozephyrus syla* (Kollar, [1844])	603	DT46	PQ850024	India
Current study	*Chrysozephyrus syla* (Kollar, [1844])	603	DT43	PQ850022	India
Current study	*Chrysozephyrus birupa* (Moore, 1877)	603	DT12	PQ849159	India
Current study	*Chrysozephyrus birupa* (Moore, 1877)	603	DT33	PQ677695	India

Results and Discussion

TAXONOMIC DESCRIPTIONS

Genus *Chrysozephyrus* Shirozu & Yamamoto, 1956
Chrysozephyrus Shirôzu & Yamamoto, 1956; *Sieboldia, 1*(4), 381
Hypaurotis; Zhang, Cong, Shen, Opler & Grishin, 2020, *Taxonomic Rep., 8*(7), 13
Type species: *Thecla smaragdina* Bremer, 1861

Diagnostic characters: Eyes hairy, labial palpi projected forward, projecting beyond head, with a hairy second segment; forewing with 11 veins; R_3+R_5 stalked, M_1 arising freely beyond the end of the cell; male genitalia with uncus bifid, short and flattened; tegumen with prominent lateral processes, brachia serrate at base, smoothly curved medially, distally straight, vesica furnished with multiple cornute; female genitalia with prominent genital plate, eye-shaped signa.

Key to species of the genus *Chrysozephyrus* Shirozu & Yamamoto, 1956

1. Forewing dorsally in male with border thicker at the apex; ventrally brownish white; male genitalia with base strongly dentate and spinose; saccus broader and smaller; aedeagus shorter, broader; female genitalia with ductus bursae shorter, semi-sclerotized tube……………………………………………. *birupa* Moore
- Forewing dorsally in male with uniform border; ventrally silvery-white; male genitalia with the base of the brachia not dentate; saccus exceptionally long; aedeagus longer, narrower; female genitalia with the ductus bursae narrow, elongated, membranous and tubular…………………………………………….. *syla* Kollar

Chrysozephyrus birupa (Moore, 1877) (Figure 2: (A-G))
Moore, 1877, *Ann. Mag. nat. Hist.* (4)*20*(115), 51 (*Dispas*); Howarth, 1957, *Bull. Br. Mus. nat. Hist., 5*(6), 266 (*Neozephyrus*); Shirôzu, 1962, *Tyô to Ga, 12*(4), 147 (*Chrysozephyrus*); Zhang, Cong, Shen, Opler and Grishin, 2020, *Taxonomic Rep., 8*(7), 13 (*Hypaurotis*).

Material examined: 1 ♀, 19-V-22, Dharamkot, Kangra; 1 ♂, 18-VI-24, Kareri Village, Kangra, Himachal Pradesh.

Adult (Male): Forewing dorsally metallic green, with black scales interspersed, bordered by a smooth, continuous black margin, ventrally brownish white, with an end-cell spot, a submarginal band, a discal band extending from the costa; hindwing crenulate, metallic green dorsally with powdery black scales bordered black, tailed ventrally brownish white, an obscure terminal cell spot, an elongated discal band, an indistinct submarginal band, a tornal region with black spot, crowned orange, with an additional black spot, encircled orange, all markings brown, white edged.

Adult (Female): Forewing dorsally dark brown, with two bluish-white subapical spots and slight blue suffusion at the base, otherwise like male.

Male genitalia: Uncus bilobed, each lobe filamentous, densely pilose; elongated, basal region produced into a strongly dentate, elongated elbow-like structure, with abundant spines, curved arms, tegumen very broad, lateral windows deeply clefted; lower half with narrow vinculum, saccus elongated; valvae rectangular, costa narrow, harpe with rounded apex, ampulla extends into an elongated finger-like process, pilose; juxta V shaped, arms broad; aedeagus long, subzone larger than suprazonal portion, bulbus ejaculatorius entering dorsally, rounded coecum, vesica with numerous spines.

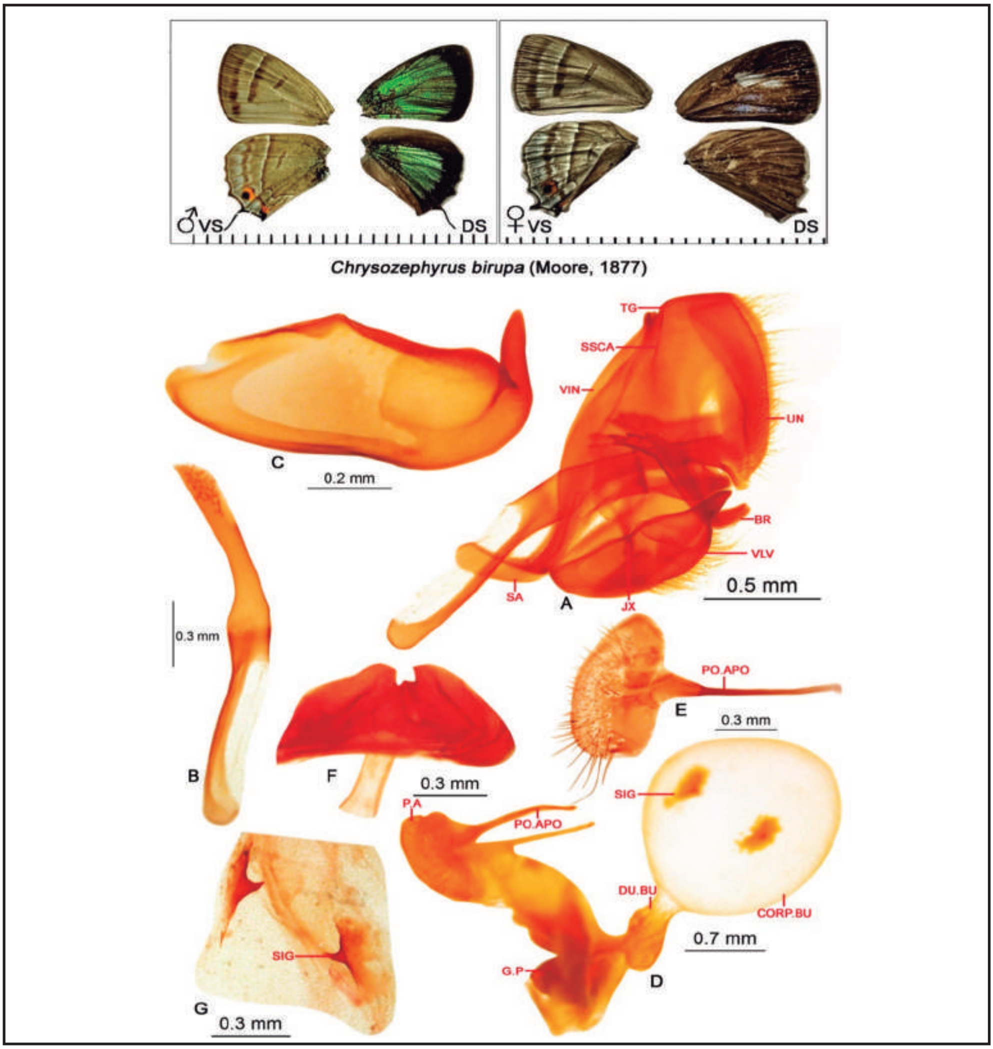
Female genitalia: Lodix rounded; genital plate broadly sclerotized and bilaterally symmetrical; ductus bursae small, semi-sclerotized tube, connects ostium bursae to the corpus bursae; corpus bursae rounded, membranous with pair of well-developed signae; signae sclerotized and pointed, apophyses anterioris sharp; posterior apophyses short and broad near base; papilla analis oval, pilose.

Wing expanse: Half: Male: 19.0 mm, Female: 19.5 mm. Range: 1400-2700 m ASL.

Old distribution: India: Shimla to Kumaon, Kangra, Mussoorie, Doon Valley. Other Countries: East to Central Nepal. Larval host plant: *Rhododendron arboreum* Sm.

Remarks: During the survey period (2022-2024), *C. birupa* was recorded at altitudes ranging from 1900-2100 m ASL. Specific collection sites included the vicinity of Dal Lake and Kareri village (Kangra district), where specimens were observed in riparian zones and temperate forested habitats. The ventral wing surfaces exhibit silver-brown cryptic maculation; similar phenotypes in Theclini have been noted for their resemblance to dried leaf litter (Howarth, 1957). Adults demonstrated high vagility and rapid escape flight when disturbed, a behavioural trait common to high-altitude Theclinae. The spatial association of adults with *Rhododendron arboreum* suggests a potential host-plant relationship or specific habitat correlation, although further larval rearing is required for confirmation. This investigation provides the first formal documentation and illustration of the female genitalia for this species, significantly expanding the known morphological record for the *C. birupa* group in the Indian Himalayas.

Figure 2. A. Male genitalia (lateral view). **B.** Aedeagus (lateral view). **C.** Valva (inner view). **D.** Female genitalia (lateral view). **E.** Papilla analis. **F.** Genital plate. **G.** Signum.



Chrysozephyrus syla (Kollar, [1844]) (Figure 3: (A-G))
Kollar, [1844] in Hügel, *Kaschmir und das Reich der Siek, 4*, 414 (*Thecla*); Moore, [1858] in Horsfield & Moore, *Cat. lep. Ins. Mus. East India Coy, 1*, 30 (*Dispas*); Howarth, 1957, *Bull. Br. Mus. nat. Hist., 5*(6), 267, (*Neozephyrus*); Shirôzu, 1962, *Tyô to Ga, 12*(4), 148 (*Chrysozephyrus*); Zhang, Cong, Shen, Opler and Grishin, 2020, *Taxonomic Rep., 8*(7), 13 (*Hypaurotis*).

Material examined: 1 ♀, 1 ♂, 18-VI-24, Kareri Trek, Kangra, Himachal Pradesh.

Adult (Male): Forewing dorsally metallic green iridescence, with a narrow black margin, ventrally silvery white with an end-cell spot, a brown curved discal band from the costa to the inner margin, a faint submarginal band, white bordered outwardly; hindwing dorsally metallic green, broad black border, tailed, ventrally a postdiscal band, bordered white outwardly, a distinct tornus adorned with prominent tornal spots in black, bordered by orange.

Adult (Female): Forewing dorsally iridescent violet-bluish with white spot at the cell end, black dark border, apically broad; otherwise, like males.

Male genitalia: Uncus bilobed with each lobe long, pilose; brachia long, with broad base, arms slender, curved; tegumen broad, lateral window deeply cleft, viniculum broad in upper half, terminates into exceptionally long tubular saccus; valva large, triangular, well divided into ampulla and harpe, ampulla broad at base produced into an elongated narrow curved apical process, pilose; harpe with elongated curved apex, pilose; juxta V-shaped; exceptionally long narrow, slightly curved aedeagus, suprazonal portion much longer than subzonal; bulbus ejaculatorius enters dorsally, coecum small rounded; vesica with numerous, minute cornuti.

Female genitalia: Lodix rectangular; genital plate broad, flattened, triangular in shape with sclerotized edges; ductus bursae narrow, elongated and tubular, dilated near base; corpus bursae rounded, bulbous and membranous with two distinctly large, pointed, spine-like well sclerotized signae; anterior apophysis sharp; posterior apophysis long, broad and curved near base; papilla analis subovate, weakly sclerotized, pilose.

Wing expanse: Half: Male: 18.0-21.5 mm, Female: 18.5-21.0 mm. Range: 1800-2700 m ASL.

Old distribution: India: Northwest India to Sikkim and Manipur, Jammu and Kashmir to Kumaon (including Safed Koh, Chitral-Kumaon). Other Countries: Afghanistan, Pakistan, Nepal, Bhutan.

Remarks: Specimens of *C. syla* were recorded at an elevation of approximately 2450 m ASL during surveys along the Kareri Lake trek (altitudinal range: 2100-2934 m). The species was observed in close spatial association with oak-dominated forests (*Quercus* spp.), which is consistent with the known ecological niche and host-plant associations for this genus in the Western Himalayas (Wynter-Blyth, 1957). The ventral wing surfaces exhibit cryptic coloration; a morphological trait frequently associated with predator-avoidance in sub-canopy environments. Field observations indicated a bimodal diel activity pattern, with peak flight occurring during the early morning and late afternoon. This temporal partitioning may be related to environmental thermoregulation, as activity was significantly reduced during periods of high solar radiation at midday. Notably, the male and female genitalia of this species are described and illustrated here for the first time, providing a critical morphological baseline for Indian populations. In accordance with national conservation priorities, this species is legally protected under Schedule II of the Wildlife (Protection) Act, 1972, as amended in 2022.

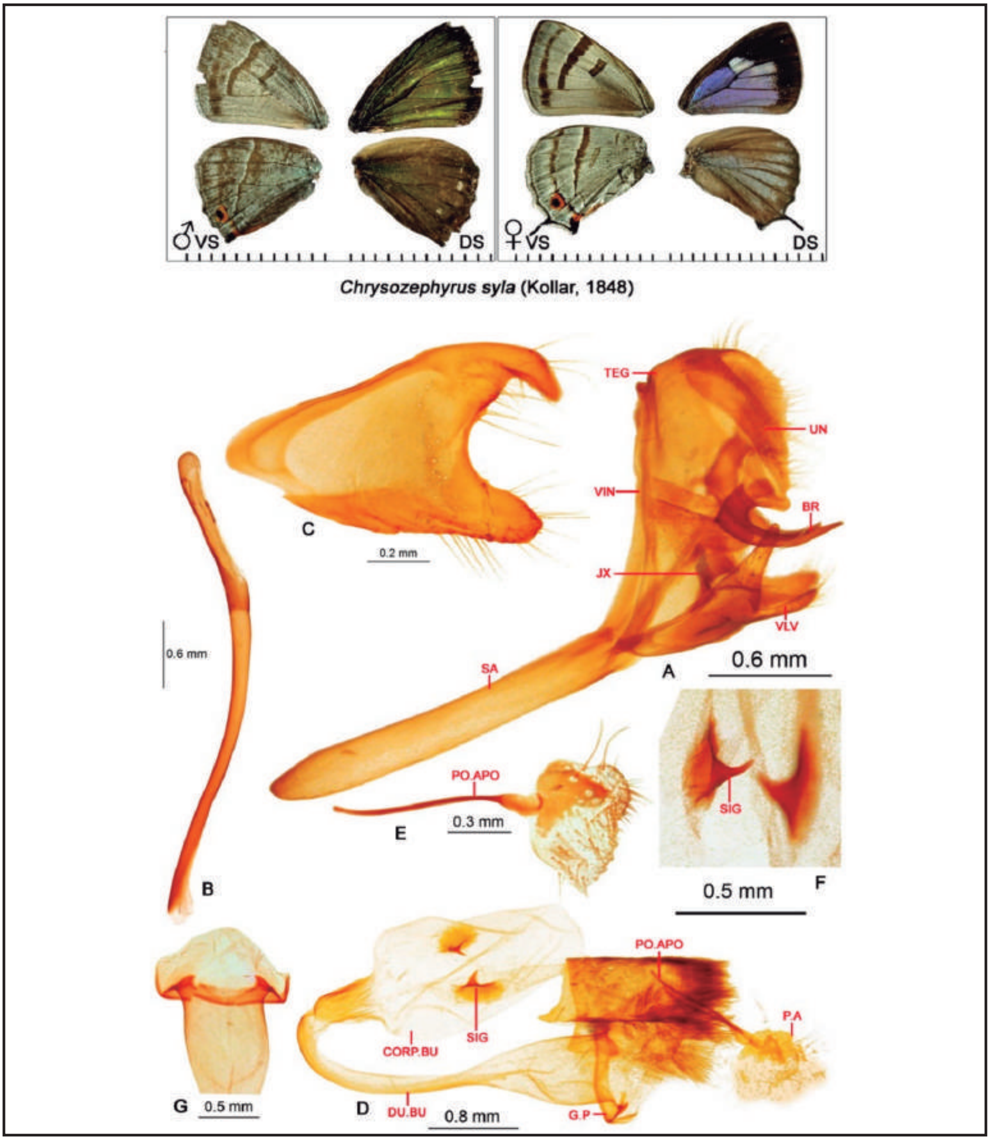
PHYLOGENETIC INSIGHTS

DNA Barcoding: In the present study, sequences representing two species of the genus *Chrysozephyrus* (*C. syla* and *C. birupa*) were successfully barcoded and deposited in the GenBank database. This is the first global molecular barcoding effort for these species within the subfamily Theclinae, providing a significant contribution to the molecular repository and advancing phylogenetic and taxonomic studies in this group.

Nucleotide Composition, Conserved, Variable, Parsimony Informative Sites and Singleton Sites*:* Across the final alignment of COI sequences of 603 bp, there are 475 conserved sites, 128 variable sites, 71 parsimony informative sites and 57 singleton sites in the dataset, which confirms that the COI gene is highly conserved. Figure 4 shows the nucleotide composition percentages for all the species. The average nucleotide frequencies are 31.37% (A), 38.92% (T), 15.09% (C) and 14.62% (G) (Figure 4). The nucleotide composition across codon positions in insects follows a distinct and consistent pattern, with a strong A + T bias, particularly in the first and third codon positions, whereas the second codon position has a more balanced composition. Yang et al. (2021) reported that in the mitochondrial genomes of Tortricidae, adenine (A) is the most frequent nucleotide at the first codon position, followed by thymine (T), guanine (G), and cytosine (C). This aligns with the observed values (A-1: 34.3 > T-1: 30.3 > G-1: 24.2 > C-1: 11.2), suggesting that the first codon position is relatively conserved, with a preference for purines (A, G) over pyrimidines (T, C).

At the second codon position, thymine (T) is dominant (44.4%), followed by cytosine (C) (26.4%), adenine (A) (15.2%), and guanine (G) (14.0%), which is consistent with the findings of Kokate et al. (2021) in *Drosophila* Fallén, 1823. The second codon position plays a crucial role in determining amino acid properties, as it directly affects protein function, which may explain the greater presence of T and C, as these bases are often associated with hydrophobic or structurally stable amino acids.

Figure 3. A. Male genitalia (lateral view), B. Aedeagus (lateral view), C. Valva (inner view), D. Female genitalia (lateral view), E. Papilla analis, F. Signum G. Genital plate



The third codon position exhibited the greatest variability, with adenine (50.6%) and thymine (41.6%) being dominant, whereas cytosine (7.3%) and guanine (0.6%) were significantly underrepresented. This finding supports the findings of Näsvall et al. (2023), who highlighted a strong G/C to A/T substitution bias in butterflies. This suggests that natural selection and mutational pressures favour A + T richness at the third codon position, which is known to be the most synonymous and variable site in codon evolution. These findings indicate that the A + T content is highest in the third codon position, followed by the first, whereas the second position is relatively balanced. This pattern is consistent across different insect taxa, reflecting the influence of mutation pressure, translational efficiency, and natural selection in shaping codon usage bias (Figure 5).

Figure 4. Bar graph showing the nucleotide compositions of all the species in percentage.

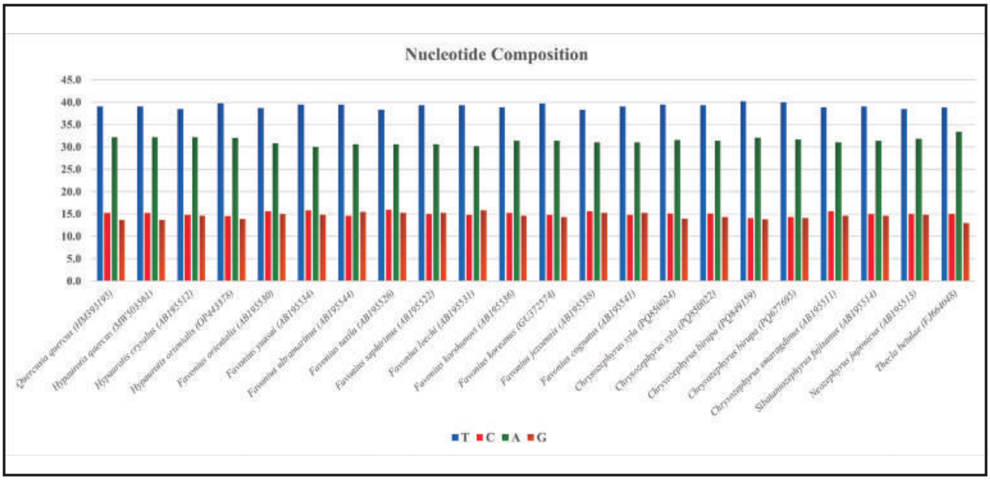
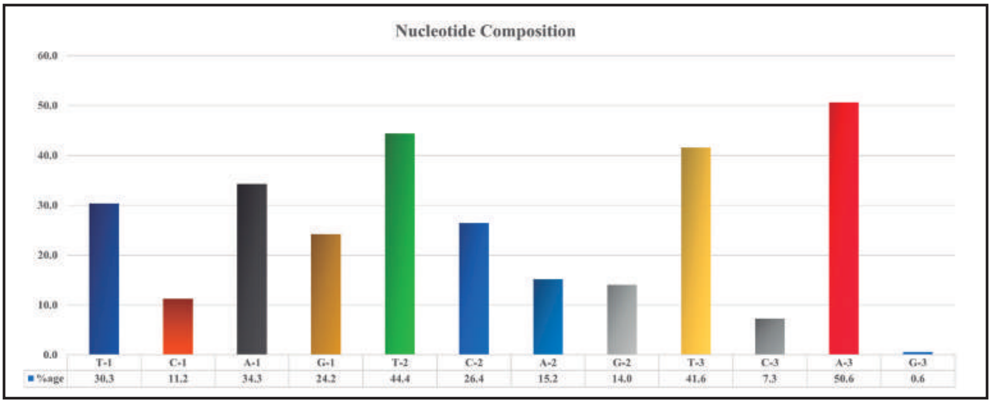


Figure 5. Nucleotide composition at the 1st, 2nd, and 3rd codon positions.



The transition/transversion rate ratios are $k_1 = 2.49$ (purines) and $k_2 = 7.098$ (pyrimidines). The overall transition/transversion bias is $R = 2.138$, where $R = [A*G*k_1 + T*C*k_2]/[(A+G)*(T+C)]$. The analytical procedure encompassed 22 coding nucleotide sequences at the 1st, 2nd, 3rd, and noncoding positions. The pairwise deletion option was applied to all ambiguous positions for each sequence pair, resulting in a final dataset comprising 603 positions. Evolutionary analyses were conducted in MEGA12 (Table 2).

Table 2. Each entry shows the probability of substitution (r) from one base (row) to another base (column). For simplicity, the sum of the r values is equal to 100. The rates of different transitional substitutions are shown in **bold**, and those of transversionsal substitutions are shown in *italics*.

	A	T	C	G
A	-	*5.58*	*2.16*	**5.22**
T	*4.5*	-	**15.35**	*2.09*
C	*4.5*	**39.58**	-	*2.09*
G	**11.19**	*5.58*	*2.16*	-

Genetic distance (Table 3): The interspecific divergence ranged from 0.2% to 7.9%, excluding the outgroup. The low interspecific genetic divergence (0.2-0.8%) observed among *Favonius cognatus* (Staudinger, 1892)*, F. koreanus* (Riley, 1939), and *F. ultramarinus* (Fixsen, 1887) suggests recent evolutionary divergence, potentially influenced by ongoing gene flow or shared ecological adaptations. This finding is consistent with that of Lavina et al. (2017), who reported that some Papilionoidea species exhibit minimal interspecific divergence, sometimes below 1%, indicating recent speciation events or incomplete lineage sorting. Similarly, Dinca et al. (2021) reported low genetic distances among European butterflies, reinforcing the notion that closely related species may retain genetic similarities despite being taxonomically distinct. These parallels suggest that while greater genetic divergence is typical among species, low divergence values, as observed in *Favonius*, could reflect either recent divergence or the need for taxonomic re-evaluation. Therefore, comprehensive morphological, ecological, and genomic investigations are crucial to better understand their evolutionary relationships and validate their species status. The high genetic divergence (7.9%) between *Chrysozephyrus birupa* and *Favonius yuasai* Shirôzu, 1948 is due to the primarily to long-term evolutionary separation, geographic isolation, distinct ecological adaptations and the accumulation of genetic differences over time. *C. birupa* shows greater divergence from *C. smaragdinus* (4.5%), indicating that it is the most genetically distinct within this group. *C. syla* is closer to *C. smaragdinus* (3.7%), suggesting that they may share more recent common ancestry. *C. syla* and *C. birupa* also significantly diverged (4.3-4.8%).

The intergeneric distance values among *Hypaurotis* Scudder*,* 1876, *Favonius* Sibatani & Ito, 1942*, Chrysozephyrus* Shirôzu & Yamamoto, 1956*, Sibataniozephyrus* Inomata, 1986 and *Neozephyrus* Sibatani & Ito, 1942 range from 5.0-6.5, with the minimum distance of 5.0 observed between *Hypaurotis* and *Favonius*, suggesting a close evolutionary relationship, whereas the maximum distance of 6.5 between *Favonius* and *Chrysozephyrus* indicates greater divergence. These distances, although relatively low, suggest a close genetic and evolutionary affinity among these genera. Wiemers & Fiedler (2007) reported that the mean congeneric interspecific sequence divergence in Lycaenidae was 5.1% for *Agrodiaetus* Hübner, [1822] and 5.0% for other genera. Hebert et al. (2003) established an intergeneric divergence threshold of 10-16% in Lepidoptera, whereas Ratnasingham & Hebert (2013) reported that insect genera rarely exhibit genetic divergence below 10%. Given these findings, the observed distances in this analysis fall well below the expected intergeneric divergence range, reinforcing the hypothesis that these genera may not be evolutionarily distinct at the genus level. This aligns with the findings of Zhang et al. (2020), who suggested that, on the basis of COI barcode analysis, *Sibataniozephyrus, Neozephyrus, Chrysozephyrus,* and *Favonius* should be considered junior subjective synonyms of *Hypaurotis* rather than distinct genera. This taxonomic interpretation is further supported by the morphological similarities among these species, as noted by Eliot (1973). The low intergeneric distances observed in the present study provide additional evidence supporting the synonymization of these taxa, suggesting that they represent a single evolutionary lineage rather than separate genera (Table 4).

Table 4. Intergeneric distance percentages.

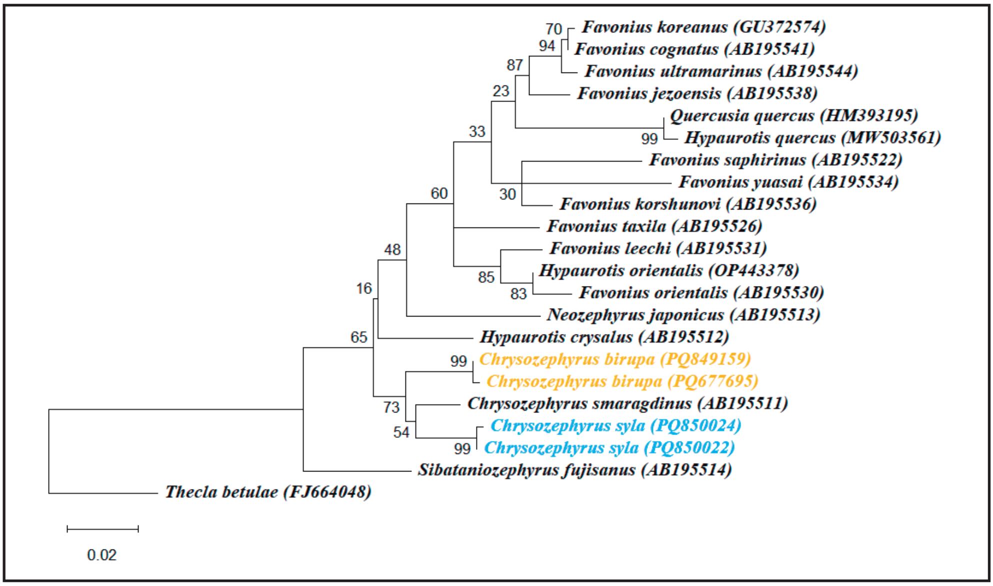
Genera	*Hypaurotis*	*Favonius*	*Chrysozephyrus*	*Sibataniozephyrus*	*Neozephyrus*
Hypaurotis					
Favonius	5.0				
Chrysozephyrus	5.3	6.5			
Sibataniozephyrus	5.9	6.2	5.9		
Neozephyrus	5.7	5.3	5.9	5.8	

Thecla betulae, used as an outgroup, exhibited genetic divergence ranging from 7.7% to 10.5% among the analysed species, with the lowest divergence (7.7%) observed with *Hypaurotis crysalus* (Edwards, 1873), whereas the highest (10.5%) was recorded with *Favonius yuasai*. In the present study, the genetic divergence rate between *Hypaurotis crysalus* and *Favonius orientalis* was found to be 6%, whereas the divergence rate between *H. crysalus* and *Thecla betulae* was 7.7%. These findings align with those of Zhang et al. (2020), who reported a 6% divergence between *H. crysalus* and *F. orientalis*, indicating a relatively close genetic relationship, whereas the divergence between *H. crysalus* and *T. betulae* was slightly greater (8.2%). The minor discrepancy in the *H. crysalus-T. betulae* divergence values between the two studies (7.7% vs. 8.2%) may result from differences in sample populations, sequencing methodologies, or alignment techniques.

Phylogenetic analysis: A phylogenetic tree was reconstructed on the basis of the mitochondrial gene COI gene sequences of 19 species along with the outgroup (*Thecla betulae*). Tree was generated via the maximum likelihood method and the Tamura (1992) model (Figure 6). Five major clades ((*Favonius koreanus* + *Favonius cognatus* + *Favonius ultramarinus*) + *Favonius jezoensis* + (*Quercusia quercus* +*Hypaurotis quercus*) + (*Favonius saphirinus* + *Favonius yuasai* +*Favonius korshunovi*) + *Favonius taxila* + (*Favonius leechi*, + *Hypaurotis orientalis* + *Favonius orientalis*)) + (*Neozephyrus japonicus*) + (*Hypaurotis crysalus*) + (*Chrysozephyrus birupa* + *Chrysozephyrus smaragdinus* + *Chrysozephyrus syla*) + (*Sibataniozephyrus fujisanus*).

The Indian specimens of *Chrysozephyrus birupa* and *C. syla* clustered into distinct monophyletic clades with maximum bootstrap support (99%), confirming their molecular identity at the species level. The topology reveals that *C. syla* (India) shares a more recent common ancestor with the Japanese *C. smaragdinus* (73% support) than it does with *C. birupa*. This confirms that *C. smaragdinus* and *C. syla* have undergone less evolutionary divergence from each other, potentially reflecting a closer evolutionary link between Western Himalayan and East Asian populations within this genus. While species-level clades are robustly supported, several deeper intergeneric nodes exhibit low bootstrap values, such as the nodes with 16%, 23% and 33% support. These values indicate that while the COI gene fragment is highly effective for species-level barcoding, it lacks sufficient signal to fully resolve the deep-time ancestral relationships within the Theclini tribe. Acknowledging these limitations directly addresses known biases associated with exclusive reliance on mitochondrial markers for genus-level taxonomy. The tree illustrates a high degree of paraphyly among the genera *Favonius*, *Hypaurotis* and *Chrysozephyrus*. Notably, the clustering of *Quercusia quercus* and *Hypaurotis quercus* with 99% support, combined with the low intergeneric genetic distances observed across the tree, provides molecular evidence that aligns with the recent proposal for the synonymization of these taxa under *Hypaurotis* Scudder, 1876.

Figure 6. Evolutionary analysis via the maximum likelihood method and the Tamura (1992) model of nucleotide substitutions and the tree with the highest log likelihood (-1,863.70) are shown. The percentage of replicate trees in which the associated taxa clustered together (1,000 replicates) is shown next to the branches. The evolutionary rate differences among sites were modelled via a discrete gamma distribution across 5 categories (+*G*, parameter = 0.6489), with 62.19% of sites deemed evolutionarily invariant (+*I*). The analytical procedure included 22 nucleotide sequences with 603 positions in the final dataset.



Conclusion

The present study provides an integrative molecular and morphological analysis of the tribe Theclini (Lepidoptera: Lycaenidae, Theclinae) from the Western Himalayas, specifically focusing on *Chrysozephyrus syla* and *C. birupa*. Through this investigation, the female of *C. birupa* and both sexes of *C. syla* have been studied and illustrated for the first time, filling critical gaps in the morphological record of these high-altitude taxa. The integration of DNA barcoding and phylogenetic reconstruction recovered five major clades with high bootstrap support for species-level monophyly. Nucleotide composition analysis confirmed a strong A + T bias (average 70.3%), particularly at the third codon position, which is consistent with the mitochondrial genome evolution of insects. The identification of conserved, variable, and parsimony-informative sites further clarifies the genetic architecture of these species within the Indian Himalayas. Most notably, the low intergeneric distances (5.0-6.5%) and the paraphyletic nature of the tree topology provide robust molecular evidence supporting the synonymization of several taxa, including *Chrysozephyrus*, under *Hypaurotis*. These findings challenge older morphological classifications and underscore the necessity of integrative taxonomic approaches that combine genital morphology with molecular data. By refining species delineations and providing the first barcodes for these protected Himalayan species, this study not only enhances our understanding of Papilionoidea phylogenetics but also contributes essential data to future conservation strategies within the tribe Theclini.

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Conflict of Interest

The authors declare that there is no known financial interest or personal relationship that could have influenced the work presented in this article.

References

Cantlie, K. (1963). *The Lycaenidae portion (except the Arhopala group) of Brigadier Evans' The Identification of Indian Butterflies 1932 (India, Pakistan, Ceylon, Burma)*. Bombay Natural History Society.

Dincă, V., Dapporto, L., Somervuo, P., Vodă, R., Cuvelier, S., Gascoigne-Pees, M., Huemer, P., Mutanen, M., Hebert, P. D., & Vila, R. (2021). High resolution DNA barcode library for European butterflies reveals continental patterns of mitochondrial genetic diversity. *Communications Biology*, *4*(1), 315. https://doi.org/10.1038/s42003-021-01834-7 PMid:33750912 PMCid:PMC7943782

Eliot, J. N. (1973). The higher classification of the Lycaenidae (Lepidoptera): a tentative arrangement. *Bulletin of the British Museum (Natural History), Entomology, 28,* 373-505. https://doi.org/10.5962/bhl.part.11171

Evans, W. H. (1932). *The identification of Indian butterflies* (second ed. revised). Bombay Natural History Society.

Flomer, O. (1994). DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. *Molecular marine biology and biotechnology, 3*, 294-299.

Fujioka, T. (1993). A list of Theclini of the world. In S Hurita. ed. *Zephyrus*. (in Japanese)

Garlani, L. (2024). Annotated Checklist of Rhopalocera of Himachal Pradesh, India (Insecta: Lepidoptera). *SHILAP Revista de lepidopterología, 52*(208), 623-676. https://doi.org/10.57065/shilap.1009

Hausmann, A., Haszprunar, G., Segerer, A. H., Speidel, W., Behounek, G., & Hebert, P. D. (2011). Now DNA-barcoded: the butterflies and larger moths of Germany. *Spixiana*, *34*(1), 47-58.

Hebert, P. D., Cywinska, A., Ball, S. L., & DeWaard, J. R. (2003). Biological identifications through DNA barcodes. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, *270*(1512), 313-321. https://doi.org/10.1098/rspb.2002.2218 PMid:12614582 PMCid:PMC1691236

Hebert, P. D., Dewaard, J. R., Zakharov, E. V., Prosser, S. W., Sones, J. E., McKeown, J. T., & La Salle, J. (2013). A DNA 'Barcode Blitz': Rapid digitization and sequencing of a natural history collection. *PloS one*, *8*(7), e68535. https://doi.org/10.1371/journal.pone.0068535 PMid:23874660 PMCid:PMC3707885

Howarth, T. G. (1957). A revision of the genus *Neozephyrus* Sibatani and Ito (Lepidoptera: Lycaenidae). *Bulletin of the British Museum (Natural History), Entomology, 5,* 233-285.

Huang, H. (2021). New or little-known butterflies from China-4. *Atalanta, 52*(3), 345-413.

Kehimkar, I. D. (2016). *Butterflies of India: BNHS field guides*. Bombay Natural History Society.

Kim, M. I., Wan, X., Kim, M. J., Jeong, H. C., Ahn, N. H., Kim, K. G., Han, Y. S., & Kim, I. (2010). Phylogenetic relationships of true butterflies (Lepidoptera: Papilionoidea) inferred from COI, 16S rRNA and EF-1α sequences. *Molecules and cells*, *30*, 409-425. https://doi.org/10.1007/s10059-010-0141-9 PMid:20853063

Klots, A. B. (1970). Lepidoptera. *Taxonomist's glossary of genitalia in insects* (pp. 115-130). J. Jørgensen & CO.

Koiwaya, S. (1999). A tentative list of the Theclini of the world. *Nishikaze-Tsushin 10*, 2-12.

Koiwaya, S. (2007). *The Zephyrus hairstreaks of the World*. Mushi-Sha [in Japanese]

Kokate, P. P., Techtmann, S. M., & Werner, T. (2021). Codon usage bias and dinucleotide preference in 29 *Drosophila* species. *G3*, *11*(8), jkab191. https://doi.org/10.1093/g3journal/jkab191 PMid:34849812 PMCid:PMC8496323

Kumar, V., Kundu, S., Chakraborty, R., Sanyal, A., Raha, A., Sanyal, O., Ranjan, R., Pakrashi, A., Tyagi, K., & Chandra, K. (2019). DNA barcoding of Geometridae moths (Insecta: Lepidoptera): a preliminary effort from Namdapha National Park, Eastern Himalaya. *Mitochondrial DNA Part B*, *4*(1), 309-315. https://doi.org/10.1080/23802359.2018.1544037

Lavinia, P. D., Núñez Bustos, E. O., Kopuchian, C., Lijtmaer, D. A., Garcia, N. C., Hebert, P. D., & Tubaro, P. L. (2017). Barcoding the butterflies of southern South America: Species delimitation efficacy, cryptic diversity and geographic patterns of divergence. *PloS one, 12*(10), e0186845. https://doi.org/10.1371/journal.pone.0186845 PMid:29049373 PMCid:PMC5648246

Lomov, B., Keith, D. A., Britton, D. R., & Hochuli, D. F. (2006). Are butterflies and moths useful indicators for restoration monitoring? A pilot study in Sydney's Cumberland Plain Woodland. *Ecological Management & Restoration*, *7*(3), 204-210. https://doi.org/10.1111/j.1442-8903.2006.00310.x

Lukhtanov, V. A., Sourakov, A., Zakharov, E. V., & Hebert, P. D. (2009). DNA barcoding Central Asian butterflies: increasing geographical dimension does not significantly reduce the success of species identification. *Molecular ecology resources*, *9*(5), 1302-1310. https://doi.org/10.1111/j.1755-0998.2009.02577.x PMid:21564901

Nakabayashi, Y., & Ohshima, I. (2024). Geographical variation in parasitoid communities and the cause of enemy-free space in a range-expanding myrmecophilous lycaenid butterfly. *Biological Journal of the Linnean Society*, *141*(1), 17-32. https://doi.org/10.1093/biolinnean/blad060

Näsvall, K., Boman, J., Talla, V., & Backström, N. (2023). Base composition, codon usage, and patterns of gene sequence evolution in butterflies. *Genome Biology and Evolution*, *15*(8), evad150. https://doi.org/10.1093/gbe/evad150 PMid:37565492 PMCid:PMC10462419

Odagiri, K. (2004). *Molecular phylogeny of the silvicolous hairstreaks, Favonius and Japonica (Lepidoptera: Lycaenidae)* [PhD Thesis]. Kyushu University.

Prieto, C., Núñez, R., & Hausmann, A. (2019). Molecular species delimitation in the genus *Rhamma* Johnson, 1992 (Lepidoptera: Lycaenidae, Theclinae). *Mitochondrial DNA Part A*, *30*(1), 101-117. https://doi.org/10.1080/24701394.2018.1462348 PMid:29671657

Ratnasingham, S., & Hebert, P. D. (2013). A DNA-based registry for all animal species: the Barcode Index Number (BIN) system. *PloS one*, *8*(7), e66213. https://doi.org/10.1371/journal.pone.0066213 PMid:23861743 PMCid:PMC3704603

Robinson, G. S. (1976). The preparation of slides of Lepidoptera genitalia with special reference to the Microlepidoptera. *Entomologist's Gazette, 27,* 127-132.

Saito, K., & Hasegawa, T. (2016). Description of a new species of the subtribe Theclina (Lepidoptera: Lycaenidae) from Central Vietnam. *Butterflies, 72*, 46 48.

Shirôzu, T. (1956). A generic revision and the phylogeny of the tribe Theclini (Lepidoptera, Lycaenidae). *Sieboldia*, *4*, 329-421.

Varshney, R. K., & Smetacek, P. (2015). *A synoptic catalogue of the Butterflies of India*. [1st ed.]. Butterfly Research Centre.

Wahlberg, N., Braby, M. F., Brower, A.V., De Jong, R., Lee, M. M., Nylin, S., Pierce, N. E., Sperling, F. A., Vila, R., Warren, A. D., & Zakharov, E. (2005). Synergistic effects of combining morphological and molecular data in resolving the phylogeny of butterflies and skippers. *Proceedings of the Royal Society B: Biological Sciences*, *72*(1572), 1577-1586. https://doi.org/10.1098/rspb.2005.3124 PMid:16048773 PMCid:PMC1560179

Wiemers, M., & Fiedler, K. (2007). Does the DNA barcoding gap exist? a case study in blue butterflies (Lepidoptera: Lycaenidae). *Frontiers in zoology*, *4*, 1-16. https://doi.org/10.1186/1742-9994-4-8 PMid:17343734 PMCid:PMC1838910

Wynter-Blyth, M. A. (1957). *Butterflies of the Indian Region*. Bombay Natural History Society.

Yang, F., Ding, F., Chen, H., He, M., Zhu, S., Ma, X., Jiang, L., & Li, H. (2018). DNA barcoding for the identification and authentication of animal species in traditional medicine. *Evidence-Based Complementary and Alternative Medicine*, *2018*(1), p.5160254. https://doi.org/10.1155/2018/5160254 PMid:29849709 PMCid:PMC5937547

Yang, M., Li, J., Su, S., Zhang, H., Wang, Z., Ding, W., & Li, L. (2021). The mitochondrial genomes of Tortricidae: nucleotide composition, gene variation and phylogenetic performance. *BMC genomics*, *22*, 1-12. https://doi.org/10.1186/s12864-021-08041-y PMid:34674653 PMCid:PMC8532297

Zhang, J., Cong, Q., Shen, J., Opler, P. A., & Grishin, N. V. (2020). Genomic evidence suggests further changes of butterfly names. *The taxonomic report of the International Lepidoptera Survey*, *8*, 7.

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Table 3. Estimates of evolutionary divergence between sequences.

Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Quercusia quercus (HM393195)																						
Hypaurotis quercus (MW503561)	0.3																					
Hypaurotis crysalus (AB195512)	5.4	5.6																				
Hypaurotis orientalis (OP443378)	5.0	5.0	5.4																			
Favonius orientalis (AB195530)	6.1	6.1	6.0	1.0																		
Favonius yuasai (AB195534)	5.4	5.4	6.4	4.5	4.9																	
Favonius ultramarinus (AB195544)	5.0	5.0	5.6	4.5	5.1	5.3																
Favonius taxila (AB195526)	5.0	5.0	5.3	4.1	3.9	5.8	5.3															
Favonius saphirinus (AB195522)	5.6	5.6	5.7	5.2	5.5	5.1	4.1	4.9														
Favonius leechi (AB195531)	6.6	6.6	6.0	1.9	2.6	4.5	4.9	4.1	5.3													
Favonius korshunovi (AB195536)	4.7	5.2	4.5	4.1	4.5	3.6	3.4	4.3	3.7	4.1												
Favonius koreanus (GU372574)	4.3	4.3	6.0	4.1	5.1	5.3	0.8	5.4	4.1	4.9	3.5											
Favonius jezoensis (AB195538)	5.0	5.4	5.8	4.7	5.4	5.8	2.2	5.2	4.5	4.9	3.3	2.2										
Favonius cognatus (AB195541)	4.7	4.7	5.8	4.3	4.9	5.1	0.6	5.1	3.9	4.7	3.2	0.2	2.0									
Chrysozephyrus syla (PQ850024)	5.8	6.0	4.1	5.0	6.2	7.3	5.8	6.0	6.6	6.4	5.3	5.4	6.2	5.6								
Chrysozephyrus syla (PQ850022)	5.6	6.0	4.9	4.8	6.6	7.7	6.2	6.6	7.1	6.9	5.8	5.7	6.7	6.0	0.7							
Chrysozephrus birupa (PQ849159)	4.8	4.8	6.0	4.7	6.9	7.9	6.9	7.3	7.7	7.1	6.9	6.4	7.8	7.1	4.7	4.3						
Chrysozephyrus birupa (PQ677695)	5.0	5.0	5.3	4.8	6.2	7.3	6.2	6.6	7.1	6.4	6.2	5.9	7.1	6.4	4.5	4.8	1.0					
Chrysozephyrus smaragdinus (AB195511)	6.5	7.0	4.1	5.4	5.8	6.8	5.8	6.2	6.6	6.0	5.3	6.2	6.2	6.0	3.2	3.7	4.5	3.9				
Sibataniozephyrus fujisanus (AB195514)	6.3	6.3	5.5	5.6	6.6	7.1	6.0	6.9	6.2	5.8	6.0	6.0	6.0	5.8	5.5	6.0	6.6	6.0	5.5			
Neozephyrus japonicus (AB195513)	6.5	6.5	5.1	4.5	5.1	6.4	4.5	5.5	6.2	4.9	5.1	4.9	5.6	4.7	6.0	6.4	6.6	5.5	5.1	5.8		
Thecla betulae (FJ664048)	9.2	9.2	7.7	10.0	9.7	10.5	10.3	9.0	10.3	9.8	9.8	10.0	10.3	10.0	8.9	8.9	8.7	8.9	8.7	8.2	9.2	

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NOTICIAS GENERALES
GENERAL NEWS

REVISORES 2024-2025 / *REFEREES 2024-2025*.- En SHILAP Revista de lepidopterología (SHILAP Revta. lepid.) utilizamos el método de revisión por pares a doble ciego, lo que significa que ni los revisores conocen los nombres de los autores, ni los autores saben quiénes los revisaron. Los siguientes revisores colaboraron en la evaluación de los manuscritos durante los años 2024-2025. Expresamos nuestros más sinceros agradecimientos a estas personas por el tiempo y energía que dedicaron a sus evaluaciones, de las cuales dependen los estándares de calidad y la puntualidad de la revista SHILAP Revista de lepidopterología (SHILAP Revta. lepid.). Una vez más, gracias a todos por el trabajo de revisión realizado / *At SHILAP Revista de lepidopterología (SHILAP Revta. lepid.) we use the doubleblind peer review method, which means that neither the reviewers know the names of the authors, nor the authors know who reviewed them. The following referees collaborated on the evaluation of manuscripts during the years 2024-2025. We express our sincerest thanks to them for the time and energy devoted to their evaluations, since the standards of quality and timeliness of the journal SHILAP Revista de lepidopterología (SHILAP Revta. lepid.) depend on them. Once again, thank you all for your review work*: Mr. Leif Aaarvik (Noruega / *Norway*); Dr. Vasily Anikin (Rusia / *Russia*); Dr. Hatice Bas (Turquía / *Türkiye*); Dr. Bipin Kumar Aggarwal (India / *India*); Dr. Atanu Bora (India / *India*); Dr. John Brown (EE.UU. / *USA*); Mr. Martin F. V. Corley (Reino Unido / *United Kingdom*); Dr. Indiana Cristóbal Ríos Málaver (Colombia / *Colombia*); Dr. Villy De Prins (Bélgica / *Belgium*); Dr. Eric Drouet (Francia / *France*); Dr. Pedro del Estal Padillo (España / *Spain*); Ing. Andrés Expósito Hermosa (España / *Spain*); Dr. Reinhard Gaedike (Alemania / *Germany*); Dr. Lovish Garlani (India / *India*); Dr. Jorge M. González (EE.UU. / *USA*); Dr. Muhammad Asghar Hassan (China / *China*); Dr. Axel Hausmann (Alemania / *Germany*); Dr. Fernando Hernández Baz (México / *Mexico*); Dr. Edona Kabashi-Kastrati (Kosovo / *Kosovo*); Dr. Amritpal Sigh Kaleka (India / *India*); Dr. Sibel Kizildağ (Turquía / *Türkiye*); Dr. Stanislav Korb (Rusia / *Russia*); Mr. Ole Karsholt (Dinamarca / *Denmark*); Mr. Anthony Koren (Alemania / *Germany*); Dr. Monish Kumar Thapa (India / *India*); Dr. Gerardo Lamas Müller (Perú / *Peru*); Dr. Zdeněk Laštůvka (República Checa / *Czech Republic*); Dr. Houhun Li (China / *China*); Dr. Miguel López Munguira (España / *Spain*); Dr. Carlos López Vaamonde (Francia / *France*); Dr. Vladimir Lukhtanov (Rusia / *Russia*); Dr. Mohammad Danish Masroor (India / *India*); Dr. Tanner Matson (EE.UU. / *USA*); Dr. Carlos G. C. Mielke (Brasil / *Brazil*); Dr. Scott Miller (EE.UU. / *USA*); Dr. Antonio S. Ortiz (España / *Spain*); Dr. Mônica Piovesan (Brasil / *Brazil*); Dr. Subhajit Roy (India / *India*); Dr. Taslima Sheikh (India / *India*); Dr. Arturo Serrano (Portugal / *Portugal*); Mr. Jan Šumpich (República Checa / *Czech Republic*); Dr. D. R. Thakur (Turquía / *Türkiye*); Dr. Marysol Trujano (México / *Mexico*); Dr. Héctor Andrés Vargas Ortiz (Chile / *Chile*); Dr. Sergei Vasilenko (Rusia / *Russia*); Dr. Roger Vila Ujaldón (España / *Spain*); Dr. Antonio Vives Moreno (España / *Spain*); Dr. Martin Wiemer (Alemania / *Germany*); Dr. Saleem Yatoo (India / *India*); Dr. José Luis Yela García (España / *Spain*).- **DETALLES / *DETAILS*:** SHILAP; Apartado de correos, 331; E-28080 Madrid, ESPAÑA / *SPAIN* (E-mail: avives1954@outlook.es).

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Descripción en la península ibérica de una nueva especie del género *Metzneria* Zeller, 1839 (Lepidoptera: Gelechiidae)

Javier Gastón, Peter Huemer & Antonio Vives Moreno

Resumen

Se describe una nueva especie del género *Metzneria* Zeller, 1839 para la península ibérica. Se presentan los caracteres diferenciales con otras especies del género, referidas a la morfología externa, genitalia y análisis genético.

Palabras clave: Lepidoptera, Gelechiidae, *Metzneria*, descripción, nueva especie, península ibérica.

Description of a new species of the genus *Metzneria* Zeller, 1839 from the Iberian Peninsula (Lepidoptera: Gelechiidae)

Abstract

A new species of the genus *Metzneria* Zeller, 1839 is described from the Iberian Peninsula. The distinguishing characteristics from other species of the genus are presented, including external morphology, genitalia and genetic analysis.

Keywords: Lepidoptera, Gelechiidae, *Metzneria*, description, new species, Iberian Peninsula.

Descrição, na Península Ibérica, de uma nova espécie do género *Metzneria* Zeller, 1839 (Lepidoptera: Gelechiidae)

Resumo

Descreve-se uma nova espécie do género *Metzneria* Zeller, 1839 para a Península Ibérica. Apresentam-se as características que a distinguem das outras espécies do género, no que se refere à morfologia externa, à genitália e à análise genética.

Palavras-chave: Lepidoptera, Gelechiidae, *Metzneria*, descrição, nova espécie, Península Ibérica.

Introducción

Los Gelechiidae europeos han despertado un interés considerable en las últimas décadas, incrementando el número de registros nominales de especies de 617 a 865 en tan solo 24 años (Huemer & Karsholt, 2020; Karsholt & Razowski, 1996). Sin embargo, los datos moleculares aún indican un número considerable de especies previamente pasadas por alto, particularmente en algunos géneros diversos, pero no revisados, por ejemplo, *Stomopteryx* Heinemann, 1870, *Aproaerema* Durrant, 1897, *Aristotelia* Hübner, [1825] y *Monochroa* Heinemann, 1870 (Huemer et al. 2020).

No obstante, las lagunas en las listas de especies también son evidentes en géneros que ya han sido revisados mediante métodos morfológicos estándar. *Metzneria* Zeller, 1839, es un ejemplo de ello. El género fue revisado exhaustivamente por Englert (1974) con 27 especies, incluyendo cuatro nuevas. Posteriormente, según datos más recientes, el género comprende 48 especies descritas y aceptadas (Hobern et al. 2025).

A pesar de un enfoque moderno en aquel momento, con el estudio del material tipo y el examen de la genitalia del macho y de la hembra, la obra presenta serias deficiencias desde el punto de vista actual. En particular, la falta de imágenes de adultos y de la estructura genital de las hembras, suele ser un obstáculo considerable para la correcta identificación.

Como consecuencia, las incertidumbres en la correcta identificación de especies individuales del género *Metzneria* se reflejan en la extremadamente diversa fauna de España. Vives Moreno (2014) listó 24 especies de España y, por lo tanto, abarcó (con la excepción de *M. filia* Piskunov, 1979) la totalidad del inventario de especies europeas. Dos de ellas han pasado a sinonimia como *M. expositoi* Vives, 2001 y *M. varennei* Nel, 1997 (Huemer & Karsholt, 2020), mientras que *M. neli* Huemer, 2021 se añadió recientemente a la fauna española (Huemer, 2021). Inspirado por este estudio, se reexaminaron varios ejemplares de este género y especialmente las procedentes del sur de España, encontrando otra especie hasta ahora desconocida, que se describe a continuación.

Material y métodos

El material utilizado para el estudio se ha obtenido mediante muestreos nocturnos, con trampas de luz actínica distribuidas en los biotopos apropiados y con las autorizaciones de las regiones pertinentes. Para su identificación nos hemos basado en el examen comparativo de los caracteres morfológicos externos y, sobre todo, en el análisis de la estructura genital de los especímenes. El material se fijó y secó por el método tradicional. El montaje de la genitalia se ha efectuado siguiendo las técnicas estándar (Robinson, 1976), con modificaciones.

Para la documentación fotográfica de la genitalia, se utilizaron microscopios NIKON Eclipse E400 y cámaras digitales NIKON D3100. Para la documentación fotográfica de los adultos, se utilizó una cámara digital SONY α100 DSLR-A100K con un objetivo AF MACRO de 100 mm 1:2.8 (32). Los retoques fotográficos se realizaron con el programa Adobe Photoshop ©.

Las muestras de tejido (una sola pata posterior) se prepararon siguiendo los estándares establecidos para obtener secuencias de código de barras de ADN de un fragmento de 658 pares de bases del gen mitocondrial COI (subunidad 1 de la citocromo c oxidasa) (Ratnasingham & Hebert 2007). Estas se procesaron en el Centro Canadiense de Código de Barras de ADN (CCDB, Instituto de Biodiversidad de Ontario, Universidad de Guelph) utilizando el protocolo estándar de alto rendimiento descrito en Dewaard et al. (2008). Las secuencias obtenidas abarcan 23 especies y, con excepción de *M. filia* y *M. agraphella* (Ragonot, 1895) representan prácticamente toda la fauna europea. Excepto por cuatro secuencias más cortas, todos los códigos de barras de ADN analizados superan los 600 pb de longitud. La gran mayoría de las secuencias proviene de nuestras propias muestras y se complementa con unos pocos datos públicos de BOLD. Sin embargo, no se realizó un análisis completo de todas las secuencias disponibles, considerando únicamente a modo de ejemplo todos los BINs existentes. Más detalles, incluidos los datos completos de los ejemplares de referencia y las imágenes, están disponibles en el conjunto de datos público DS-METZNLUC «Metzneria luciae sp. nov. from Spain».

Las secuencias se asignaron a BINs, unidades taxonómicas operativas basadas en algoritmos que constituyen un proxy fiable de las especies (Ratnasingham & Hebert, 2013). Los BINs se calculan automáticamente en BOLD Systems para los registros que cumplen con el estándar de código de barras de ADN. Los grados de variación intra- e interespecífica de los fragmentos de código de barras de ADN se calcularon bajo el modelo de sustitución de nucleótidos modelo de Kimura de dos parámetros utilizando las herramientas analíticas de BOLD Systems v. 4.0 (Ratnasingham, 2018). Se construyó un árbol de Neighbor-Joining a partir de los datos de códigos de barras de ADN del conjunto de datos mediante MEGA11 (Tamura et al. 2021), aplicando el modelo de Kimura de dos parámetros para las sustituciones de nucleótidos y enraizado con *Aristotelia ericinella* (Zeller, 1839) como grupo externo.

Abreviaturas

JG	Javier Gastón (Vizcaya, España)
MNCN	Museo Nacional de Ciencias Naturales, Madrid, España

prep. gen.	preparación de genitalia
sp. nov.	especie nueva
fot.	fotografía

Resultados

Metzneria luciae Gastón, Huemer & Vives, sp. nov.

https://zoobank.org/A6806469-B9A9-4ED0-A719-2E0F47D7CD4E

Material estudiado: Holotipo, 1 ♂, ESPAÑA, Cádiz, Casa Athene, a 125 m, Vejer de la Frontera, 10-IV-2025, Stephen Knapp leg., J. Gastón col., prep. gen. 10806JG, Barcode TLMF_Lep_47288, depositado en el Museo Nacional de Ciencias Naturales, en Madrid, España (MNCN). Paratipos, 1 ♂, ESPAÑA, Cádiz, Casa Athene, a 125 m, Vejer de la Frontera, 2-V-2025, Stephen Knapp leg., J. Gastón col., prep. gen. 11129JG; 1 ♂, Cádiz, Casa Athene, a 125 m, Vejer de la Frontera, 2-V-2025, Stephen Knapp leg., P. Huemer col., prep. gen. 11130JG; 2 ♂, Cádiz, Casa Athene, a 125 m, Vejer de la Frontera, 27-IV-2026, Stephen Knapp leg., J. Gastón col., prep. gen. 11127JG y 11128JG.

Descripción del adulto (Figuras 1-2,5): Envergadura alar: 14 mm (n=1). Cabeza con escamas compactas de color ocre pálido en la frente y el vértice, algo más oscuras en la zona del entronque con el escapo de la antena; palpo labial bien desarrollado, segundo segmento largo dirigido hacia adelante, con abundante capa de largas y espesas escamas filiformes de color ocre claro en su parte interna y ocres oscuras en la externa. Tercer segmento fuertemente curvado hacia arriba cubierto de escamas muy cortas de color ocre claro; antenas filiformes cubiertas de cortas escamas de color marrón oscuro en su parte superior y algo más pálido en la inferior. Tórax y tégulas de color ocre pálido; abdomen de color ocre ligeramente más pálido; fémur de todas las patas con pelos ocres oscuros en su parte externa y claros en la interna. Tibias con pelos ocres claros; Ala anterior esbelta, con ápice agudo, característico del género. Color de fondo de las escamas del ala superior ocre claro sustituidas por unas algo más oscuras en la parte basal y central de la costa y a lo largo de la vena anal, desde su base hasta el margen externo, donde se aprecia una mancha irregular de escamas muy oscuras cerca de la base. Fila de escamas de color muy oscuro bordeando el ápice de ala que se extienden ligeramente hacia la costa y hacia el margen interno. Area de color ocre amarillento poco visible entre las venas M1 y M2, en la zona postdiscal, con una pequeña mácula negra en su centro; alas posteriores esbeltas con el ápice típico de la familia, cubiertas de escamas de color ocre muy claro con largas fimbrias del mismo color con tendencia a oscurecerse en sus extremos.

Genitalia del macho (Figuras 3-4): Uncus triangular y apuntado, con dos proyecciones bilobulares semicirculares triangulares y una escotadura central en forma elíptica, amplia. Tegumen mucho más ancho que largo, con margen posterior redondeado. Valva de base corta y ancha, estrecha en el centro y ensanchada nuevamente en la parte distal, que es digitiforme y con un leve apuntamiento en forma de un pequeño gancho en el extremo del cucullus, a veces poco perceptible. Sacculus bien definido, esclerotizado, de forma digitiforme, basalmente ancho, estrechándose suavemente hasta un ápice redondeado; Saccus subtriangular y de mediano tamaño. Phallus ancho, bulboso y corto con el ápice puntiagudo y esclerotizado y con un grupo de microespinas agrupadas en su tercio posterior (Figuras 3a, 3b).

Genitalia de la hembra: Desconocida.

Diagnosis: *Metzneria luciae* sp. nov., se diferencia del resto de las especies del género *Metzneria* por la especial configuración del andropigio. Genéticamente está separada del resto de las especies del género *Metzneria* (Figura 6). También presenta un habitus sin las líneas marcadas en las alas anteriores, como ocurre en la mayoría de las especies de este género.

Biología: No se conocen los estados inmaduros, ni las plantas nutricias de las orugas. Los adultos vuelan probablemente en una sola generación durante el mes de abril.

Distribución (Figura 7): Únicamente se conoce de la localidad de Vejer de la Frontera (Cádiz), España.

Datos genéticos: BIN BOLD: AHJ0729 (n = 1). La distancia interespecífica determinada mediante la herramienta BOLD ID con respecto a las secuencias más similares es de aproximadamente 8-9 % e incluye cuatro BINs diferentes, de los cuales algunos no están asignados a ningún género o especie. La secuencia nombrada más cercana corresponde a *Metzneria aprilella* (Herrich-Schäffer, 1845), con una divergencia del 8,95 %. En el árbol NJ, la nueva especie *Metzneria ehikella* Gozmány, 1954 (BIN BOLD: AAN2252) se sitúa como la más próxima, aunque presenta una divergencia del 8,05 %.

Discusión

Ya ha pasado más de medio siglo desde la última revisión de las especies del oeste de la región Paleártica, que en su momento fue muy moderna y se basaba principalmente en las estructuras genitales, sobre todo de los machos (Englert, 1974). Desde entonces, no solo se han reconocido algunas especies nuevas y otras se han pasado a sinonimia, sino que, sobre todo, en tiempos recientes, también se han introducido métodos moleculares para la delimitación de especies, en particular el código de barras de ADN (Hebert et al. 2003).

Este método evidencia divergencias interespecíficas claras dentro del género *Metzneria*, que en la fauna europea aquí, casi completamente estudiada, oscilan entre un mínimo de 1,12 % y un máximo de 8,76 %, con una distancia media del 5,66 % (Figura 4). En cambio, las distancias intraespecíficas son mucho menores, con un promedio del 1,01 % en nuestra muestra. Con excepción de la pareja de especies genéticamente muy cercana *Metzneria fulva* Labonne, Huemer, Thibault & Nel, 2019 - *M. torosulella* (Rebel, 1893), todas las especies difieren también en su BIN.

Sin embargo, resulta notable la amplia variación intraespecífica registrada en un número considerable de especies. Así, cinco especies presentan actualmente una variación de código de barras aún considerada intraespecífica de entre 3,5 y 4,7 %. Estas divergencias se reflejan en 2 a 6 BINs (*Metzneria aprilella*, *M. artificella* (Herrich-Schäffer, 1861), *M. diffusella* Englert, 1974, *M. ehikella*, *M. metzneriella* Stainton, 1851). Tales distancias, respaldadas por la existencia de varios BINs, hacen que la posibilidad de diversidad críptica parezca bastante realista y requieren futuros estudios taxonómicos integrativos y exhaustivos.

Aunque la divergencia intraespecífica de *Metzneria luciae* sp. nov. aún se desconoce, la distancia genética con respecto a las especies más cercanas, especialmente *M. ehikella* y *M. aprilella*, superior al 8 % en ambos casos, ya constituye un indicio claro de la presencia de una especie adicional en la fauna europea. Esto también se ve respaldado por rasgos morfológicos, como el hábito inconfundible y las particularidades genitales. Incluso las especies aún no secuenciadas de regiones faunísticas adyacentes no se confunden con la nueva especie basándose en sus descripciones originales, entre ellas *Metzneria hastella* Chrétien, 1915, *Metzneria strictella* (Turati, 1924) de Norte de África, o varios taxas descritos por Piskunov en Asia Occidental.

Etimología: Se dedica esta especie a Lucía Páramo, colaboradora del primer autor.

Siguiendo a Vives Moreno (2014), *Metzneria luciae* Gastón, Huemer & Vives, sp. nov., por sus características tan especiales, debería de situarse al final del género *Metzneria*.

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Referencias

Chrétien, P. (1915). Contribution à la connaissance de lépidoptères du Nord de l'Afrique. *Annales de la Société entomologique de France, 84*, 289-374.

Dewaard, J. R., Ivanova, N. V., Hajibabaei, M., & Hebert, P. D. N. (2008). Assembling DNA Barcodes: Analytical Protocols. (pp. 275-293). In C. C. Martin (ed.). Methods in Molecular Biology: Environmental Genomics (364 pp). Humana Press Inc. https://doi.org/10.1007/978-1-59745-548-0_15 PMid:18642605

Durrant, J. H. (1897). *Aproaerema* n. n. *Entomologist's Monthly Magazine, 33*, 221. https://doi.org/10.1016/0093-691X(90)90645-A

Englert, W. D. (1974). Revision der Gattung *Metzneria* Zeller (Lepid., Gelechiidae) mit Beiträgen zur Biologie der Arten. *Zeitschrift für angewandte Entomologie, 75*, 381-421. https://doi.org/10.1111/j.1439-0418.1974.tb01862.x

Gozmány, L. (1954). Studies on Microlepidoptera. *Annales historico-naturales Musei nationalis hungarici, 46***(**series nova 5), 273-285.

Hebert, P. D. N., Cywinska, A., Ball, S. L., & Dewaard, J. R. (2003). Biological identifications through DNA barcodes. *Proceedings of the Royal Society of London B*, *270*, 313-321. https://doi.org/10.1098/rspb.2002.2218 PMid:12614582 PMCid:PMC1691236

Heinemann, H. (1870). *Die Schmetterlinge Deutschlands und der Schweiz. 2. Kleinschmetterlinge, 2*(1), 388 + 102. Braunschweig.

Herrich-Schäffer, G. A. W. (1843-1856). *Systematische Bearbeitung der Schmetterlinge von Europa, zugleich als Text, Revision und Supplement zu Jakob Hübner's Sammlung europäischer Schmetterlinge. Die Tagfalter* (Vol. 1) (1843-(1855). *Die Schwärmer, Spinner und Eulen* (Vol. 2) (1843)-1845-(1855). *Die Spanner* (Vol. 3) (1843)-1847-(1856). *Die Zünsler und Wickler* (Vol. 4) ((1847)-1849-(1855). *Die Schaben und Federmotten* (Vol. 5) (1847)-1853-1855). *Sechster und letzter Band* (Vol. 6) (1843-1856). Regensburg.

Herrich-Schäffer, G. A. W. (1861). *Neue Schmetterlinge aus Europa und den angrenzenden Ländern*. Drittes Heft: 24-32, pl. [19]-[26]. Regensburg (G. J. Manz).

Hobern, D., Sattler, K., & Lee, S. (2025). Catalogue of World Gelechiidae (version 1.1.25.114). In O. Bánki, Y. Roskov, M. Döring, G. Ower, D. R. Hernández Robles, C. A. Plata Corredor, T. Stjernegaard Jeppesen, A. Örn, T. Pape, D. Hobern, S. Garnett, H. Little, R. E. DeWalt, K. Ma, J. Miller, T. Orrell, R. Aalbu, J. Abbott, R. Adlard, et al. *Catalogue of Life* (Version 2025-05-13). https://doi.org/10.48580/dgqdn-4th

Hübner, J. (1816-[1825]). *Verzeichnis bekannter Schmettlinge* (sic.). Augsburg. https://doi.org/10.5962/bhl.title.48607

Huemer, P. (2021). *Metzneria neli* Huemer, sp. n., a new species hitherto mixed with *M. tristella* Rebel, 1901 (Lepidoptera: Gelechiidae). *SHILAP Revista de lepidopterología, 49*(196), 647-655. https://doi.org/10.57065/shilap.226

Huemer, P. & Karsholt, O. (2020). Commented checklist of European Gelechiidae (Lepidoptera). *ZooKeys, 921*, 65-140. https://doi.org/10.3897/zookeys.921.49197 PMid:32256151 PMCid:PMC7109147

Huemer, P., Karsholt, O., Aarvik, L., Berggren, K., Bidzilya, O., Junnilainen, J., Landry, J. F., Mutanen, M., Nupponen, K., Segerer, A., Sumpich, J., Wieser, C., Wiesmair, B., & Hebert, P. D. N. (2020). DNA barcode library for European Gelechiidae (Lepidoptera) suggests greatly underestimated species diversity. *ZooKeys, 921*, 141-157. https://doi.org/10.3897/zookeys.921.49199 PMid:32256152 PMCid:PMC7109146

Karsholt, O., & Razowski, J. (1996). *The Lepidoptera of Europe. A Distributional Checklist*. Apollo Books. https://doi.org/10.1163/9789004631717

Labonne, G., Huemer, P., Thibault, M. & J. Nel (2019), Description de *Metzneria fulva* sp. nov., découverte dans le sud de la France, proche de *M. torosulella* (Rebel, 1893) (Lepidoptera, Gelechiidae, Anomologinae). *Revue de l'Association Roussillonaise d'Entomologie, 28*(1), 44-51.

Nel, J. (1997). Une nouvelle espèce de *Metzneria* Zeller, 1839, dans le Midi de la France (Lepidoptera, Gelechiidae). *Bulletin de la Société entomologique de France, 102*(2), 158. https://doi.org/10.3406/bsef.1997.17323

Piskunov, V. I. (1979). New species of Gelechiidae (Lepidoptera) from the USSR. *Entomologicheskoe Obozrenie, 58*(2), 369-372. (en ruso)

Ragonot, E.-L. (1895). Microlépidoptères de la Haute-Syrie récoltés par M. Ch. Delagrange et descriptions des espèces nouvelles. *Bulletin des séances et bulletin bibliographique de la Société entomologique de France, 1895*, XCIV-CIX.

Ratnasingham, S., & Hebert, P. D. N. (2007). BOLD: The Barcode of Life Data System (http://www. barcodinglife.org). *Molecular Ecology Notes, 7*, 355-364. https://doi.org/10.1111/j.1471-8286.2007.01678.x. PMid:18784790 PMCid:PMC1890991

Ratnasingham, S., & Hebert, P. D. N. (2013). A DNA-based registry for all animal species: The Barcode Index Number (BIN) system. *PLoS ONE, 8*(7), e66213. https://doi.org/10.1371/journal.pone.0066213 PMid:23861743 PMCid:PMC3704603

Ratnasingham, S. (2018). *BOLD Barcode of Life Data System* (version 4). http://www.boldsystems.org.

Rebel, H. (1893). Neue oder wenig gekannte Microlepidopteren des paläarktischen Faunengebietes. *Stettiner Entomologische Zeitung, 54*, 37-59.

Robinson, G. S. (1976). The preparation of slides of Lepidoptera genitalia with special reference to the

Microlepidoptera. *Entomologist's Gazette, 27*, 127-132.

Stainton, H. T. (1851). *A supplementary catalogue of the British Tineidae & Pterophoridae. Appendix. A catalogue of the Tineidae obtained from Herr Joseph Mann, of Vienna, in 1849*. John van Voorst.

Tamura, K., Stecher, G., & Kumar, S. (2021). MEGA 11: Molecular Evolutionary Genetics Analysis Version 11. *Molecular Biology and Evolution, 38*(7), 3022-3027. https://doi.org/10.1093/molbev/msab120 PMid:33892491 PMCid:PMC8233496

Turati, E. (1924). Spedizione Lepidotterologica in Cirenaica 1921-1922. *Atti della Società italiana di Scienze naturale in Milano, 63*(1-2), 21-191, pl. 1-6

Vives Moreno, A. (2001). Contribución al conocimiento de los microlepidópteros de España, con la descripción de ocho nuevas especies para la Ciencia (Insecta: Lepidoptera). *SHILAP Revista de lepidopterología, 29*(114), 165-178.

Vives Moreno, A. (2014). *Catálogo sistemático y sinonímico de los Lepidoptera de la Península Ibérica, de Ceuta, de Melilla y de las islas Azores, Baleares, Canarias, Madeira y Salvajes (Insecta: Lepidoptera)*. Improitalia.

Zeller, P. C. (1839). Versuch einer naturgemäßen Einteilung der Schaben und der schaben-ähnlichen Schmetterlinge (Lep. Crambina und Lep. Tinacea). *Isis von Oken, 1839*(3), 167-220.

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Figuras 1-5. Adulto y genitalia del macho de *Metzneria luciae* Gastón, Huemer & Vives, 2025, ♂. **1**. “in vivo”, Casa Athene, a 125 m, Vejer de la Frontera, 10-IV-2025, Cádiz, España. Imagen: Stephen Knapp. **2**. Holotipo ♂, Casa Athene, a 125 m, Vejer de la Frontera, 10-IV-2025, Cádiz, España. **3**. Holotipo, prep. gen. 10806JG; TLMF_Lep_47288. **3a**. Ídem, phallus. **3b**. Ídem detalle del phallus. **4**. Detalle del cucullus, Paratipo, prep. gen. 11127JG. **5**. Detalle de cabeza y palpos.

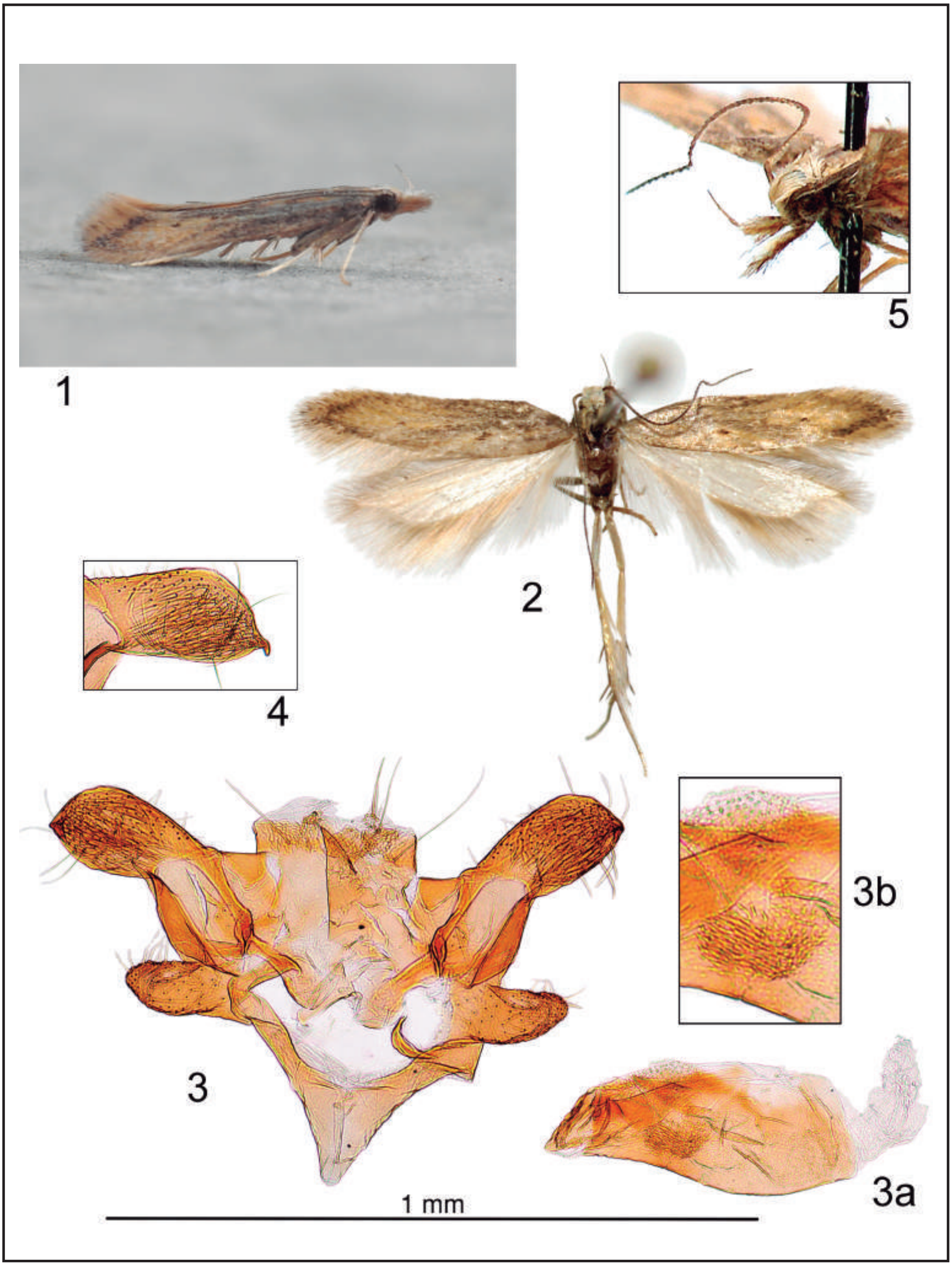

Figura 6. Árbol Neighbour-Joining de las especies europeas de *Metzneria* enraizado con *Aristotelia* como grupo externo (Kimura 2-parámetros), construido con MEGA 11 (Tamura et al. 2021). Fuente: datos de código de barras de ADN de BOLD (Base de datos del código de barras de la vida; Ratnasingham 2018).

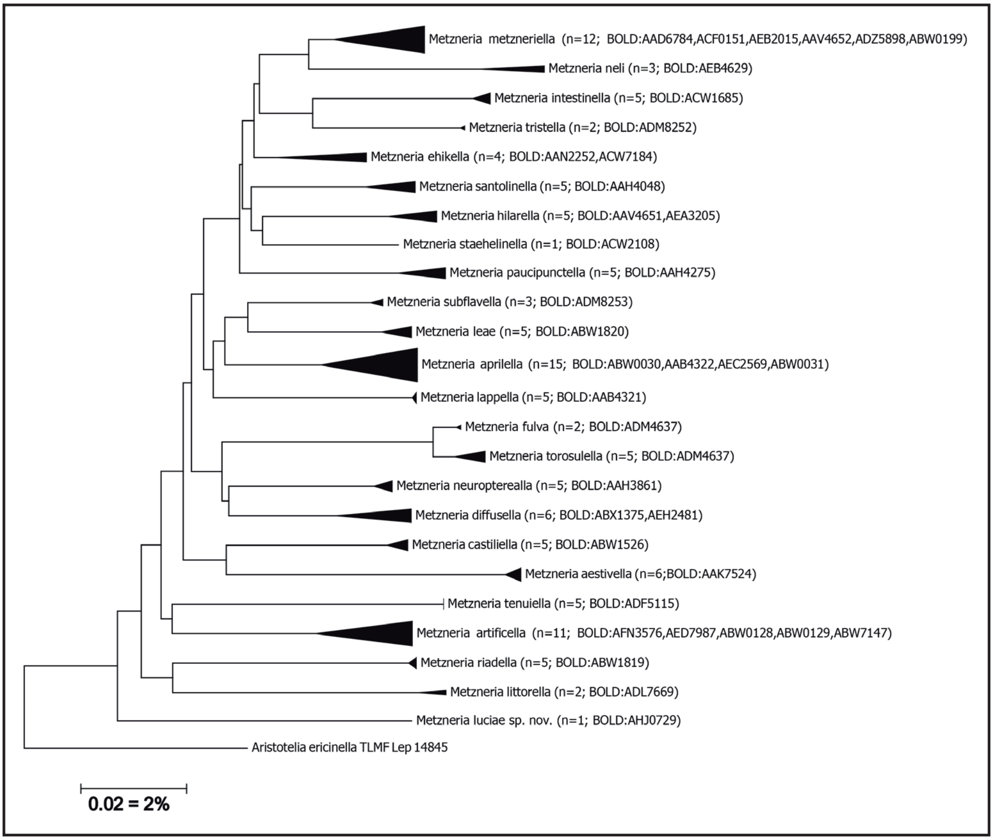

Figura 7. Mapa de distribución en la península ibérica de *Metzneria luciae* Gastón, Huemer & Vives, 2026.

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Alive and kicking in Central America and the Riviera Maya: first reports of *Papilio demoleus* Linnaeus, 1758 in Panama, Costa Rica, and Mexico, with a warning to their citrus producers (Lepidoptera: Papilionidae)

José de Jesús García-Díaz & Jorge M. González

Abstract

Papilio demoleus malayanus Wallace, 1865 is reported for the first time in Mexico, based on four specimens collected in Cancún, Quintana Roo, and 11 additional observations from the state Quintana Roo, documented on the citizen science platform iNaturalist.org. This species is a recognized pest of citrus crops, and its monitoring is recommended to prevent its spread within the country and to mitigate potential economic impacts on the citrus industry. Furthermore, records of this species from other countries in the Americas are presented, based on citizen researchers' observations uploaded in iNatuaralist.org, including the first documented records for Costa Rica and Panama. Two new host plants are reported for *Papilio demoleus*, and various aspects of its ecology are discussed. Lastly, the importance of iNaturalist.org as an effective platform for detecting rare species, Lepidoptera pests, and other taxonomic groups is emphasized.
Key words: Lepidoptera, Papilionidae, citrus pest, geographic distribution, iNaturalist.org, invasive species, Neotropical.

Vivitos y coleando en Centroamérica y la Riviera Maya: primeros reportes de *Papilio demoleus* Linnaeus, 1758 en Panamá, Costa Rica y México, con una advertencia a sus citricultores (Lepidoptera: Papilionidae)

Resumen

Papilio demoleus malayanus Wallace, 1865 es reportado por primera vez en México, basados en cuatro ejemplares recolectados en Cancún, Quintana Roo, además de 11 observaciones adicionales en el estado de Quintana Roo, documentadas en la plataforma de ciencia ciudadana iNaturalist.org. Esta especie es una plaga reconocida en los cultivos de cítricos, por lo que se recomienda su monitoreo para evitar su dispersión en el país y mitigar posibles impactos económicos en la industria citrícola. Además, se presentan registros de la especie en otros países de las Américas, basados en observaciones de investigadores ciudadanos incluidas en iNaturalist.org, incluyendo los primeros registros documentados para Costa Rica y Panamá. Se reportan dos nuevas plantas hospederas para *Papilio demoleus* y se discuten varios aspectos de su ecología. Por último, se destaca la importancia de iNaturalist.org como plataforma eficaz para la detección de especies raras, plagas de Lepidoptera y otros grupos taxonómicos.
Palabras clave: Lepidoptera, Papilionidae, distribución geográfica, especie invasora, iNaturalist.org, plaga de los cítricos, Neotropical.

Introduction

Papilionidae is one of the best-studied families of Lepidoptera. They are easily recognized by having a medium to large size and being conspicuous, although there are species of reduced size, such as those of the subfamilies Baroniinae and Parnassiinae (DeVries, 1987; Tyler et al. 1994; James & Lohman, 2024). Their distribution is preeminently tropical but several species are found in temperate regions, making this large group of Papilionoidea, with over 600 species, almost cosmopolitan (Nieukerken et al. 2011; Yu et al. 2023; James & Lohman, 2024). According to De la Maza-Elvira & De la Maza-Elvira (2022), 73 species and 64 subspecies of Papilionidae are known from Mexico, about 12% of the total number of species estimated worldwide. Of these, 18 species and 46 subspecies seem to be endemic to Mexico (De la Maza-Elvira & De la Maza-Elvira, 2022). After two years of thorough research in Quintana Roo, De la Maza-Elvira & Gutierrez-Carbonell (1992) identified 22 species of Papilionidae. They highlighted the importance of investigating flooded and coastal areas to determine whether species from the Antilles are merely passing through or have already established themselves in the peninsula. Some doubtful and unconfirmed records of Papilionidae exist from the country, such as *Battus belus chalceus* (Rothschild & Jordan, 1906) [=*Battus belus varus* (Kollar, 1850)] from Central and South America, or the North American species *Parnassius smintheus* Doubleday, 1847 and *Pterourus glaucus* (Linnaeus, 1758) (De la Maza-Ramírez, 1987; Tyler et al. 1994; De la Maza-Elvira & De la Maza-Elvira, 2022). However, to date no swallowtails from other continents had been reported in Mexico.

Papilio demoleus Linnaeus, 1758 is a tailless species of Asian origin and it is perhaps the most widely distributed in the world (Collins & Morris, 1985; Morgun & Wiemers, 2012). It is commonly known as checkered swallowtail, lime butterfly, lime swallowtail, lemon butterfly, and citrus swallowtail (Riaz et al. 2020). According to Smith & Vane-Wright (2008) and Nielsen (2017), five subspecies are recognized: *P. demoleus demoleus, P. d. malayanus* Wallace, 1865, *P. d. novoguineensis* Rothschild, 1908, *P. d. sthenelinus* Rothschild, 1895 and *P. d. sthenelus* Macleay, 1826. The nominotypical subspecies and *P. demoleus malayanus* are known to be invasive Papilionidae of economic importance as pests of citrus (Guerrero et al. 2004; Garraway et al. 2009; Riaz et al. 2020). Originally, the five subspecies had disjunct distributions (Morgun & Wiemers, 2012); however, the rapid expansion of *P. d. demoleus* and *P. d. malayanus* in several Asian countries since the late 1950s, unified their distribution, with the consequent overlapping of some subspecies (Moonen, 1991; Matsumoto, 1996, 2002; Benyamini et al. 2007; Smith & Vane-Wright, 2008; Morgun & Wiemers, 2012). *Papilio demoleus* has also spread along the Mediterranean region and Europe, and populations are present in Syria and Turkey, including an isolated record in Portugal (Morgun & Wiemers, 2012; Başbay et al. 2020).

Interestingly, *P. demoleus malayanus* was recorded for the first time in the Americas in Hispaniola (Dominican Republic) by Guerrero et al. (2004). After morphological comparisons and analyzing several genetic markers, Eastwood et al. (2006) confirmed that the individuals of this population originated from Southeast Asia, after a single introduction. Subsequently, this taxon had spread in the Caribbean, and it is now known from Puerto Rico, Jamaica, Bahamas, Cuba, and Haiti (Homziak & Homziak, 2006; Núñez-Águila, 2007; Wehling et al. 2006; Garraway et al. 2009; Segarra-Carmona et al. 2010; Bastardo, 2012; Fernández-Hernández & Minno, 2015; Yong et al. 2018; Riaz et al. 2020). Hayden et al. (2022) published a pest alert for the United States on *P. demoleus* based on the photographs of two larvae found in Key West, Florida, and shown on the iNaturalist.org platform.

In late December 2024, the first author (JJGD) was contacted separately by two Mexican lepidopterologists, who informed him that they had collected specimens of *Papilio demoleus* in Cancún, Quintana Roo, Mexico. These atypical records prompted JJGD to check the iNaturalist.org platform to investigate whether there had been observations of the species within Mexico. Surprisingly, there were 11 additional observations from 15 October 2022 to the moment we wrote this note, all from the state of Quintana Roo. After a more detailed exploration within the platform, 496 records were found in 16 North and Central American countries and several Caribbean islands. Among these reports, the first records of the presence of *P. demoleus*, were found in Costa Rica and Panama. Such findings motivated the authors to write the present not only to expand the knowledge on *P. demoleus* in the Americas but also to emphasize the relevance of the platform iNaturalist.org as a valuable tool for studying biodiversity.

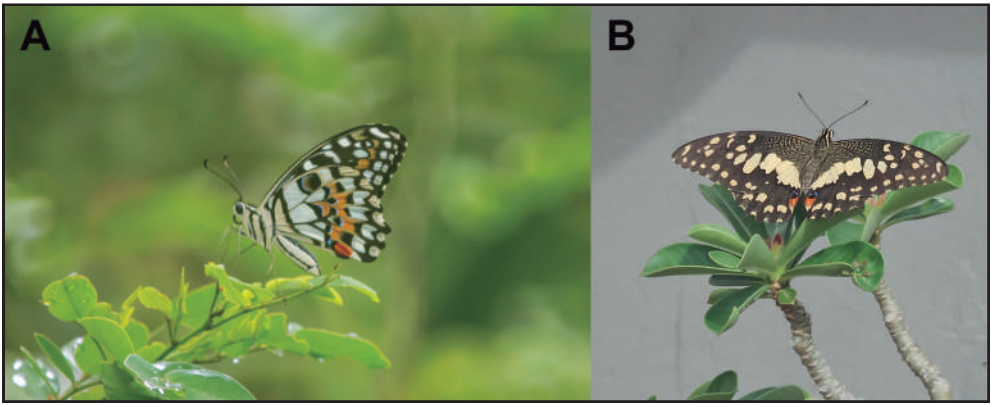
Materials and methods

Three specimens collected by Carlos Velázquez on 23-XII-2024 and one specimen collected by Shuster Alberto Nah on 26-XII-2024 are provided as evidence of the presence of *P. demoleus* in the Yucatán Peninsula, in Mexico (Figure 1). Two specimens are deposited at the collection of Carlos Velázquez and two are now part of the research material of JJGD. The photograph of the specimen in Figure 1 was taken with a Fujifilm FinePix HS20EXR camera.

Figure 1. *Papilio demoleus* ♂, Cancún, Quintana Roo, Mexico, 26-XII-2024, leg. Shuster Alberto Nah. Scale bar = 1cm.

The distribution of *Papilio demoleus* in the Americas was determined thanks to the existing observations provided by numerous citizen scientists into the iNaturalist.org (2025) platform. All records within this platform were carefully checked and corroborated to avoid repeating data and detecting misidentifications; information published up to 12-I-2025 was included.

Figure 2. Live adults of *Papilio demoleus* in Quintana Roo, Mexico. **A.** Tulúm municipality, 04-X-2024 (photo: Elias Siebenborn; https://inaturalist.org/observations/246329072); **B.** Beníto Juárez municipality, 13-X-2024 (photo: Evangelina Améndola; https://inaturalist.org/observations/247121479).



The distribution map (Figure 4) was produced by using the SimpleMappr tool (Shorthouse, 2010). The plots in Figure 3 were produced in R software (R Core Team, 2023), and their editing was enhanced using the "ggplot2" package (Wickham, 2016). Adobe Photoshop 2020 was used to edit the figures.

Results and discussion

When comparing the Mexican specimens with those illustrated by Guerrero et al. (2004), Nielsen (2017), and Smith & Vane-Wright (2008), they seem to correspond to the subspecies *P. demoleus malayanus*, the only one reported so far for the Americas. Based on information provided by the iNaturalist.org (2025) platform, the first observation of *Papilio demoleus* in Mexico was on 15-X-2022 in Tulúm, Quintana Roo (https://inaturalist.org/observations/139651305). Subsequently, nine more specimens in the state of Quintana Roo in 2024. It is not known how the species arrived in Mexico, but it is most likely that its dispersal was facilitated by a tropical storm or a hurricane.

Hurricane season was particularly active in 2021 and at least one hurricane (Grace) passed through Hispaniola and Jamaica, crossing Yucatán and ending along the coast of Veracruz-Tamaulipas (National Hurricane Center and Central Pacific Hurricane Center, n.d.1). During the 2022 Hurricane season, at least one hurricane (Lisa) passed close to Jamaica and ended in the Gulf of Mexico after crossing Yucatán (National Hurricane Center and Central Pacific Hurricane Center, n.d.2). However, the first specimen photographed and uploaded in iNaturalist.org could have been part of a population established some time before 2021, and arriving to the coast of Mexico from any other island.

On 12-X-2024 a female was detected ovipositing on *Fortunella japonica* (Thunb.) Swingle (Rutaceae), and *Passiflora edulis* Sims (Passifloraceae) plants in Cancun, Quintana Roo (https://inaturalist.org/observations/139651305); Evangelina Améndola pers. comm.). In their review, Riaz et al. (2020) do not mention these two species as host of *P. demoleus*. The kumquat appears to be a new host plant record for the species, while passion fruit is the first known host within the family Passifloraceae. Some adults were sighted feeding on flowers of *Tithonia diversifolia* (Hemsl.) A. Gray (Asteraceae) and *Bauhinia divaricata* Lam (Fabaceae) (Carlos Velázquez, Ana Patricia Montero, Shuster Alberto Nah & Evangelina Améndola, pers. comm.). All specimens recorded in Quintana Roo were observed between September and December.

While reviewing all observations of *P. demoleus* in the Americas within iNaturalist.org (2025), it was detected that two specimens were photographed before the first formal continental record of the species by Guerrero et al. (2004). One specimen was observed on 17-IV-1997 in Pococí, Limón, Costa Rica (https://inaturalist.org/observations/223307439), corresponding to the first record of *P. demoleus* for Central America, and of course, Costa Rica. Another earlier record for the Americas was posted on 01-IX-2002 in Mao, Valverde, Dominican Republic (https://inaturalist.org/observations/111800640).

Among other relevant observations, we noticed that the first record of *P. demoleus* in Panama (https://inaturalist.org/observations/100187256) occurred on 03-XI-2021 in David, Chiriquí. After reviewing the observations in the United States, it was noted that there are six records before the one reported by Hayden et al. (2022) in Key West, Florida, being the first on 23-IV-2020 in San Luis Obispo County, California (https://inaturalist.org/observations/66278726).

In total, there were 496 observations of this swallowtail within the iNaturalist.org (2025) platform up to 12-I-2025. They were distributed in 16 countries/islands of the Americas (Table 1; Figures 3 and 4). Most observations (84%) occurred in the Dominican Republic (260), Jamaica (76), Puerto Rico (50), and Cuba (32), suggesting that *P. demoleus* populations are already well established on these islands. Other countries had less than 15 records each, Costa Rica and Panama being the only ones with only one record so far (Figures 3A and 4). These 496 observations far exceed the number of previously known sightings of this swallowtail in the Americas, demonstrating the potential of iNaturalist.org to provide information on the geographic distribution of organisms with the invaluable help of Citizen Researchers.

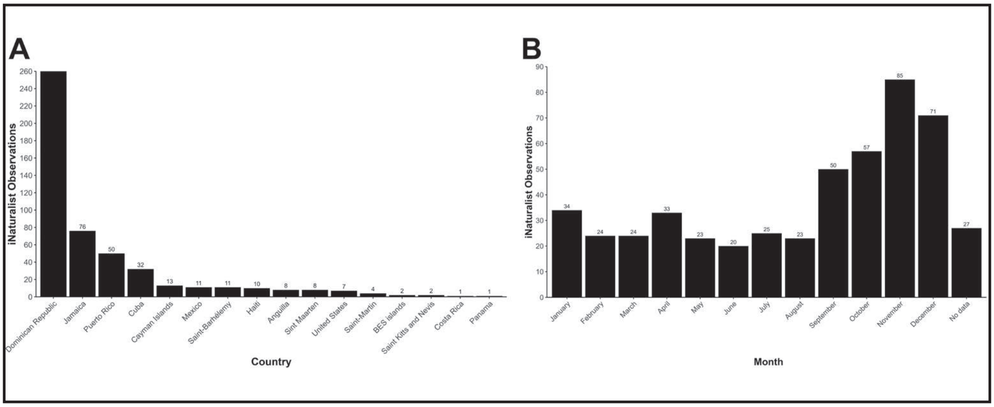
Table 1. Number of observations of *Papilio demoleus* by country and year uploaded in the iNaturalist.org (2025) platform in the Americas.

Country	1997-2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024 / 2025*
Dominican Republic	7	7	3	12	13	19	43	55	34	31	25 / 0
Jamaica	0	2	2	5	1	2	1	6	17	16	20 / 1
Puerto Rico	1	0	1	0	1	0	7	5	8	13	8 / 1

Cuba	0	0	3	4	2	4	6	2	4	1	4 / 0
Cayman Islands	0	0	0	0	1	0	1	0	3	3	4 / 0
México	0	0	0	0	0	0	0	0	2	0	9 / 0
Saint-Barthélemy	0	1	1	0	0	0	0	0	3	2	3 / 1
Haiti	0	0	0	1	0	0	1	0	2	2	0 / 0
Anguilla	0	0	0	1	0	2	0	0	3	1	1 / 0
Sint Maarten	1	1	0	0	0	4	0	0	1	1	0 / 0
United States	0	0	0	0	0	0	3	0	3	1	0 / 0
Saint-Martin	0	0	0	0	0	0	0	2	0	1	0 / 0
BES islands	0	0	0	0	0	0	0	0	0	0	0 / 2
Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	2 / 0
Costa Rica	1	0	0	0	0	0	0	0	0	0	0 / 0
Panamá	0	0	0	0	0	0	0	1	0	0	0 / 0
TOTAL	**10**	**11**	**10**	**23**	**18**	**31**	**62**	**71**	**80**	**72**	**76 / 5**

Note: BES islands: Bonaire, Saint Eustatius and Saba. *Information published up to 12-I-2025.

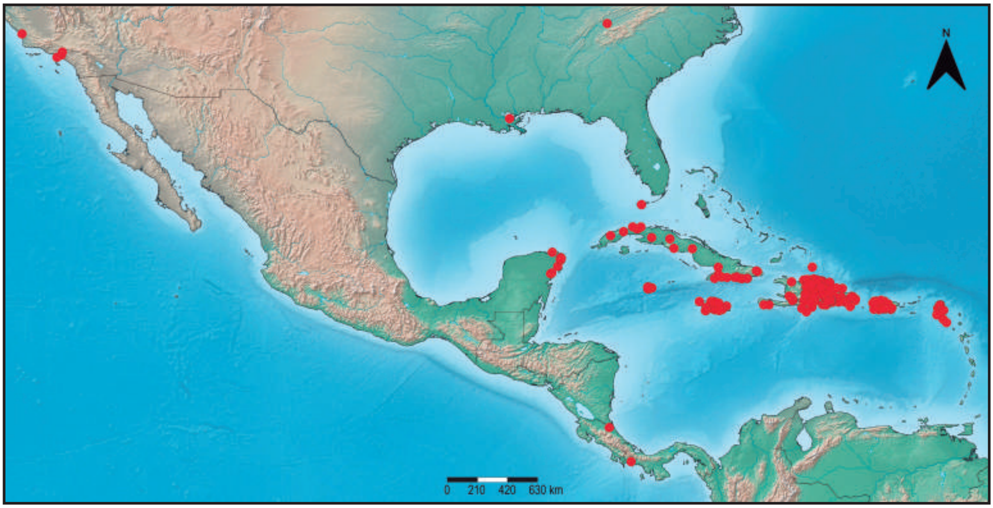
Figure 3. *Papilio demoleus* observations in the Americas, as found in the iNaturalist.org platform (up to January 2025). **A.** Total number of observations by country; **B.** Total number of observations by month.



Since its first formal record in the Americas (Guerrero et al. 2004), *P. demoleus* has expanded rapidly in the Caribbean islands, where it appears to be well established. Between 1997 and 2014 there are only 10 observations for the species in iNaturalist.org (2025). However, from 2015 onwards the number of observations has increased considerably, with a minimum number of annual observations of 10 specimens, and a maximum of 80 in 2022 (Table 1). The species seems to be multivoltine and has been recorded year-round, but with a marked increase in sightings during autumn (iNaturalist.org, 2025) (Figure 3B), aligning with previous research in other parts of the world (Devi et al. 2018; Riaz et al. 2020).

The life cycle of this species has been studied in different host plants, climatic conditions, and in different countries (e.g., Peggie et al. 2022). The complete life cycle lasts between 20 and 38 days, with about 15 days for five larval instars and 11 days in its pupal stage. The morphology and color pattern of larvae during the first four instars is very similar and resembles the excreta of a bird. In these instars, the larva also has small spines along its body. During the fifth instar, the larva turns green and has dark brown bands and dots in both dorsal and lateral views (Mihn et al. 2015; Jahnavi et al. 2018).

Figure 4. Geographic distribution of *Papilio demoleus* in the Americas.



Badawi (1981) and Mihn et al. (2015) found the life cycle of this specie gets shorter as the temperature increases (>25ºC). Jahnavi et al. (2018) observed very low standard deviations in the duration of the different larval stages. Such a short life cycle allows the species to be multivoltine. Adults have a short life span, and there is no major difference between sexes, even though females might live slightly longer than males (Rao, 2015).

According to CONAGUA (2025), the average monthly temperature in two Quintana Roo's cities where *P. demoleus* were reported in iNaturalist.org (2025), Cancún, and Playa del Carmen, is above 24ºC throughout the year. The warmest period of the region is between April and October when the average monthly temperature exceeds 27.3ºC and reaches 30.7ºC. All known records of the butterfly from Quintana Roo, Mexico (11 observations), were posted between September 8 and December 26. This could be related to favorable environmental conditions as other authors have pointed out but could also be linked to their somehow recent arrival in the country, and a low number of individuals as opposed to native species, among other reasons. Consequently, we have found a low number of sightings reported in iNaturalist.org (2025).

Eleven observations of *P. demoleus* on the coast of Quintana Roo, two years after the first known Mexican record, might indicate that even though it might be incipient, at least a population has been already established in the region. Having citrus trees in homes is customary, undoubtedly favoring the establishment of this butterfly. The information available to date is not enough to assess if the species has spread to other municipalities or states; however, it is necessary to take precautions, since this swallowtail is considered a serious citrus pest in many parts of its range (Heppner, 2006; Segarra-Carmona et al. 2010; Minh et al. 2015; Lewis, 2018).

Mexico is one of the main citrus producers and exporters in the world (Maya-Ambía, 2017; Ruiz-Rodríguez et al. 2017). Citriculture is one of the most relevant agricultural activities in Mexico, generating numerous direct and indirect jobs, and an important source of income in rural areas, benefiting 67,000 families who depend on this activity nationwide (Blanco-Rodríguez et al. 2015; Maya-Ambía, 2017; Ruiz-Rodríguez et al. 2017). During the last decades, Mexico has been the world's largest producer and exporter of limes, being Mexican or Key lime [*Citrus ×aurantiifolia* (Christm. & Panz.) Swingle] and Persian lime [*Citrus ×latifolia* (Yu.Tanaka ex Yu.Tanaka) Yu.Tanaka] the most popular ones (Mendoza-Tornez et al. 2016).

The presence of *P. demoleus* in citrus plantations in Mexico could significantly affect its citrus industry and generate a large economic impact, since its larvae, mainly in the later stages, cause significant damage in nurseries, young seedlings, and new shoots of adult trees (Jahnavi et al. 2018). Severe infestations cause tree defoliation, generating stunted growth and a significant decrease in fruit production (Rao, 2015; Jahnavi et al. 2018; Riaz et al. 2020).

The present work demonstrates that iNaturalist.org is a powerful tool that can provide significant information, whether ecological, phenological or distributional, about any species. In this case, it could be used to monitor the expansion of *Papilio demoleus* in Mexico, and other regions, allowing the development of actions and strategies to manage or control the species in citrus plantations.

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Conflict of Interest

The authors declare that there is no known financial interest or personal relationship that could have influenced the work presented herein.

References

Badawi, A. (1981). Studies on some aspects of the biology and ecology of the citrus butterfly *Papilio demoleus* L. in Saudi Arabia (Papilionidae, Lepidoptera). *Zeitschrift für Angewandte*, *91*(1-5), 286-292. https://doi.org/10.1111/j.1439-0418.1981.tb04481.x

Başbay, O., John, E., & Salimeh, M. (2020). Preliminary note on the range expansion of *Papilio demoleus* (Lepidoptera: Papilionidae) in south-eastern Turkey, and on the first documented arrival of this invasive species at the Mediterranean coast of Syria. *Phegea*, *48*, 20-21.

Bastardo, R. H. (2012). Nuevas localidades para *Greta diaphanus quisqueya* (Fox, 1963) y *Papilio demoleus* Linnaeus, 1758 (Lepidoptera: Papilionoidea) en la Hispaniola. *Novitates Caribaea*, (5), 103-109. https://doi.org/10.33800/nc.v0i5.139

Benyamini, D., Bruschini, C., Serra, G., & John, E. (2007). First confirmed records of *Papilio demoleus* (Linnaeus 1758) in Syria, with comments on the species' appearance in Turkey and the Dominican Republic. *News of the Israeli Lepidopterists Society*, *24*(2), 4-11.

Bhutani, D. K., & Jotwani, M. G. (1975). Trends in the control of insect pests of fruit crops in India. *Pesticides*, *9*(4), 139-149.

Blanco-Rodríguez, E., Romero-Nápoles, J., Lomelí-Flores, J. R., Mora-Aguilera, G., & Dietrich, C. (2015). Cicadélidos asociados a cítricos en la Península de Yucatán, México. *Entomología Mexicana*, *2*, 830-834.

Collins, N. M., & Morris, M. G. (1985). *Threatened Swallowtail Butterflies of the World: The IUCN Red Data Book*. Gland & Cambridge, IUCN.

CONAGUA (2019). *Información Estadística Climatológica. Información de Estaciones Climatológicas*. Estaciones (Cancún, Playa del Carmen). https://smn.conagua.gob.mx/es/climatologia/informacion-climatologica/informacion-estadistica-climatologica

De la Maza-Elvira, J., & De la Maza-Elvira, R. G. (2022). *An illustrated atlas of Mexican butterflies: Papilionidae*. Colección de la Maza de Lepidoptera de México.

De la Maza-Elvira, R. G., & Gutiérrez-Carbonell, D. (1992). Rhopaloceros de Quintana Roo, su distribución, origen y evolución. *Revista de la Sociedad Mexicana de Lepidopterología*, *15*(1), 1-43.

De la Maza-Ramírez, R. F. (1987). *Mariposas Mexicanas: Guía para su colecta y determinación*. Fondo de Cultura Económica, S. A.

Devi, M., Jaglan, R., Yadav, G., & Singh, N. (2018). Population dynamics of citrus butterfly, *Papilio demoleus* L. (Lepidoptera: Papilionidae) in Kinnow (*Citrus nobilis* × *Citrus deliciosa*) as influenced by abiotic factors. *International Journal of Current Microbiology and Applied Sciences*, *7*(2), 475-478. https://doi.org/10.20546/ijcmas.2018.702.059

DeVries, P. J. (1987) *The Butterflies of Costa Rica and their natural history. Papilionidae, Pieridae, Nymphalidae*. Princeton University Press.

Eastwood, R., Boyce, S. L., & Farrell, B. D. (2006). The Provenance of Old World Swallowtail Butterflies, *Papilio demoleus* (Lepidoptera: Papilionidae), Recently Discovered in the New World". *Annals of the Entomological Society of America*, *99*(1), 164-168. https://doi.org/10.1603/0013-8746(2006)099[0164:tpoows]2.0.co;2

Fernández Hernández, D. M., & Minno, M. C. (2015). The slowly expanding range of *Papilio demoleus* Linnaeus (Lepidoptera: Papilionidae) in Cuba. *Tropical Lepidoptera Research*, *25*(1), 8-14.

Garraway, E., Murphy, C. P., & Allen, G. A. (2009). *Papilio demoleus* (the lime swallowtail) (Lepidoptera: Papilionidae), a potential pest of citrus, expanding its range in the Caribbean. *Tropical Lepidoptera Research*, *19*(1), 58-59.

Guerrero, K. A., Veloz, D., Boyce, S. L., & Farrell, B. D. (2004). First new world documentation of an Old World Citrus Pest, the Lime Swallowtail *Papilio demoleus* (Lepidoptera: Papilionidae), in the Dominican Republic (Hispaniola). *American Entomologist*, *50*(4), 227-229. https://doi.org/10.1093/ae/50.4.227

Hayden, J. E., Burnette, K. M., & Moore, M. R. (2015). *Pest alert: Papilio demoleus, Lime Swallowtail, on Key West, Florida. Gainesville (FL, USA)*. Florida Department of Agriculture and Consumer Services, Division of Plant Industry.

Hernández-Lara, J. L., Vargas-Zaleta, N. E., Enríquez-García, F., Uranga-Valencia, L. P., & Morelos-Suet, P. E. (2022). Principales cítricos cultivados en Veracruz, México. *Revista Biológica Agropecuaria Tuxpan*, *10*(2), 212-218. https://doi.org/10.47808/revistabioagro.v10i2.445

Heppner, J. B. (2006). *Lime Swallowtail in the Caribbean and Possible Impacts for Florida Citrus*. Florida Department of Agriculture and Consumer Services, Division of Plant Industry. https://ccmedia.fdacs.gov/content/download/9794/file/papilio-demoleus.pdf

Homziak, N. T., & Homziak, J. (2006). *Papilio demoleus* (Lepidoptera: Papilionidae): A new record for the United States. Commonwealth of Puerto Rico. *Florida Entomologist*, *89*(4), 485-488. https://doi.org/10.1653/0015-4040(2006)89[485:PDLPA N]2.0.CO;2

iNaturalist.org (2025) https://www.inaturalist.org

Jahnavi, M., Ramakrishna, R., & Sarada, G. (2018). Biology and morphology of citrus butterfly *Papilio demoleus* Linnaeus (Lepidoptera: Papilionidae) on acid lime. *Journal of Entomology and Zoology Studies*, *6*(1), 1556–1561.

James, D. G., & Lohman, D. J. (2024). *The lives of butterflies. A natural history of our planet's butterfly life*. Princeton, Princeton University Press. https://doi.org/10.2307/j.ctv303wbwf

Lewis, D. S. (2018). *Lime Swallowtail Papilio demoleus Linnaeus (Insecta: Lepidoptera: Papilionidae)*. University of Florida. Department of Entomology and Nematology UF/IFAS, Extension 2018. https://edis.ifas.ufl.edu/publication/IN786

Matsumoto, K. (1996). Establishment of *Papilio demoleus* L. (Papilionidae) in Java. *Journal of the Lepidopterists' Society*, *50*, 139-140.

Matsumoto, K. (2002). *Papilio demoleus* (Papilionidae) in Borneo and Bali. *Journal of the Lepidopterists' Society*, *56*, 108-111.

Maya-Ambía, C. J. (2017). Cítricos mexicanos en el mercado japonés: experiencias y oportunidades para Sinaloa. *México y la Cuenca del Pacífico*, *6*(16), 107-142. https://doi.org/10.32870/mycp.v6i16.523

Mendoza-Tornez, R., Marquez-Berber, S. R., Almaguer-Vargas, G., Aguilar-Avila, J., Gardezi, A. K., & Ayala-Garay, A. V. (2016). Value network of the persian lime in Mexico. *AGROFOR International Journal*, *1*(3), 39-45. https://doi.org/10.7251/AGRENG1603039T

Mihn, H. G., Giang, H. T. T., & Trang, H. T. Q. (2015). Studies on some aspects of the biology and ecology of citrus butterfly *Papilio demoleus* (Papilionidae: Lepidoptera) on citrus in Vietnam. *Journal of Tropical Asian Entomology*, *4*(1), 20-27.

Moonen, J. J. M. (1991). *Papilio demoleus* L. in Java (Lep.; Papilionidae). *Tyô to Ga*, *42*, 93-94.

Morgun, D. V., & Wiemers, M. (2012). First record of the Lime Swallowtail *Papilio demoleus* Linnaeus, 1758 (Lepidoptera, Papilionidae) in Europe. *Journal of Research on the Lepidoptera*, *45*, 85-89. https://doi.org/10.5962/p.266485

National Hurricane Center and Central Pacific Hurricane Center (n.d.1) 2021 Atlantic Hurricane Season. https://www.nhc.noaa.gov/data/tcr/index.php?season=2021

National Hurricane Center and Central Pacific Hurricane Center (n.d.2) 2022 Atlantic Hurricane Season. https://www.nhc.noaa.gov/data/tcr/index.php?season=2022&basin=atl

Nielsen, J. E. (2017). Additional characters for separating adults of *Papilio demoleus sthenelus* W.S. Macleay, 1826 (Lepidoptera: Papilionidae) from *P. demoleus* L. subspecies of biosecurity concern to Australia. *Australian Entomologist*, *44*(2), 75-84.

Nieukerken, E. J. van, Kaila, L., Kitching, I. J., Kristensen, N. P., Lees, D. C., Minet, J. et al. (2011). Order Lepidoptera Linnaeus, 1758. In Z.-Q. Zhang (Ed.). Animal biodiversity: an outline of higher-level classification and survey of taxonomic richness. *Zootaxa*, *3148*, 212-221. https://doi.org/10.11646/zootaxa.3148.1.39

Núñez-Águila, R. (2007). *Papilio demoleus* Linnaeus, 1758 en Cuba (Lepidoptera: Papilionidae). *Boletín Sociedad Entomológica Aragonesa, 41*, 440.

Peggie, D., Supadi, S., Guntoro, G., Sarino, S., Fatimah, F., Rachmatiyah, R., & Haeuser, C. (2022). *Papilio demoleus* L. and *Papilio polytes* L. (Lepidoptera: Papilionidae) reared on some host plants at butterfly research facility, Lipi

- Cibinong, West Java, Indonesia. *Treubia*, *49*(1), 41-56. https://doi.org/10.14203/treubia.v49i1.4468

R Core Team. (2023). *R: a language and environment for statistical computing*. R Foundation for Statistical Computing.

Rao, A. R. (2015). Studies on biology and morphometrics of citrus butterfly *Papilio demoleus* (Linnaeus) (Lepidoptera: Papilionidae) on Sathgudi Sweet Orange *Citrus sinensis* Swingle. *International Journal of Current Research in Life Sciences*, *4*(3), 168-171.

Riaz, S., Johnson, J. B., Rasheed, T., & Wiemers, M. (2020). Morphology, life cycle and management of two invasive subspecies of *Papilio demoleus* (Lepidoptera: Papilionidae): A review. *Journal of Applied Entomology*, *144*(10), 1-12. https://doi.org/10.1111/jen.12828

Ruiz-Rodríguez, R., Vela-Hernández, G. V., & Moreno-Luce, R. G. (2017). Exportación de cítricos mexicanos, alternativas para el mercado de exportación. *Horizontes de la Contaduría en las Ciencias Sociales*, *3*(6), 77-85.

Segarra-Carmona, A. E., Cabrera-Asencio, I., Flores-López, L. E., & Morales-Collado, L. (2010). Ciclo de vida y control de la mariposa asiática de los cítricos, *Papilio demoleus* (Lepidoptera: Papilionidae), una nueva plaga invasive en Puerto Rico. *The Journal of Agriculture of the University of Puerto Rico, 94*, 165-174. https://doi.org/10.46429/jaupr.v94i1-2.2592

Shorthouse, D. P. (2010). *SimpleMappr, an online tool to produce publication-quality point maps*. http://www.simplemappr.net

Smith, C. R., & Vane-Wright, R. I. (2008). Classification, nomenclature and identification of lime swallowtail butterflies: A post-cladistic analysis (Lepidoptera: Papilionidae). *Systematics and Biodiversity*, *6*(2), 175-203. https://doi.org/10.1017/S1477 20000 8002703

Tyler, H. A., Brown, K. S., & Wilson, K. H. (1994). *Swallowtail butterflies of Americas: a study in biological dynamics, ecological diversity, biosystematics, and conservation*. Gainesville, Scientific Publishers, Inc.

Wehling, W., Núñez, C., & Glassberg, J. (2006). Lime swallowtails in a new world. *American Butterflies*, *14*(2), 30-34.

Wickham, H. (2016). *ggplot2: elegant graphics for data analysis*. Springer-Verlag. https://doi.org/10.1007/978-3-319-24277-4

Yong, S., Teruel, R., & Breto, D. (2018). Occurrence of the Lime Swallowtail *Papilio demoleus* Linnaeus, 1758(Lepidoptera: Papilionidae) in Western Cuba. *Ecologica Montenegrina*, *18*, 15-17. https://doi.org/10.37828/em.2018.18.2

Yu, X.-T., Yang, F.-L., Da, W., Li, Y.-C., Xi, H.-M., Cotton, A. M., Zhang, H.-H., Duan, K., Xu, Z.-B., Gong, Z.-X., Wang, W.-L., & Hu, S.-J. (2023). Species richness of Papilionidae butterflies (Lepidoptera: Papilionoidea) in the Hengduan mountains and its future shifts under climate change. *Insects*, *14*(3), 259. https://doi.org/10.3390/insects14030259 PMid:36975944 PMCid:PMC10058169

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Listado de especies de Megalopygidae, Saturniidae y Arctiinae de Icononzo, Tolima, Colombia (Lepidoptera: Heterocera)

Laura N. Garzón-Matamoros, Andrés R. López-Preciado, Cristian C. Ramírez-Galeano & Alexander García-García

Resumen

Este estudio presenta un listado de especies de Lepidoptera de las familias Megalopygidae, Saturniidae y la subfamilia Arctiinae colectadas en el municipio de Icononzo, Tolima, Colombia. Se establecieron tres zonas diferenciadas por su cobertura vegetal y el grado de intervención antrópica, en las que se realizaron 12 noches de muestreo utilizando una trampa de luz LED portátil. Se registraron un total de 175 individuos y 68 especies/morfoespecies. La subfamilia Arctiinae presentó 124 individuos distribuidas en 50 especies, la familia Saturniidae 34 individuos agrupadas en 12 especies y la familia Megalopygidae 17 individuos repartidos en 6 especies. Esta investigación contribuye al conocimiento de la biodiversidad de estos grupos de Lepidoptera en el departamento del Tolima y proporciona información valiosa para la conservación de los ecosistemas locales.

Palabras claves: Lepidoptera, Heterocera, Megalopygidae, Saturniidae, Arctiinae, riqueza, intervención, bosque andino, Colombia.

Checklist of Megalopygidae, Saturniidae and Arctiinae from Icononzo, Tolima, Colombia (Lepidoptera: Heterocera)

Abstract

This study presents a list of Lepidoptera species of the families Megalopygidae, Saturniidae and the subfamily Arctiinae collected in the municipality of Icononzo, Tolima, Colombia. Three zones differentiated by vegetation cover and degree of anthropogenic intervention were established, where 12 sampling nights were conducted using a portable LED light trap. A total of 175 individuals and 68 species/morphospecies were recorded. The subfamily Arctiinae presented 124 individuals distributed in 50 species, the family Saturniidae 34 individuals grouped in 12 species and the family Megalopygidae 17 individuals distributed in 6 species. This research contributes to the knowledge of the biodiversity of these groups of Lepidoptera in the department of Tolima and provides valuable information for the conservation of local ecosystems.

Keywords: Lepidoptera, Heterocera, Megalopygidae, Saturniidae, Arctiinae, richness, intervention, Andean Forest, Colombia.

Introducción

Los Lepidoptera representan uno de los grupos de insectos más diversos a nivel mundial. Se estima que el número total de especies de Lepidoptera descritas en el mundo sobrepasa las 150.000, siendo las familias Erebidae y Geometridae las que presentan una mayor riqueza, con aproximadamente 24.600 y 23.002 especies respectivamente (van Nieukerken et al. 2011; Watson & Goodger, 1986).

Colombia, debido a su ubicación geográfica y diversidad de ecosistemas, alberga una gran variedad de especies de Heterocera. Sin embargo, el conocimiento actual y los inventarios faunísticos de estas especies en el país aún no se han completado (Lamas, 2000). Aunque se han realizado esfuerzos enfocados en el estudio de algunos grupos específicos, como Castniidae (González et al. 2017; Salazar, 1999), Erebidae (González & Hernández-Baz, 2017; Rodríguez et al. 2018; Vargas-Fonseca et al. 2020), Saturniidae (Amarillo-Suárez, 2000; Comoglio & Brechlin, 2021; Jimenez-Bolívar et al. 2021), Sphingidae (Correa-Carmona, Vélez-Bravo & Echeverri, 2015) y Geometridae (Murillo-Ramos et al. 2021), aún se desconoce gran parte de la diversidad de los Heterocera en los bosques húmedos presentes en el departamento del Tolima.

La superfamilia Bombycoidea, que incluye a la familia Saturniidae, es una de las más estudiadas dentro de Lepidoptera debido a su gran tamaño, amplia distribución y variedad de funciones ecológicas. En Colombia, entre los años 2000 y 2010, se registraban 185 especies de las subfamilias Hemileucinae, Saturniinae y Arsenurinae (Amarillo, 2000; Muñoz & Amarillo, 2010). Sin embargo, en los últimos años, nuevas investigaciones han demostrado que la riqueza de especies es aún mayor, con aproximadamente de unos 55 géneros y 602 especies para el país (Comoglio & Brechlin, 2021; Jiménez-Bolívar et al. 2021).

Estos estudios proporcionan listas actualizadas y completas de las especies Saturniidae colombianas en el que se incluyen nuevos registros de taxones, además del estado de presencia y ausencia en cada departamento, señalando una mayor representación de su diversidad en la región Andina con un 60,3% (394 spp.) (Comoglio & Brechlin, 2021; Decaëns et al. 2007; Jiménez-Bolívar et al. 2021).

Por otro lado, la subfamilia Arctiinae, perteneciente a la familia Erebidae, ha sido otro de los grupos más estudiados de Heterocera. Desde la década de los 80, se han generado catálogos de especies neotropicales, en los que se enumeraban 2.308 especies (Watson & Goodger, 1986). Posteriormente, en 2014, se generó una lista actualizada con 217 géneros, 2.404 especies y 154 subespecies dentro de 5 subtribus de los Arctiini (Vincent & Laguerre, 2014). Sin embargo, en Colombia, las investigaciones sobre la diversidad de este grupo se han centrado en pocas o limitadas regiones (Hernández-Baz et al. 2017; Jaimes, 2014; Muñoz & Amarillo, 2010), lo que dificulta una representación completa de su diversidad en el país.

Finalmente, los Megalopygidae son una de las principales familias de Lepidoptera causantes de erucismo en América y aquellas que provocan la mayor parte de los accidentes causados por sus orugas en Colombia, produciendo dermatitis, dolores y calambres musculares (Diaz, 2005; Gómez, 2014). Para Colombia, la información sobre este grupo es muy incipiente y fragmentada, destacando algunos registros en el Parque Natural Chicaque, San Antonio de Tequendama, Cundinamarca (Pérez, 2019), la confirmación de presencia de *Podalia orsilochus* (Cramer, [1775]) en el Chocó (Prada-Lara et al. 2020) y la descripción de un nuevo género Neotropical que incluye una especie tipo de Colombia: *Vadimas radogast* Volkova, 2020, registrada en el Nevado del Tolima (Volkova, 2020).

Dado que las listas de especies existentes para el país no incluyen registros de zonas específicas del departamento del Tolima, este estudio contribuye significativamente al conocimiento de la diversidad de especies en la región, lo que a su vez permitirá comprender mejor las respuestas de los grupos Megalopygidae, Saturniidae y Arctiinae a los cambios en el hábitat debido a la intervención humana, brindando información valiosa para la conservación de los ecosistemas locales.

Abreviaturas usadas

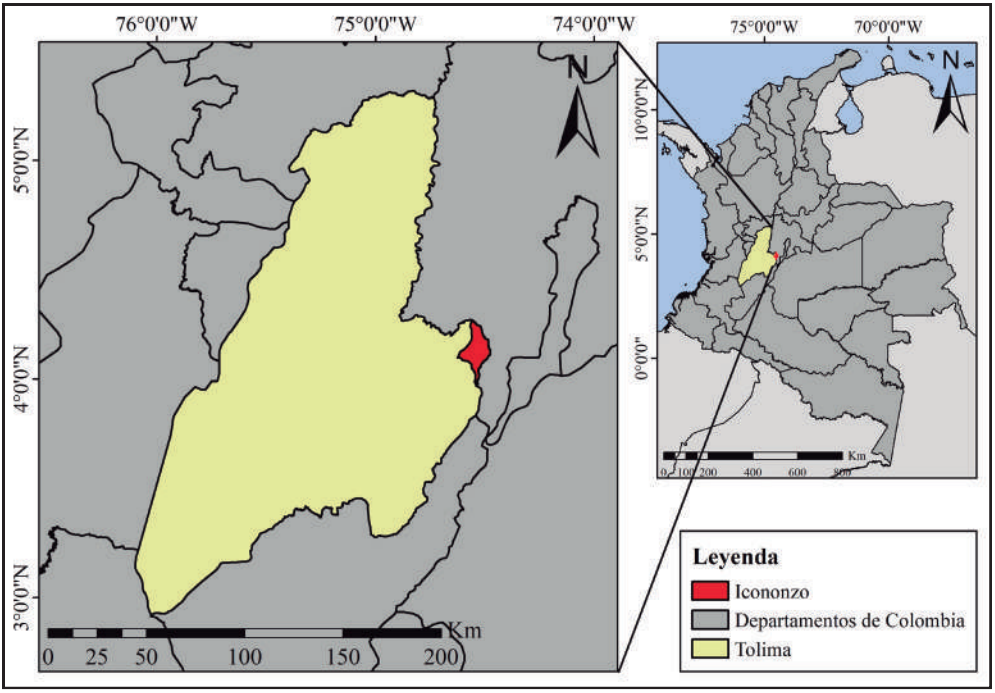
Los datos de frecuencia se codifican de la siguiente manera:

U	único (1 individuo en cada zona de muestreo)
r	rara (2 individuos)
+	ocasional (3 - 5 individuos)
++	frecuente (> 5 individuos)

Materiales y métodos

El estudio se llevó a cabo en la Vereda Cafrería, Municipio de Icononzo en el Departamento del Tolima, Colombia, que presenta en un rango altitudinal entre 500 y 2.000 msnm, su ubicación geográfica es 4º11’04” N, 70º27’20” S y su temperatura media es de 21ºC. Se establecieron tres zonas de estudio diferenciadas por su cobertura vegetal y por el grado de intervención antrópica que presentaban, de la siguiente forma (Figura 1):

Figura 1. Mapa del área de estudio. **a)** Municipio Icononzo-Tolima. **b)** Ubicación de las tres zonas de estudio.



1. Bosque húmedo andino (BS): N04º06'37.7" O74º34'08.8" a 1.432 msnm. Grado de intervención bajo.
2. Pastizal (PS): N04º06'39.8" O74º34'49.5" a 1.190 msnm. Grado de intervención medio.
3. Platanal (PL): N04º06'45.5" O74º34'16.6" a 1.344 msnm. Grado de intervención alto.

Se llevaron a cabo dos muestreos de seis noches cada uno, con un esfuerzo de muestreo diario de 12 horas (18:00 pm - 6:00 am) en las tres zonas de estudio establecidas durante septiembre del 2019 y enero del 2020. Los especímenes se colectaron empleando una trampa de luz LED portátil de 15 - 18 W en total (8 leds: 4 de luz ultravioleta, 2 de luz azul, 1 luz verde y 1 luz blanca) alimentado de una batería portátil (5V, 26.800 mAh). Esta luz se reflejó en una manta blanca de aproximadamente dos metros de alto por tres metros de largo lo que permitió la atracción de Heterocera de hábitos nocturnos, sistema replicado del propuesto por Brehm (2017). Los individuos se sacrificaron mediante inyección con etanol al 90% en el tórax, se curaron y montaron usando las Técnicas y Procesamiento para la Recolección, Preservación y Montaje de Mariposas en Estudios de Biodiversidad y Conservación, propuestas por Andrade, et al. (2013) y fueron depositados en la Colección de Artrópodos de la Universidad Distrital Francisco José de Caldas (CAUD-216).

La identificación taxonómica se llevó a cabo con la ayuda de un estereoscopio marca Motic SMZ siguiendo la clasificación de Lemaire (1978, 1980, 1987, 2002) para la familia Saturniidae, Becker (1995) para Megalopygidae y Hampson (1898, 1900, 1901, 1914), Watson & Goodger (1986) y Vicent & Laguerre (2014) para Arctiinae. En algunos casos se realizó la disección y extracción de genitalia acorde a la metodología adaptada de Andrade et al. (2013) y Guzmán (2022), debido a su importancia como carácter diagnóstico y se corroboraron los taxones con la ayuda de expertos nacionales e internacionales; familia Saturniidae: Lorenzo Comoglio (Colombia) y Alejandra Clavijo-Giraldo Colombia); familia Megalopygidae: Dr. Julia S. Volkova (Polonia) y subfamilia Arctiinae: Dr. Michel Laguerre (Francia).

Resultados

Se registraron un total de 175 individuos distribuidos en 50 géneros y 68 especies/morfoespecies para los grupos focales de esta investigación (Arctiinae, Megalopygidae y Satuniidae) como se muestra en la Tabla 1.

La subfamilia Arctiinae presentó 124 individuos agrupados en 50 especies/morfoespecies (71%) pertenecientes a las subtribus Arctiina, Callimorphina Ctenuchina, Euchromiina, Phaegopterina y Spilosomina. Para la familia Saturniidae, de las de las cinco subfamilias presentes en Colombia (Amarillo, 2000) se registraron: Arsenurinae, Ceratocampinae, Hemileucinae y Saturniinae, reflejadas en 34 individuos que se agrupan en 12 especies (10%). Finalmente, para la familia Megalopygidae, se registraron las subfamilias Megalopyginae y Trosiinae representadas en 17 individuos que se agrupan en 6 especies (19%).

Conclusiones

Los inventarios faunísticos desempeñan un papel crucial en la caracterización y conservación de la biodiversidad, y este estudio no es una excepción. Nuestros resultados muestran una riqueza considerable de lepidópteros en el municipio de Icononzo, Tolima. Esta riqueza taxonómica representa un punto de partida para futuras investigaciones sobre la ecología, biogeografía y conservación de estos grupos en la región. Es importante destacar que este estudio constituye el primer esfuerzo sistemático en catalogar las especies pertenecientes a las familias Megalopygidae, Saturniidae y la subfamilia Arctiinae en el departamento del Tolima, lo que subraya su relevancia como referencia inicial para investigaciones posteriores.

Un hallazgo significativo es la asociación entre el grado de intervención humana y la riqueza especies. Las zonas con menor grado de intervención mostraron una mayor cantidad de especies lo que sugiere que la conservación de hábitats menos perturbados es crucial para mantener la biodiversidad de estos grupos. En contraste, las áreas con una mayor intervención, especialmente aquellas destinadas a fines agrícolas y ganaderos, exhiben una menor riqueza, lo que resalta la importancia de mitigar las prácticas de uso del suelo para prevenir la pérdida de biodiversidad.

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Referencias

Amarillo-Suárez, A. R. (2000). Polillas Satúrnidas (Lepidoptera: Saturniidae) de Colombia. *Biota Colombiana, 1*(2), 177-186.

Andrade. G., Henao E., & Triviño P. (2013). Técnicas y Procesamiento para la Recolección, Preservación y Montaje de Mariposas en Estudios de Biodiversidad y Conservación. (Lepidoptera: Hesperoidea - Papilionoidea*). Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales, 37*(144), 312-325.

Becker, V. O. (1995). Megalopygidae. *Atlas of Neotropical Lepidoptera. Checklist: Part 2. Hyblaeoidea, Pyraloidea, Tortricoidea*. In J. B. Heppner (ed.). Association for Tropical Lepidoptera/Scientific Publishers.

Brehm, G. (2017). A new LED lamp for the collection of nocturnal Lepidoptera and a spectral comparison of light-trapping lamps. *Nota lepidopterologica, 40*, 87.

Comoglio, L., & Brechlin, R. (2023) An updated checklist of the wild silkmoths (Lepidoptera, Saturniidae) of Colombia. *ZooKeys, 1178,* 191-264. https://doi.org/10.3897/zookeys.1178.72084

Correa-Carmona, Y., Vélez-Bravo, A. H., & Wolff Echeverri, M. I. (2015). Current status of knowledge of Sphingidae Latreille, 1802 (Lepidoptera: Bombycoidea) in Colombia. *Zootaxa, 3987*(1), 1-73.

Decaëns, T., Rougerie, R., Bonilla, D., & Ramírez, L. D. (2007). Contribution to the knowledge of the Saturniidae fauna of Muzo (Boyaca, Colombia), with the redescription of *Copaxa apollinairei* Lemaire, 1978 (Lepidoptera, Saturniidae). *Nachrichten des Entomologischen Vereins Apollo, 28*(1/2), 69-75.

Diaz, J. H. (2005) The evolving global epidemiology, syndromic classification, management, and prevention of caterpillar envenoming. *American Journal of Tropical Medicine and Hygiene, 72*(3), 347-57.

Gómez, J. P. (2014). Lepidopterismo y erucismo en Colombia. *Biosalud, 13*(2), 59-83.

González, J. M., Andrade-C., G., Worthy, B., & Hernández-Baz, F. (2017). Giant butterfly moths of the Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, Colombia (Lepidoptera: Castniidae). *SHILAP Revista de lepidopterología, 45*(179), 447-456

González, J., & Hernández-Baz, F. (2017). Wasp moths (Lepidoptera: Erebidae: Ctenuchina-Euchromiina) of the Entomological Museum "Francisco Luis Gallego" (MEFLG), Medellín, Antioquia, Colombia. *Journal of the Lepidopterists' Society, 71*(2), 69-80.

Guzmán Pittman, R. (2022). Metodologías de conservación de lepidópteros en colecciones científicas. *Sagasteguiana, 10*(1), 81-96.

Hampson, G. F. (1898). *Catalogue of the Lepidoptera Phalaenae in the British Museum*. Order of the Trustees.

Hampson, G. F. (1900). *Catalogue of the Lepidoptera Phalaenae in the British Museum*. Order of the Trustees.

Hampson, G. F. (1901). *Catalogue of the Lepidoptera Phalaenae in the British Museum*. Order of the Trustees.

Hampson, G. F. (1914). *Catalogue of the Lepidoptera Phalaenae in the British Museum*. Order of the Trustees.

Hernández-Baz, F., Gamboa, J., Tabares, M., Guzmán, S., Montañez, M., & González, J. (2017). Wasp Moths (Lepidoptera: Erebidae: Ctenuchina - Euchromiina) of the Entomological Museum "Francisco Luis Gallego" (MEFLG), Medellin, Antioquia, Colombia. *Journal of the Lepidopterists' Society, 71,* 69-80.

Jaimes Niño, L. (2014). *Moth assemblage (Lepidoptera) in primary and secondary forests in "cueva de los guácharos National Park" (Huila-Colombia)*. Uniandes. http://hdl.handle.net/1992/19962.

Jiménez-Bolívar, A., Prada-Lara, L., Laurent, R., & Rougerie. R. (2021) The Wild Silkmoths (Lepidoptera: Bombycoidea: Saturniidae) of Colombia: a database of occurrence points and taxonomic checklist. *Zootaxa, 5081*(2), 151-202. https://doi.org/10.11646/zootaxa.5081.2.1

Kitching, I. J., Rougerie, R., Zwick, A., Hamilton, C., St Laurent, R., Naumann, S., Ballesteros Mejía, L., & Kawahara, A. (2018). A global checklist of the Bombycoidea (Insecta: Lepidoptera). *Biodiversity Data Journal, 6,* e22236.

Lamas, G. (2000). Estado actual del conocimiento de la sistemática de los lepidópteros, con especial referencia a la región Neotropical. *SEA Monografías tercer milenio. PrIBES, 1*, 253-260.

Lemaire, C. (1978). *Les Attacidae Americains Attacinae*. Édition Neuilly-sur-Seine.

Lemaire, C. (1980). *Les Attacidae Americains Arsenurinae*. Édition Neuilly-sur- Seine.

Lemaire, C. (1987). *Les Attacidae Americains Ceratocampinae*. Édition Neuilly-sur-Seine.

Lemaire, C. (2002). *The Saturniidae of America - Hemileucinae*. Goecke & Evers.

Muñoz, A., & Amarillo-S., A. (2010). Variación altitudinal en diversidad de Arctiidae y Saturniidae (Lepidoptera) en un bosque de niebla Colombiano. *Revista Colombiana de Entomología, 36*(2), 292-299.

Murillo-Ramos, L., Chazot, N., Sihvonen, P., Õunap, E., Jiang, N., Han, H., Clarke, J. T., Davis, R. B., Tammaru, T., & Wahlberg, N. (2021). Molecular phylogeny, classification, biogeography and diversification patterns of a diverse group of moths (Geometridae: Boarmiini). *Molecular Phylogenetics and Evolution, 162*, 107198. https://doi.org/10.1016/j.ympev.2021.10719

Pérez, P. A. (2019). *Diversidad de Polillas (Lepidoptera: Ditrysia: Erebidae, Geometridae, Megalopygidae, Noctuidae, Saturniidae, Sphingidae) del Parque Natural Chicaque, San Antonio del Tequendama, Cundinamarca* [Tesis de Licenciatura, Universidad Distrital Francisco José de Caldas]. Repositorio Institucional. https://repository.udistrital.edu.co/items/2eab4bbd-e5bb-4883-8858-2916c657db53.

Prada-Lara, L., Amarillo-Suárez, A. R., & Fagua, G. (2020). *Podalia orsilochus* (Lepidoptera: Megalopygidae): Confirmación de su presencia en Colombia y primer registro en el Chocó. *Biota colombiana, 21*(2), 94-100. https://doi.org/10.21068/c2020.v21n02a06.

Rodríguez, J. M. M., Rojas, H. D., & Bohórquez, N. C. V. (2018). Primer registro de polillas perforadoras de frutos (Lepidoptera: Erebidae) de Colombia. *Revista Colombiana de Entomología, 44*(1), 116-119.

Salazar, J. A. (1999). Datos de recolección para 16 especies de castnidos colombianos (Lepidoptera: Castniidae). *Boletín de Ciencias del Museo de Historia Natural de la Universidad de Caldas, Manizales, 3,* 43-51.

van Nieukerken, E. J., Kaila, L., Kitching, I. J., Kristensen, N. P., Lees, D. C., Minet, J., & Zwick, A. (2011). Order Lepidoptera Linnaeus, 1758. In Zhang, Z.-Q. (Ed.). Animal biodiversity: an outline of higher-level classification and survey of taxonomic richness. *Zootaxa*, *3148*(1), 212-221.

Vargas-Fonseca, S., Correa-Carmona, Y., Montes-Rodríguez, J. M., Calero-Mejía, H., & Zilli, A. (2020). Synopsis of fruit-piercing moths of the genus *Eudocima* (Lepidoptera, Erebidae) from Colombia. *ZooKeys, 953,* 85.

Vincent, B., & Laguerre, M. (2014). Catalogue of the Neotropical Arctiini Leach, [1815] (except Ctenuchina Kirby, 1837 and Euchromiina Butler, 1876) (Insecta, Lepidoptera, Erebidae, Arctiinae). *Zoosystema, 36*(2), 137-533. https;//doi.org/10.5252/z2014n2a1

Volkova, J. S. (2020). *Vadimas* Volkova, gen. n., a new genus of Megalopygidae (Insecta: Lepidoptera). *SHILAP Revis-*

ta de lepidopterología, 48(189), 31-38.

Watson, A., & Goodger D. T. (1986). Catalogue of the Neotropical Tiger moths. *Occasional papers on systematic entomology*. British Museum (Natural History).

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Figura 1. Vista dorsal de los Saturniidae de la vereda Cafrería, Icononzo, Tolima. Escala de 1 cm. **A.** *Arsenura archianassa.* **B.** *Automeris abdominalis.* **C.** *Atomeris cundinamarcensis.* **D.** *Automeris hamata.* **E.** *Automeris incarnata*. **F.** *Automeris liberia.* **G.** *Automeris tolimaensis.* **H.** *Automeris zaruma.* **I.** *Copaxa troetschi.* **J.** *Gamelia* sp01. **K.** *Rothschildia* sp01. **L.** *Syssphinx smithi.*

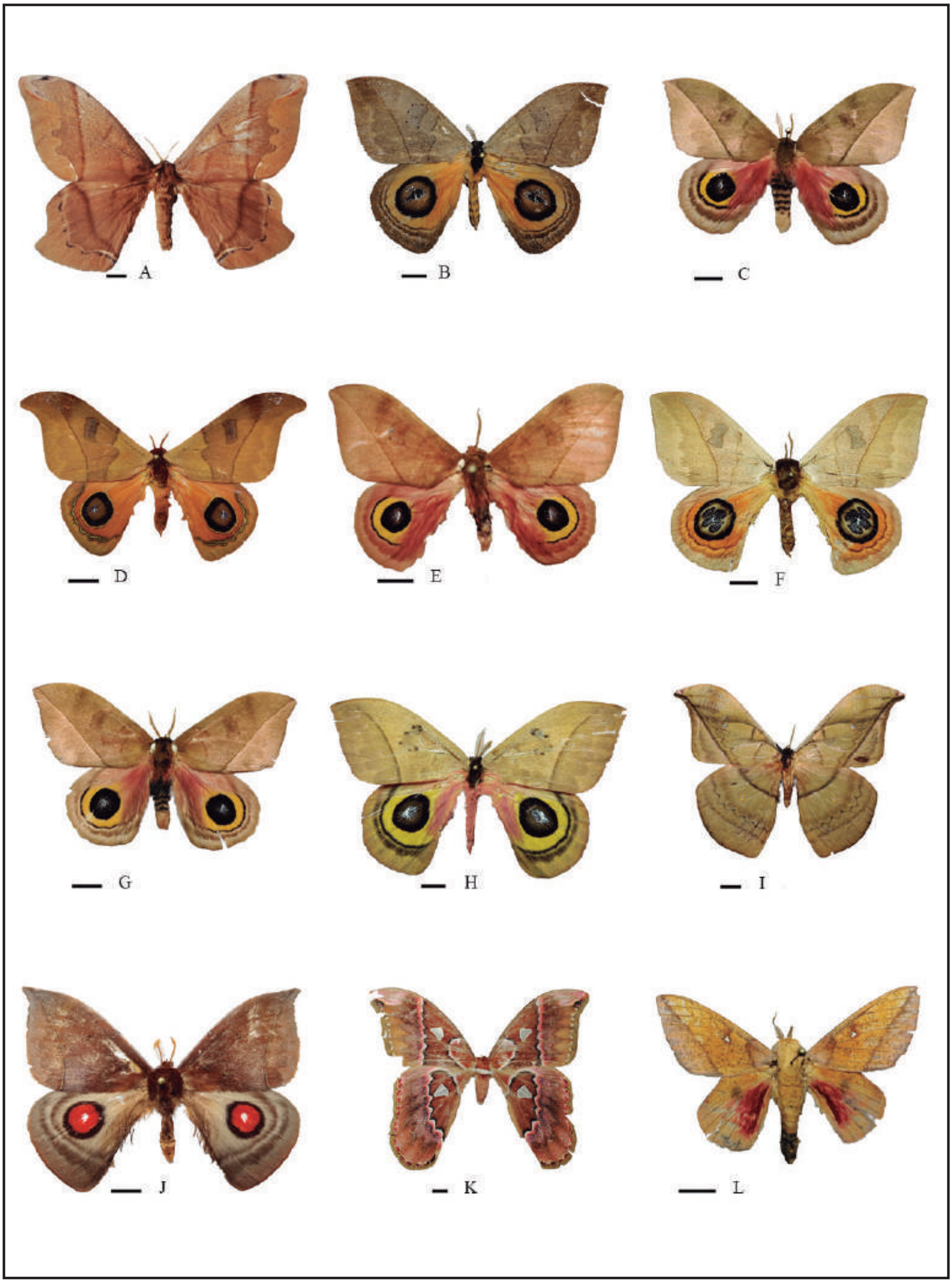

Figura 2. Vista dorsal de los Megalopygidae de la vereda Cafrería, Icononzo, Tolima. Escala de 1 cm. **A.** *Megalopyge albicollis*. **B.** *Megalopyge hina*. **C.** *Aithorape roseicornis*. **D.** *Macara argentea*. **E.** *Trosia amala*.

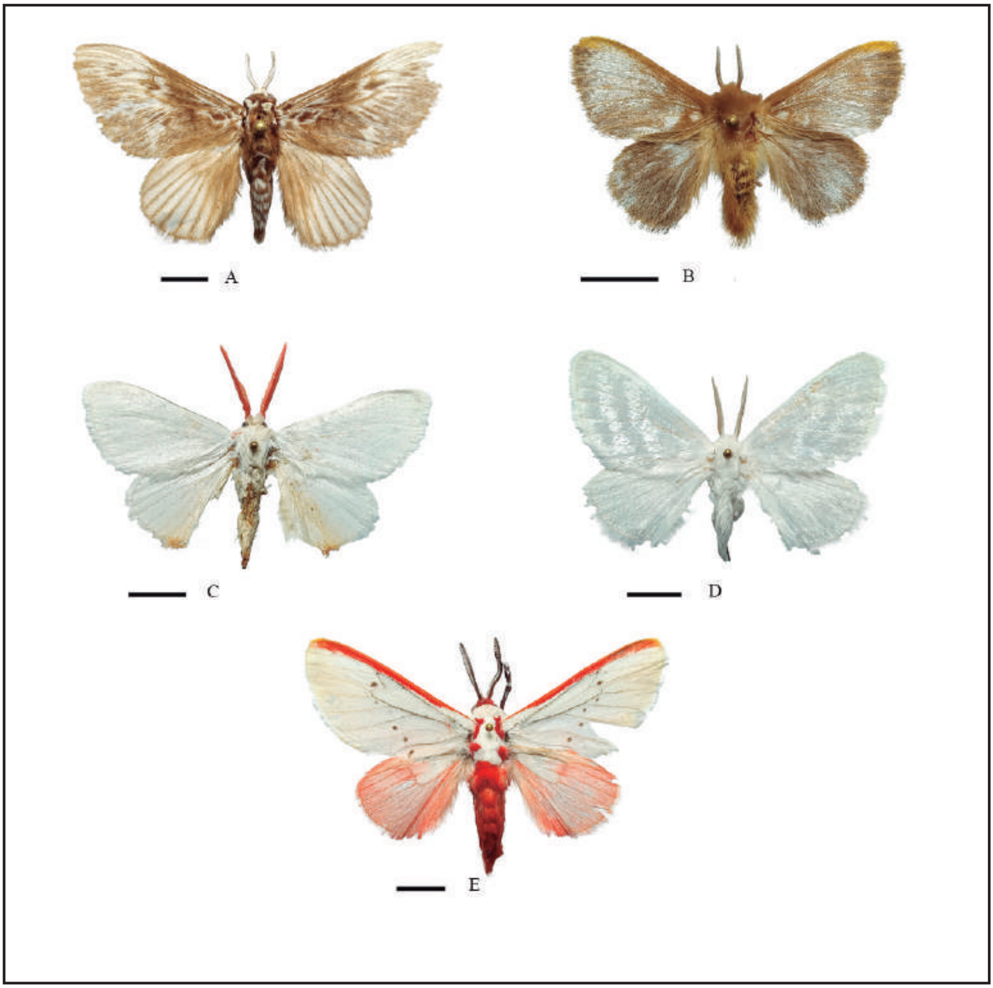

Figura 3. Vista dorsal de los Arctiinae de la vereda Cafrería, Icononzo, Tolima. Escala de 1 cm. **A.** *Aclytia ventralis*. **B.** *Amaxia osmophora*. **C.** *Bertholdia albipuncta*. **D.** *Cosmosoma stilbostictum*. **E.** *Dysschema marginalis*. **F.** *Echeta rhodocym*. G, *Eucereon casca*. H, *Horamella fassli*. **I.** *Hyalurga supposita*. **J.** *Hypercompe bricenoi*. **K.** *Idalus decisa*. **L.** *Idalus sublineata*.

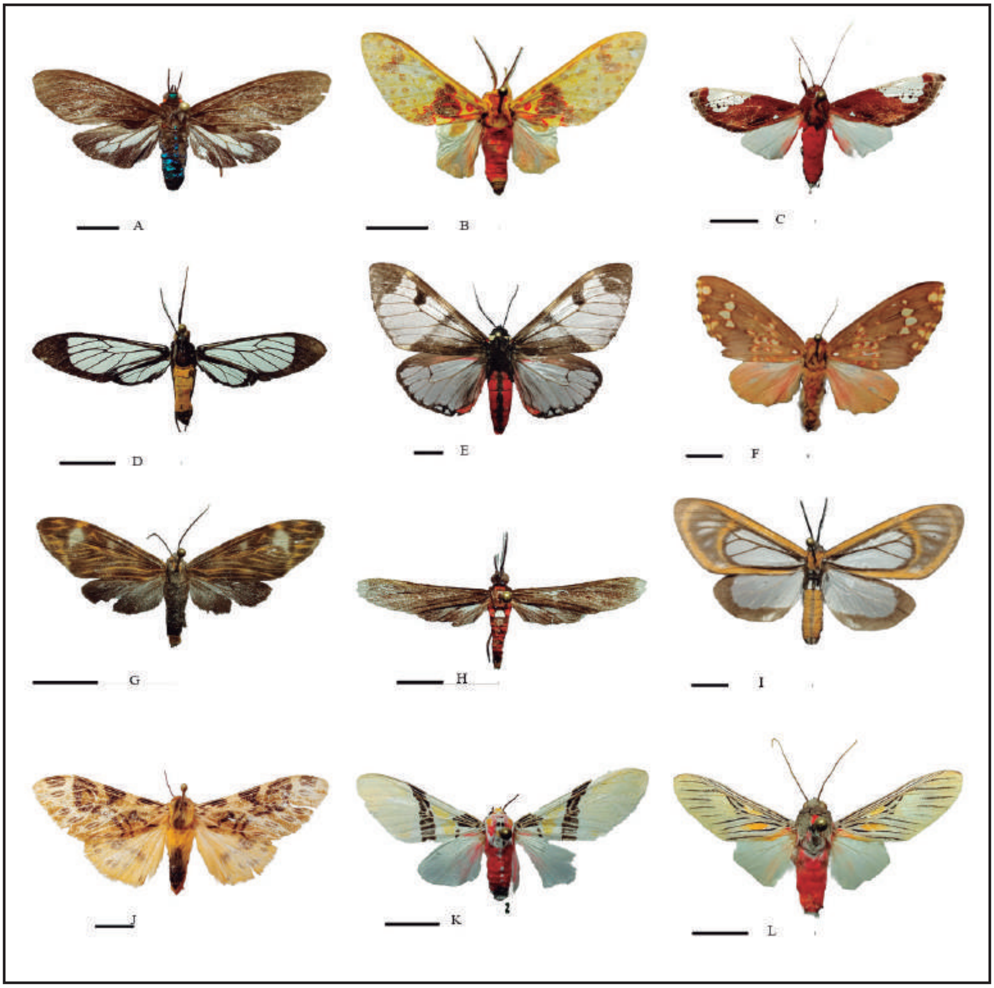

Figura 4. Vista dorsal de los Arctiinae de la vereda Cafrería, Icononzo, Tolima. Escala de 1 cm. **M.** *Isanthrene basifera.* **N.** *Lepidoneiva telephus.* **O.** *Melese veneta.* **P.** *Mesothen cardinalis.* **Q.** *Nyridela chalciope*. **R.** *Opharus belus.* **S.** *Paracles* sp01. **T.** *Pelochyta* sp2. **U.** *Phaeomolis lineata*. **V.** *Veraneacerea rufiventris*. **W.** *Viviennea moma.* **X.** *Xanthocrita bleuzeni.*

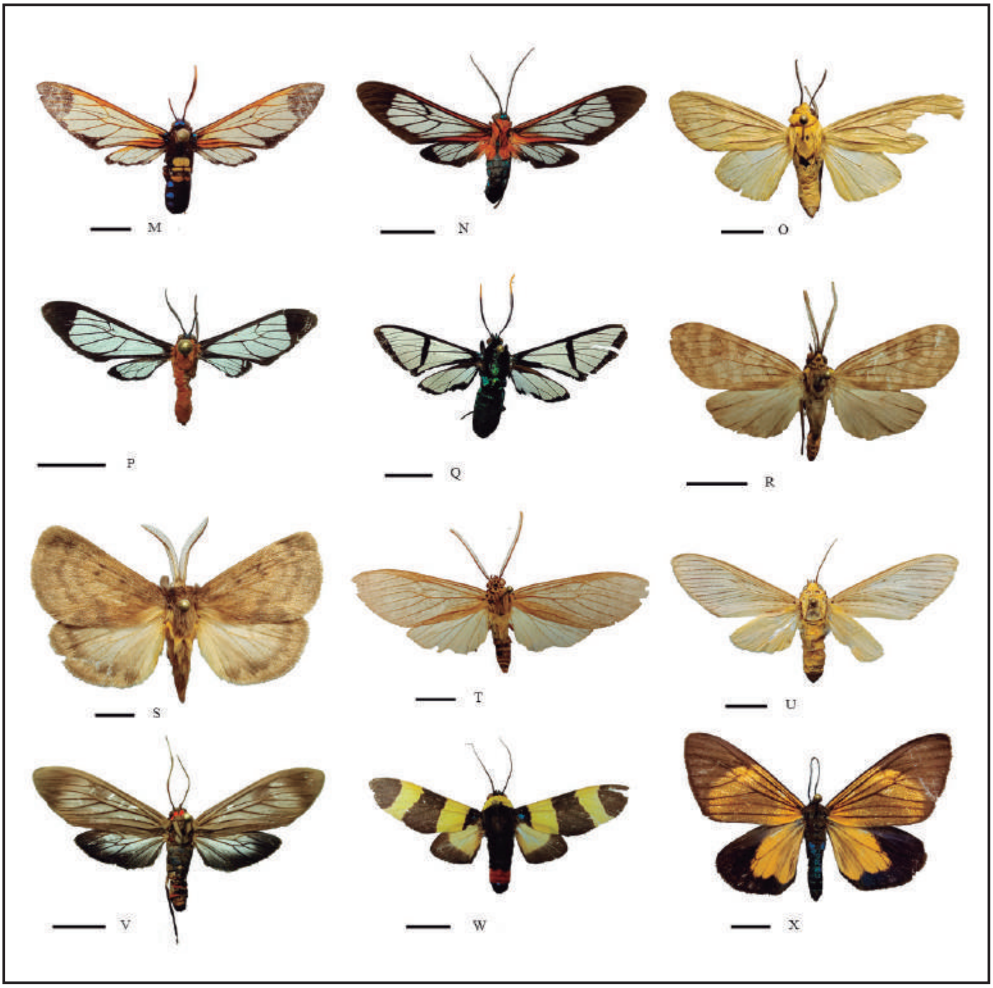

Tabla 1. Listado de familias, subfamilias y especies/morfoespecies con sus respectivas abreviaturas de frecuencias en cada zona. BS: Bosque húmedo andino, PS: Pastizal, PL: Plantaciones de *Musa paradisiaca.*

Familia	Subfamilia	Género	Especie	BS	PS	PL
Erebidae	Arctiinae	*Aclytia* Hübner, [1819]	*Aclytia ventralis* Guérin-Méneville, 1843	u		r
		Agaraea Herrich-Schäffer, 1855	*Agaraea citrinotincta* Rothschild, 1909	u		
			Agaraea longicornis Herrich-Schäffer, [1855]			u
		Amaxia Walker, 1855	*Amaxia osmophora* Hampson, 1901			u
		Amphelarctia (Schaus, 1911)	*Amphelarctia priscilla* (Schaus, 1911)			u
		Bertholdia Schaus, 1896	*Bertholdia albipuncta* Schaus, 1896			u
		Carales Walker, 1855	*Carales astur* (Cramer, 1777)	r		
		Cosmosoma Hübner, [1823]	*Cosmosoma stilbostictum* (Butler, 1876)	u	u	u
		Dycladia Felder, 1874	*Dycladia correbioides* (Felder, 1869)		u	
		Dysschema Hübner, [1818]	*Dysschema marginalis* (Walker, 1855)		u	
		Echeta Herrich-Schäffer, [1855]	*Echeta rhodocyma* (Hampson, 1909)	r		u
		Elysius Walker, 1855	*Elysius* sp01	u		
		Episcepsis Butler, 1877	*Episcepsis* sp01			u
		Eucereon Hübner, [1819]	*Eucereon facundum* Draudt, 1917			u
			Eucereon casca Dognin, 1894	u		
			Eucereon costulata (Herrich. Schäffer, [1855])			u
			Eucereon sp01	r		
		Gloora Grados, 2018	*Gloora* sp01	u		
		Halysidota Hübner, [1819]	*Halysidota* sp01			u
		Heliura Butler, 1876	*Heliura* sp01	u		
		Horama Hübner, [1819]	*Horama panthalon* (Fabricius, 1793)	u		
		Horamella Draudt, 1915	*Horamella fassli* Draudt, 1915	r		
		Hyalurga Hübner, [1819]	*Hyalurga supposita* Hering, 1925		u	u
		Hypercompe Hübner, [1819]	*Hypercompe bricenoi* (Rothschild, 1909)	+		
		Hypercompe Hübner, [1819]	*Hypercompe bricenoi* (Rothschild, 1909)	+		

Erebidae	Arctiinae	*Idalus* Walker, 1855	*Idalus decisa* (Rothschild, 1917)			u
			Idalus sublineata (Rothschild, 1917)	++		
		Isanthrene Hübner, [1819]	*Isanthrene basifera* Walker, [1865]	+	u	u
		Ischnocampa Felder, 1874	*Ischnocampa* sp01	u		
		Ixylasia Butler, 1876	*Ixylasia trogonoides* (Walker, 1864)	u		
		Lepidoneiva Travassos, 1940	*Lepidoneiva telephus* (Walker, 1854)	r		u
		Lophocampa Harris, 1841	*Lophocampa* sp01	u		u
		Melese Walker, 1854	*Melese veneta* (Dognin, 1901)	+		u
		Mesothen Hampson, 1898	*Mesothen cardinalis*	r	u	
			Mesothen sp01	u		
		Nelphe Herrich-Schäffer, 1858	*Nelphe mara* (Kaye, 1914)		u	
		Nyridela Lucas, 1857	*Nyridela chalciope* (Hübner, 1827)			u
		Opharus Walker, 1855	*Opharus belus* Druce, 1897	++		
		Paracles Walker, 1855	*Paracles* sp01		u	+++
			Paracles sp02			u
		Pareuchaetes Grote, [1866]	*Pareuchaetes* sp01			u
		Pelochyta Hübner, [1819]	*Pelochyta fassli* Rothschild, 1911	u		
			Pelochyta cinerea (Walker, 1855)	+		r
			Pelochyta misera Schaus, 1911	u		
		Phaeomolis Hampson, 1901	*Phaeomolis lineata* Hampson, 1901		u	u
		Punctumtergum Cerda, 2020	*Punctumtergum maia* (Druce, 1884)		r	
		Thysanoprymna Butler, 1875	*Thysanoprymna* sp01		u	u
		Utetheisa Hübner, [1819]	*Utetheisa ornatrix* (Linnaeus, 1758)		u	
		Veraneacerea Cerda, 2020	*Veraneacerea rufiventris* (Schaus, 1894)	+		
		Xanthocrita Laguerre, 2017	*Xanthocrita bleuzeni* (Toulgoët, 1990)	++		

Megalopygidae	Megalopyginae	*Megalopyge* Hübner, [1820]	*Megalopyge albicollis* (Walker, 1855)		u	
			Megalopyge hina (Dognin, 1911)	+	+	
	Trosiinae	*Aithorape* Hopp, 1927	*Aithorape roseicornis* (Dognin, 1899)		u	
		Macara Dognin, 1911	*Macara argentea* (Dognin, 1911)	r		u
			Macara henrichi (Hopp, 1928)	u		
		Trosia Hübner, [1820]	*Trosia amala* (Dyar, 1910)		u	
Saturniidae	Arsenurinae	*Arsenura* Duncan, 1841	*Arsenura archianassa* (Draudt, 1930)	r	u	u
	Ceratocampinae	*Syssphinx* Hübner, [1819]	*Syssphinx smithi* (Draudt, 1930)		u	
	Hemileucinae	*Automeris* Hübner, [1819]	*Automeris abdominalis* (Felder & Felder, 1874)	u		
			Automeris cundinamarcensis (Brechlin & Meister, 2011)	u		
			Automeris hamata (Schaus, 1906)			u
			Automeris incarnata (Walker, 1865)	r		u
			Automeris liberia (Cramer, 1780)	u		
			Automeris tolimaiensis (Brechlin & Meister, 2011)	+		
			Automeris zaruma (Schaus, 1898)	+		
		Gamelia Hübner, [1819]	*Gamelia* sp01	+		
	Saturniinae	*Copaxa* Walker, 1855	*Copaxa troetschi* (Druce, 1886)	++	u	
		Rothschildia Grote, 1896	*Rothschildia* sp.	r		

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Primeros registros de *Anteos maerula* (Fabricius, 1775) en los Páramos de Colombia: con notas sobre su sistemática y biogeografía (Lepidoptera: Pieridae, Coliadinae)

Óscar Mahecha-J., Vanessa Díaz-S., Óscar Jaime,
Yeison Vega-Garrido & M. Gonzalo Andrade-C.

Resumen

El género *Anteos* Hübner, [1819] y la especie *Anteos maerula* (Fabricius, 1775) se reportan por primera vez en un ecosistema de Páramo en Colombia. Se registró la presencia de esta especie en varias localidades: el Páramo de la Cuchilla El Tablazo en Subachoque, Cundinamarca; el Páramo de Guerrero en Cáchira, Norte de Santander; el Páramo Sabana Rubia y el Cerro Pintado en la Serranía del Perijá, Cesar; y el Páramo de García en Pamplona, Norte de Santander. Además, se amplía su rango altitudinal en Colombia hasta los 3.532 m, superando el límite máximo previamente reportado de 1.000 m. Asimismo, se encontró que *A. maerula* posee un rango térmico más amplio en comparación con *A. menippe* (Hübner, [1818]) y *A. clorinde* (Godart, [1824]), lo que podría facilitar su dispersión en diversos hábitats. Esto sugiere que emplea estrategias como el amortiguamiento térmico y la tolerancia térmica para enfrentar las fluctuaciones de temperatura. Se propone la relación filogenética de (*A. maerula* + *A. menippe*) + *A. clorinde*. Sin embargo, es necesario profundizar en el estudio de la especie y del género en general para comprender mejor su autoecología, sus relaciones sistemáticas y sus patrones biogeográficos. Este estudio resalta la significativa brecha en el conocimiento de la fauna de Lepidoptera en varias regiones de Colombia y subraya la necesidad de fomentar investigaciones en distintos ecosistemas del país. Del mismo modo, se enfatiza el papel fundamental de las colecciones científicas y las bases de datos sobre Biodiversidad en la conservación del patrimonio natural y en el avance del conocimiento científico.

Palabras clave: Lepidoptera, Pieridae, Coliadinae, *Anteos*, patrones de distribución, relaciones filogenéticas, rango altitudinal, Páramos, Andes Colombianos, Colombia.

First records of *Anteos maerula* (Fabricius, 1775) in the Páramos of Colombia: with notes on its systematic and biogeography (Lepidoptera: Pieridae, Coliadinae)

Abstract

The genus *Anteos* Hübner, [1819] and the species *Anteos maerula* (Fabricius, 1775) are reported for the first time in a Páramo ecosystem in Colombia. The presence of this species was recorded in several locations: the Páramo de la Cuchilla El Tablazo in Subachoque, Cundinamarca; the Páramo de Guerrero in Cáchira, Norte de Santander; the Páramo Sabana Rubia and Cerro Pintado in the Serranía del Perijá, Cesar; and the Páramo de García in Pamplona, Norte de Santander. In addition, its altitudinal range in Colombia has been extended to 3,532 m, exceeding the previously reported maximum limit of 1,000 m. It was also found that *A. maerula* has a wider temperature range than *A. menippe* (Hübner, [1818]) and *A. clorinde* (Godart, [1824]), which could facilitate its dispersal in diverse habitats. This suggests that it employs strategies such as thermal buffering and thermal tolerance to cope with temperature fluctuations. The phylogenetic relationship of (*A. maerula* + *A. menippe*) + *A. clorinde* is proposed. However, further study of the species and the genus in general is necessary to better understand its autoecology, systematic relationships, and biogeographic patterns. This study highlights the significant gap in knowledge of Lepidoptera fauna in several regions of Colombia and underscores the need to promote research in different ecosystems of the country. Similarly, it emphasizes the fundamental role of scientific collections and biodiversity databases in the conservation of natural heritage and the advancement of scientific knowledge.

Keywords: Lepidoptera, Pieridae, Coliadinae, *Anteos*, distribution patterns, phylogenetic relationships, altitudinal range, Páramos, Colombian Andes, Colombia.

Introducción

El género *Anteos* Hübner, [1819] (Pieridae, Coliadinae) comprende especies de tamaño mediano a grande, con envergaduras que suelen oscilar entre los 60 y 100 mm, caracterizándose por presentar el ángulo apical de las alas anteriores agudo (Torres, 1986; DeVries, 1987). Los patrones de coloración alar varían según la especie y el sexo, pero generalmente presentan tonos entre blancos, amarillos, naranjas o verdes pálidos, las hembras presentan dimorfismo correlacionado con las épocas secas y húmedas (DeVries, 1987; LeCrom et al. 2004). Además, las especies del género *Anteos* presentan hábitos generalistas como visitantes de inflorescencias de Verbenaceae, Fabaceae (Leguminosae), Euphorbiaceae, Bromeliaceae, Caesalpinaceae y Apocynaceae (Nieves-Uribe et al. 2016) y son especies fitófagas y de una gran importancia en procesos de polinización (De Vries, 1987; Beccaloni et al. 2008; Nieves-Uribe et al. 2016).

El género se encuentra distribuido a lo largo del Neotrópico y está conformado por tres especies, las cuales se distribuyen en Colombia: *A. clorinde* (Godart, [1824]), *A. menippe* (Hübner, [1818]) y *A. maerula* (Fabricius, 1775) (Constantino, 2004; Nieves-Uribe et al. 2016; Salazar, 2018), siendo esta última una especie poco conocida y restringida a bosques secos y áridos tropicales del país, en especial a la costa atlántica colombiana, presentando una distribución altitudinal desde el nivel del mar hasta los 1.000 m. (Torres, 1986; DeVries, 1987; Constantino, 2004; LeCrom, et al. 2004; Nieves-Uribe et al. 2016; Salazar, 2018). Es una de las especies más grandes dentro de la familia Pieridae en términos de tamaño (DeVries, 1987; LeCrom et al. 2004). Los adultos de *A. maerula* presentan un patrón de coloración variable, pero generalmente sus alas muestran tonos claros, entre el amarillo y el verde, con algunas variaciones en el borde. Los machos son especialmente más coloridos, exhibiendo un amarillo en la parte dorsal y un verde en la cara ventral. Esta coloración no solo tiene la función de atraer a las hembras, sino que también actúa como un mecanismo de defensa frente a los depredadores, ya sea mediante el camuflaje o la exhibición de colores llamativos (DeVries, 1987; LeCrom et al. 2004; Salazar, 2018).

El reporte de los primeros registros de *A. maerula* en los páramos de Colombia, basados en revisión de especímenes alojados en algunas colecciones científicas del país y bases de datos sobre biodiversidad, son de gran importancia dado a que amplía significativamente el conocimiento sobre la distribución geográfica de esta especie en el país. Su presencia, no solo en páramos, sino también en ecosistemas de alta montaña, sugiere que la especie podría estar adaptándose a nuevas condiciones ambientales, posiblemente debido a cambios climáticos o alteraciones en los ecosistemas (IPCC, 2013; 2014; Romo et al. 2013; Meineke et al. 2018; Méndez-Zambrano & Fajardo-Medina, 2024; Murillo-P. et al. 2024). Finalmente, esta revisión resalta la falta de estudios en diversas regiones geográficas de Colombia y pone de manifiesto la necesidad de fomentar la investigación en los diferentes ecosistemas del país, con el fin de aumentar nuestro conocimiento sobre la diversidad y distribución de los Lepidoptera en Colombia. Además, subraya la importancia crucial de las colecciones científicas para la preservación del patrimonio natural y el avance del conocimiento científico, lo cual es fundamental para desarrollar estrategias de conservación (Simmons & Muñoz-Saba, 2005; Delgadillo & Góngora, 2009; Giraldo et al. 2012; Meineke et al. 2018; Pertuz-Méndez, 2022).

Métodos

Recopilación de información: Para llevar a cabo este estudio, se emplearon diversas fuentes de información con el fin de obtener registros actualizados sobre el género *Anteos* y en especial sobre *A. maerula* en las diversas regiones de Colombia. En primer lugar, se obtuvieron datos de ocurrencia para la especie de las siguientes colecciones científicas del país:

ICN-ENT.: Colección Nacional de Insectos del Instituto de Ciencias Naturales ICN de la de la Universidad Nacional de Colombia.

CAUD: Colección de Artrópodos y otros Invertebrados de la Universidad Distrital Francisco José de Caldas, Bogotá, Colombia.

MHN-UPN: Colección de Entomología, Museo de Historia Natural de la Universidad Nacional Pedagógica, Bogotá, Colombia.

IAvH-E: Colección de Entomología del Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, Bogotá, Colombia.

MLS: Colección de Invertebrados, Museo de Historia Natural de la Universidad de la Salle, Bogotá, Colombia.

ANDES-E: Colección de Entomología, Museo de Historia Natural de la Universidad de los Andes, Bogotá, Colombia.

En segundo lugar, para la búsqueda de información sobre el género *Anteos*, en especial sobre la especie *A. maerula* en Colombia, se consultaron diversas bases de datos científicas y repositorios académicos. Se utilizaron plataformas como Scopus, SciELO, Web of Science, BioOne, entre otras, para acceder a publicaciones indexadas que incluyen estudios sistemáticos, ecológicos y biogeográficos. Además, se revisaron repositorios de universidades nacionales, donde se encuentran tesis, informes técnicos y otros documentos relevantes que no siempre están disponibles en revistas científicas tradicionales. Esta estrategia permitió realizar una revisión integral y complementar la información disponible para las distintas regiones del país (Torres, 1986; Constantino, 2004; LeCrom, et al. 2004; Camero & Calderón, 2007; Ríos-Málaver, 2007; Arenas- Jaramillo et al. 2009; Ospina-López et al. 2010; Torres, 2010; Boom-Urueta et al. 2013; Moreno & Acuña-Vargas, 2015; Gómez-Díaz, 2016; Nieves-Uribe et al. 2016; Mercado-Gómez et al. 2018; Salazar, 2018; Urbano et al. 2018; Ahumada-C. et al. 2020; Henao-Bañol & Gantiva-Q., 2020; Ramos-Artunduaga et al. 2021; Henao-Bañol et al. 2022; Sandoval-Bernal et al. 2022).

En tercer lugar, se consultaron plataformas de acceso abierto como el *Global Biodiversity Information Facility* (GBIF, https://www.gbif.org/) y el Sistema de Información de Biodiversidad de Colombia (SIBcolombia, https://biodiversidad.co/data/), con el objetivo de ampliar los datos de ocurrencias para el género *Anteos* en particular para *A. maerula* en Colombia.

Análisis Filogenético: Para el análisis filogenético se obtuvieron secuencias para el marcador molecular Citocromo Oxidasa I (COI) disponibles en el Sistema de Datos de Código de Barras de la Vida (The Barcode of Life Data System BOLD) (Ratnasingham & Hebert, 2007) y del GenBank (NCBI, National Centre for Biotechnology Information) (Tabla 1). Posteriormente, las secuencias se verificaron individualmente para detectar desalineaciones/ambigüedades y se recortaron a longitudes uniformes empleando el programa Geneious 7.1.3 (Biomatters LTD., 2013). El conjunto de secuencias se alineó utilizando el servicio en línea MAFFT v. 7. utilizando el método de refinamiento iterativo G-INS-i (Katoh et al. 2019). El modelo de sustitución GTR+F+G4 se determinó con ModelFinder (Kalyaanamoorthy et al. 2017) en IQ-TREE v. 2.3.6 (Minh et al. 2020) bajo el criterio de información bayesiana (BIC). A continuación, se realizó un análisis de Máxima Verosimilitud (ML) para reconstruir las relaciones filogenéticas utilizando IQ-TREE v. 2.3.6 (Minh et al. 2020). Se realizaron 1.000 réplicas de Bootstrap Ultrarrápido (UFBoot) (Minh et al. 2013; Hoang et al. 2018) para obtener el soporte de rama. El comando “-bnni” se implementó durante estos análisis para abordar las preocupaciones sobre las violaciones del modelo asociadas con el método UFBoot. El árbol con la mayor probabilidad logarítmica se visualizó utilizando Figtree v.1.4.4 (Rambaut, 2018), y se refinó en Inkscape 1.3. El soporte de rama se definió como bajo (UFBoot = < 70), moderado (UFBoot = > 70 < 95), y fuerte (UFBoot ≥ 95).

Proyección de la distribución geográfica: Se realizó una rectificación y depuración de los datos de ocurrencias para *A. maerula* obtenidos para Colombia, teniendo en cuenta que estuviera toda la información correspondiente a la información de recolecta y que las coordenadas estuvieran bien georreferenciadas, para evitar así sesgos en el análisis. Para tal fin, se usó Google Earth (Google, 2023) y ArcGIS Pro (Esri, 2023). A continuación, se procedió a proyectar en ArcGIS Pro (Esri, 2023) los datos geográficos para poder obtener la distribución geográfica de la especie para el país.

Rango altitudinal y de temperatura: En la obtención del rango altitudinal y de temperatura se siguió lo propuesto por Pyrcz et al. (2024), en donde para determinar el rango altitudinal, se utilizaron datos de altitud con una resolución espacial de 30 segundos de arco (~1 km²) obtenidos de WorldClim v.2 (Fick & Hijmans, 2017). Para la obtención del rango de temperatura, se descargaron y se sumaron datos de temperatura media entre 1979 y 2019 de CHELSA v.2.1, con la misma resolución espacial (~1 km²) (Karger et al. 2017). A partir de las coordenadas geográficas de cada registro obtenido, se calcularon los valores de altitud y de temperatura media para cada especie. Posteriormente, se generaron diagramas de caja (boxplots) para comparar los rangos altitudinales y de temperatura entre especies. Los análisis se realizaron en R (R Core Team, 2023) mediante el paquete "terra" v.1.7-65 y paquetes anexos (Hijmans et al. 2022).

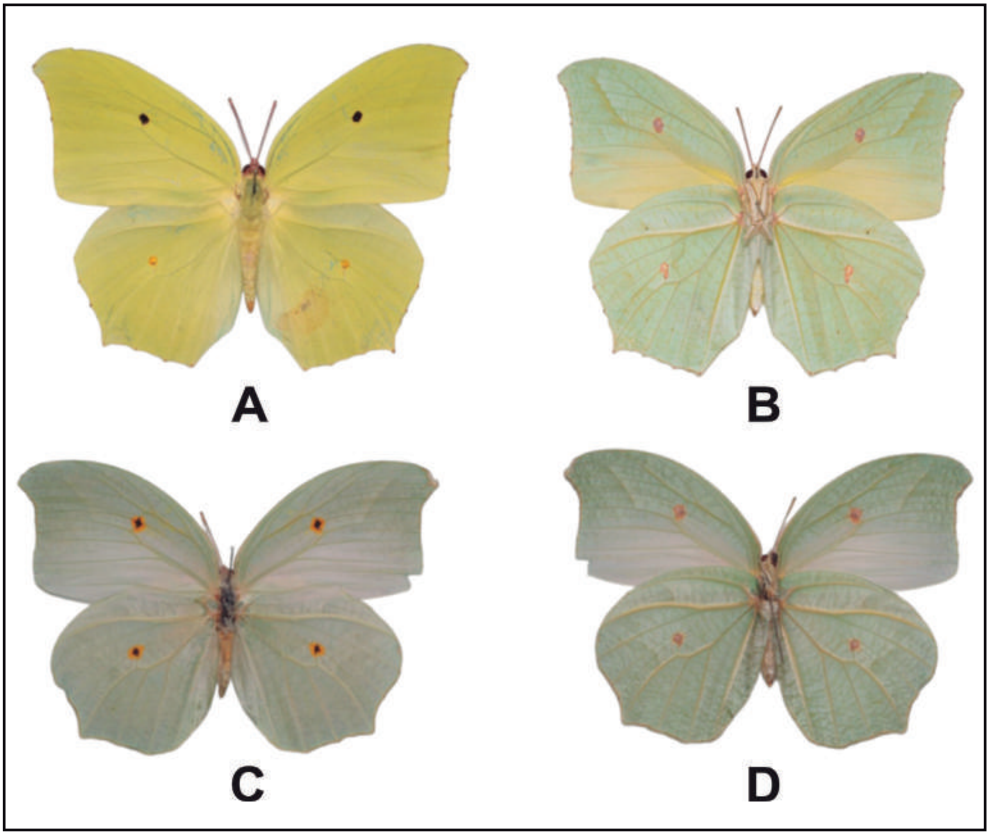
Resultados y Discusión

Notas Sistemáticas

Anteos maerula (Fabricius, 1775) **(**Figuras 1-3)

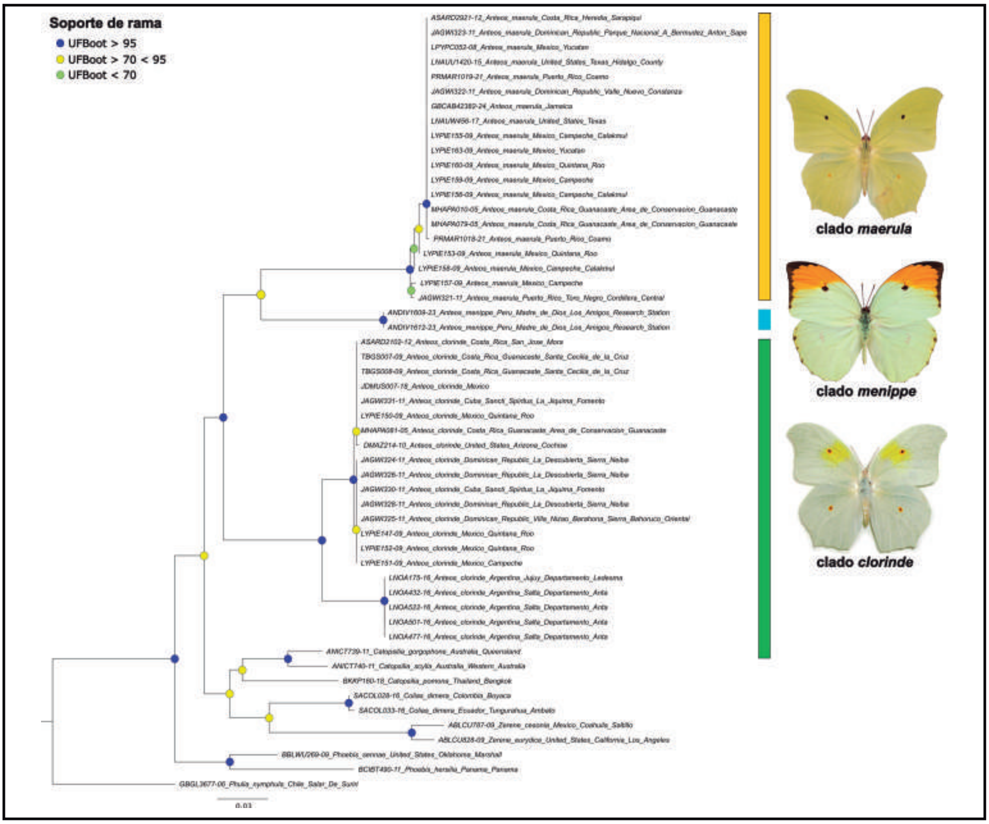
Identificación: *A. maerula* tanto la hembra como el macho presentan una amplitud alar promedio entre 43 a 55 mm (DeVries, 1987; LeCrom et al. 2004). Asimismo, esta especie presenta un dimorfismo sexual bastante marcado, puesto que el macho presenta la superficie dorsal de las alas de color amarillo con un punto negro en el extremo de la celda discal (Figura 1A-B), mientras que la hembra presenta la superficie dorsal de las alas de color blanco crema con un punto negro en el extremo de la celda discal (Figura 1C-D), (Constantino, 2004; LeCrom et al. 2004). En campo son especies que presentan un vuelo alto y bastante rápido (Torres, 1986; LeCrom et al. 2004).

Figura 1. *Anteos maerula*: **A**. Macho vista dorsal; **B**. Macho vista ventral; **C**. Hembra vista dorsal; **D**. Hembra vista ventral.



Relaciones Filogenéticas: El género hace parte del clado conformado por *Eurema* + (*Anteos* + (*Colias* + *Zerene*) según datos morfológicos (Murillo-Ramos et al. 2016) y desde una perspectiva molecular, empleando marcadores COI, 28S, wingless y EF1α, se anida en un clado formado por *Catopsilia* + ((*Colias* + *Zerene*) + (*Anteos* + (*Aphrissa* + *Phoebis*)) (Braby et al. 2006). Sin embargo, Wei et al. (2023) infirieron, desde datos mitogenómicos, que el género se encuentra dentro del clado *Phoebis + (Anteos + (Catopsilia + (Zerene + Colias)))*, siendo parte de la tribu Coliadini, corroborando la monofilia del género. Cabe resaltar que, los resultados obtenidos en nuestro análisis filogenético, empleando solo el marcador COI, se encontraron los mismos resultados conseguidos por Wei et al. (2023) (Figura 2). En cuanto a las relaciones sistemáticas de las especies del género *Anteos*, Godman & Salvin (1887-1901, p. 148) designaron a *A. maerula* como el tipo del género de Hübner, en donde seleccionaron la segunda especie de las tres citadas por Hübner (Nieves-Uribe et al. 2016). Hernández-Mejía et al. (2014), basados en un estudio coriónico (caracteres morfológicos), propusieron que *Anteos* era un grupo parafilético, puesto que proponían que *A. menippe* no hacia parte del género, sino que pertenecía al género monotípico *Rhabdodryas* Godman & Salvin, 1889 (ahora *Phoebis* acorde al estudio de Murillo-Ramos et al. (2018)). Sin embargo, el trabajo de Hernández-Mejía et al. (2014) no incluyeron a *A. menippe* dentro de los análisis coriónicos, y tampoco se hizo un análisis filogenético para soportar la parafilia del género. Posteriormente, Nieves-Uribe et al. (2016) realizaron otro estudio coriónico en el género *Anteos*, en donde incluyeron a *A. menippe*, y concluyen que el género *Anteos* es un grupo monofilético, y proponen que *A. menippe* es una especie más diferenciada, tanto por sus características genitales, algunos alares como por sus caracteres coriónicos en relación a las otras especies del género. Por último, nuestro análisis filogenético molecular, permitió corroborar la monofilia del género (UFBoot = 96). (Figura 2), confirmando lo propuesto por Nieves-Uribe et al. (2016) y Wei et al. (2023).

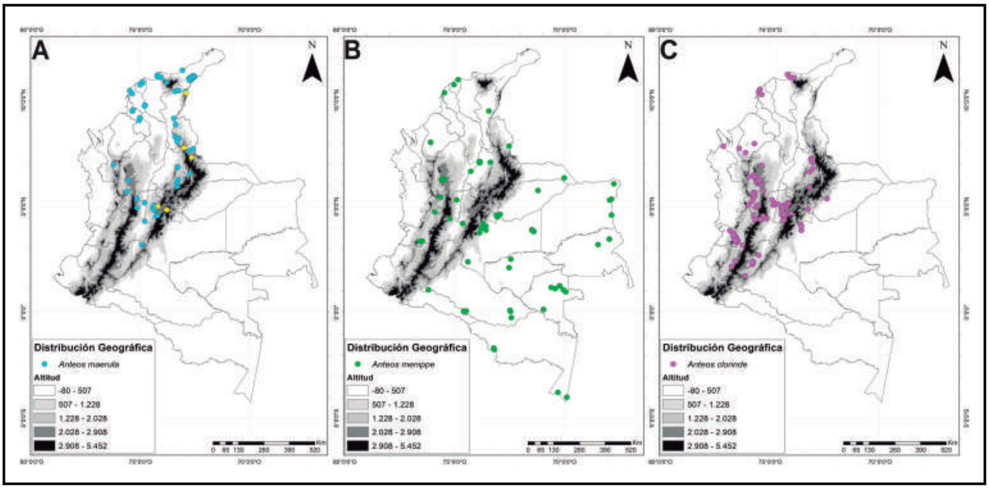
Figura 2. Reconstrucción Filogenética basado en el análisis de Máxima Verosimilitud (ML) para el género *Anteos* a partir del marcador molecular COI.



Por otra parte, actualmente no hay una filogenia en donde se muestre las relaciones sistemáticas entre las especies que componen al género *Anteos*, pero se infiere, con base en datos morfológicos, que *A. clorinde* está más relacionada a *A. maerula* que con *A. menippe* (Nieves-Uribe et al. 2016). Además, desde el reconocimiento de *Anteos* como género distinto por Godman & Salvin (1887-1901) y los estudios detallados de Klots (1929; 1931-1933), se mantuvo la idea de la relación entre *A. maerula* y *A. clorinde*, y la poca relación con *A. menippe*, al grado que a *A. menippe*, Klots (1929) le consideró bajo un subgénero distinto, *Rhodocera* Boisduval & LeConte, 1829. Así mismo, Hernández-Mejía et al. (2014) conservaron la cercanía morfológica entre *A. maerula* y *A. clorinde*, pero como ya se había mencionado, en este trabajo no incluyeron a *A. menippe* y los autores solo especularon sobre su pertenencia a *Anteos* y sus relaciones sistemáticas (Nieves-Uribe et al. 2016). No obstante, acorde a los resultados filogenéticos moleculares obtenidos en el presente estudio, en donde se incluye por primera vez secuencias genéticas para *A. menippe*, se logró observar que *A. maerula* se anida en un mismo clado como especie hermana de *A. menippe*, y no de *A. clorinde* (UFBoot = 90) (Figura 2). No obstante, es importante poder incluir más datos genéticos y morfológicos de las diferentes especies del género para poder realizar un análisis filogenético mucho más robusto e integrativo que permita corroborar las relaciones sistemáticas obtenidas dentro del género *Anteos* en la presente investigación.

Notas Biogeográficas: Conforme a la revisión realizada, se obtuvieron un total de 115 registros geográficos para *A. maerula,* 135 para *A. clorinde*, y 80 para *A. menippe*. Lo anterior, permite tener una aproximación sobre la distribución geográfica actual del género *Anteos* para Colombia, lográndose observar que *A. menippe* tiene una distribución mucho más amplia con respecto a *A. maerula* y *A. clorinde* (Figura 3). Los círculos amarillos en la Figura 3A, indican los registros en Páramos para *A. maerula*.

Figura 3. Distribución geográfica del género *Anteos* en Colombia. **A**. *A. maerula*: los círculos amarillos indican los registros en Páramos. **B**. *A. menippe*. **C**. *A. clorinde*.



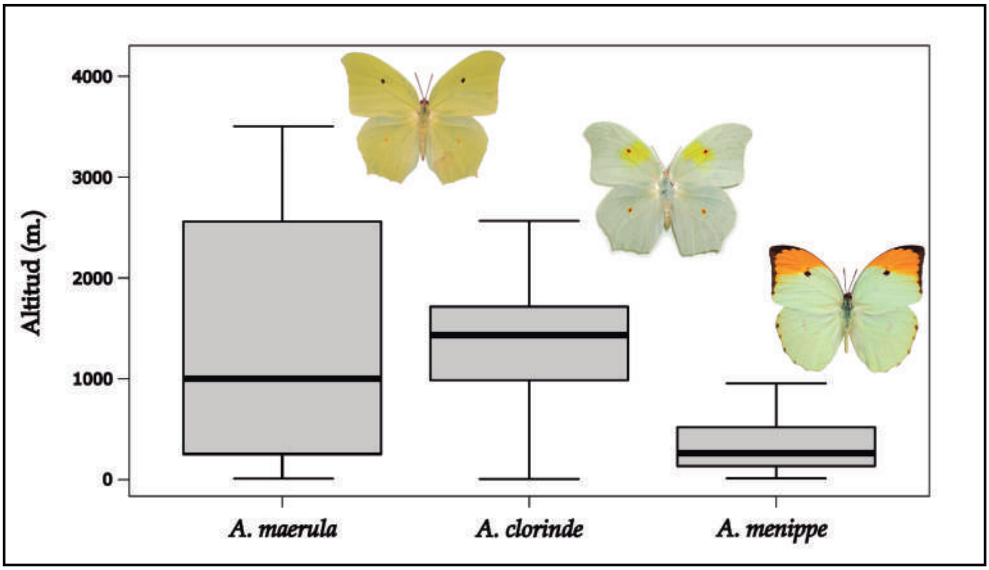
Adiciones sobre la distribución geográfica: A continuación, se muestran los nuevos registros sobre la distribución de *A. maerula* en páramos y bosques altoandinos de Colombia, los cuales representan varias localidades como el Páramo de la Cuchilla El Tablazo en Subachoque, Cundinamarca; el Páramo de Guerrero en Cáchira, Norte de Santander; el Páramo Sabana Rubia y el Cerro Pintado en la Serranía del Perijá, Cesar; y el Páramo de García en Pamplona, Norte de Santander.

Registros en Páramos: COLOMBIA, Cundinamarca, municipio de Subachoque, Vda. Pantano de Arce, Páramo Cuchilla El Tablazo, a 3.422 m., 5.012595ºN, -74.197818ºW, 1 ♂, 19-IX-2021, O. Mahecha-J. leg., ICN-MHN-L 103777. Municipio de Subachoque, Vda. Pantano de Arce, Páramo Cuchilla El Tablazo, a 3.385 m., 5.007194ºN, -74.208426ºW, 1 ♂, 19-IX-2021, Y. Vega-G. leg., ICN-MHN-L 10379. Ídem, a 3.410 m., 5.012595ºN, -74.197818ºW, 1 ♂, 10-IX-2022, O. Mahecha-J. leg., ICN-MHN-L 103778. Guasca, Complejo Páramo Grande-Chingaza, a 3.272 m., 4.841232ºN, -73.797689ºW, 1 ♂, 08-IX-2024, O. Jaime leg., CAUD. Ídem, a 3.220 m., 4.839498ºN, -73.792627ºW, 1 ♂, 08-IX-2024, O. Jaime leg., CAUD. Cesar, Manaure, Serranía del Perijá, Páramo de Sabana Rubia, a 3.150 m., 10.362347ºN, -72.911592ºW, 1 ♂, 07-X-2021, L. G. Restrepo leg., 229740112. NORTE DE SANTANDER, Cáchira, Páramo de Guerrero, a 3.296 m., 7.771439ºN, -72.993280ºW, 1 ♂, 12-IX-2024, O. Jaime leg., ICN-MHN-L 103789. Ídem, a 3.357 m., 7.767809ºN, -72.996545ºW, 1 ♂, 13-IX-2024, O. Mahecha-J. leg., ICN-MHN-L 103790. Ídem, a 3.532 m., 7.763263ºN, -72.992405ºW, 1 ♂, 13-IX-2024, O. Mahecha-J. leg., ICN-MHN-L 103791. Pamplona, Páramo de García, a 3.357 m., 7.322121ºN, -72.658407ºW, 1 ♂, 16-IX-2024, O. Jaime leg., ICN-MHN-L 103792. Ídem, 3.370 m., 7.321349ºN, -72.658558ºW, 1 ♂, 16-IX-2024, O. Mahecha-J. leg., ICN-MHN-L 103793. Ídem, a 3.397 m., 7.319325ºN, -72.659008ºW, 1 ♂, 16-IX-2024, O. Mahecha-J. leg., ICN-MHN-L 103794.

Registros en Bosque Altoandino: COLOMBIA, GUAJIRA, Serranía del Perijá, Vda. Guajira, a 2.791 m., 10.428278ºN, -72.935639ºW, 1 ♂, 09-IX-2015, L. Granados leg., IAvH-ACC474. CUNDINAMARCA, Municipio de Soacha, Br. Juan Pablo II, a 2.560 m., 4.58126ºN, -74.211918ºW, 1 ♂, 26-V-2024, H. J. Herrera leg., 220612394.

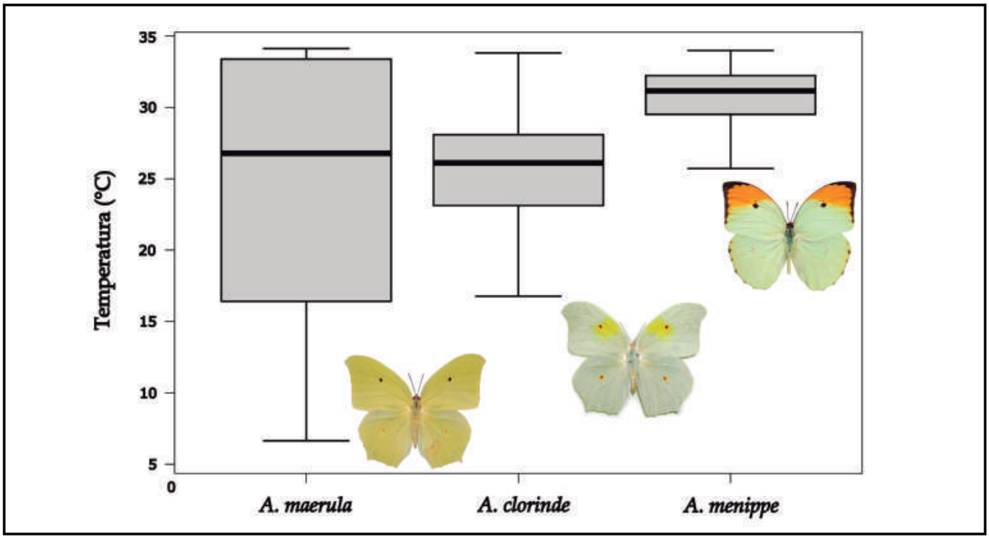
Distribución geográfica: El género *Anteos* se encuentra distribuido en toda la región Neotropical (Salazar, 2018) incluyendo a las Antillas (Nieves-Uribe et al. 2016), desde el nivel del mar hasta lugares por debajo de los 2.300 m. Por su parte, *A. maerula* y *A. clorinde* presentan una distribución geográfica más amplia a nivel mundial en comparación con *A. menippe* que sólo se encuentra distribuida en Sudamérica desde el norte de Colombia hasta Paraguay, y norte de Argentina, por debajo de los 1.800 m. (Nieves-Uribe et al. 2016). En Colombia, *A. clorinde* está presente en las tres cordilleras hasta los 2.300 m.; *A. menippe* se distribuye principalmente en la región tropical de América del Sur, tanto en zonas secas como húmedas; y *A. maerula* se registra en bosques secos y áridos tropicales del país, en especial en la Costa Atlántica Colombiana desde el nivel del mar hasta los 1.000 m. (DeVries, 1987; Constantino, 2004; LeCrom et al. 2004; Nieves-Uribe et al. 2016; Salazar, 2018). Por lo tanto, con la presente revisión se amplía el rango altitudinal de *A. maerula* a 3.532 m., y se registra la especie a ecosistemas de páramos y bosques altoandinos en Colombia. A su vez, se aumenta también el rango altitudinal de *A. clorinde* a 2.873 m. Por su parte, se encontró que la altura máxima para *A. menippe* es de 1.180 m. (Figura 4).

Figura 4. Rango Altitudinal para las especies del género *Anteos* en Colombia (*Boxplot* con mediana y cuartiles).



Por otro lado, se evidencia que *A. maerula* presenta un rango de temperatura más amplio (6ºC - 34ºC), en comparación a *A. clorinde* (14ºC - 34ºC) y *A. menippe* (25ºC - 34ºC) (Figura 5). Lo anterior permite inferir que *A. maerula* presenta una mayor tolerancia térmica lo que le permite habitar en diferentes tipos de ecosistemas, desde zonas cálidas y secas hasta bosques altoandinos y páramos. Basado en lo anterior, deducimos que es posible que *A. maerula* también tenga hábitos migratorios como sucede en *A. clorinde* y otros Pieridae (Negret, 1988; Lamas, 2004; LeCrom et al. 2004; Braby et al. 2006; Hernández-Mejía et al. 2014), y el presentar un rango de temperatura tan amplio, le permitiría sin problema dispersarse en diferentes tipos de hábitats.

Figura 5. Rango de Temperatura para las especies del género *Anteos* en Colombia (*Boxplot* con mediana y cuartiles).



Por otra parte, se ha reportado que las larvas de *A. maerula* se alimentan de plantas de la familia Caesalpinaceae y Fabaceae especialmente de las especies *Senna bicapsularis* (L.) Roxb., *Senna atomaria* (L.) H.S.Irwin y Barneby, *Senna papillosa* (Britton & Rose) H. S. Irwin & Barneby, y *Senna hayesiana* (Britton & Rose) H. S. Irwin & Barneby (Braby & Trueman, 2006; Robinson et al. 2010). Sin embargo, no se han observado estas especies en las áreas de Páramo en donde se recolectaron los ejemplares, lo que permite inferir que *A. maerula* no se está estableciendo en el páramo, sino que podría estar usando el área como parte de una posible ruta de dispersión, permitiendo conectar poblaciones en diferentes zonas de Colombia, lo que estaría apoyando lo mencionado anteriormente sobre que *A. maerula* podría presentar hábitos migratorios. No obstante, aún es necesario realizar estudios acerca de este tema en la especie para poder corroborar lo propuesto aquí.

A su vez, al observar la información de recolecta en las etiquetas de algunos ejemplares, se logró evidenciar que, por ejemplo, los ejemplares recolectados en el Páramo de la Cuchilla El Tablazo en Cundinamarca, las fechas de captura correspondían al mes de septiembre del año 2021 y 2022, el registrar varios ejemplares de *A. maerula* en diferentes años, pero en el mismo mes y el cual corresponde a la época seca en esta zona (Montero-A. & Ortiz-P., 2013), permite inferir que la época seca podría estar favoreciendo la presencia de *A. maerula* en este Páramo, y dado al amplio rango de temperatura que presenta *A. maerula* (Figura 5), es posible que esté utilizando el amortiguamiento térmico y la tolerancia térmica como estrategias alternativas para hacer frente al aumento de la temperatura, como se ha reportado en otras especies de mariposas tropicales pertenecientes a la familia Pieridae (Ej. *Phoebis argante* (Fabricius, 1775)), en donde se encontró que esta familia presentaba los valores más altos de amortiguación térmica en comparación a las otras familias de Lepidoptera (Ashe-Jepson et al. 2023). Del mismo modo, se ha reportado que especies más grandes tienden a tener una mejor capacidad de amortiguación térmica que otras especies pequeñas (Bladon et al. 2020; Ashe-Jepson et al. 2023). Además, los insectos grandes generalmente experimentan fluctuaciones más pequeñas en la temperatura corporal que los insectos pequeños (Gilchrist, 1990; Kemp & Krockenberger, 2004; Ashe-Jepson et al. 2023), por lo que el gran tamaño debería dar como resultado una mayor capacidad de amortiguación térmica. En condiciones frías, los Papilionoidea de alas grandes también pueden usar las grandes áreas superficiales de sus alas para absorber calor, lo que les permite un calentamiento y una actividad rápida. Igualmente, las alas grandes aumentarían la movilidad de estas especies, lo que les permitiría acceder a una mayor variedad de microclimas en un área más amplia que las especies más pequeñas (Ashe-Jepson et al. 2023).

De igual manera, Bladon et al. (2020) también encontraron alguna evidencia de que el color de las alas influye en las capacidades de amortiguación térmica de las especies de Papilionoidea que habitan en zonas templadas. Sin embargo, esto se atribuyó a la distribución de colores entre familias. Se sabe que el color influye en las tasas de calentamiento de las especies y, estudios anteriores, encontraron que las especies oscuras tendían a experimentar cambios más rápidos en la temperatura corporal que las más claras (Watt, 1968; Ashe-Jepson et al. 2023). Estas fluctuaciones rápidas permitirían que las más oscuras se calentaran más rápido en condiciones frías e irradiaran calor y se enfriaran más rápidamente en condiciones cálidas. Como tal, los rasgos morfológicos pueden beneficiar la capacidad de amortiguación térmica de las especies (Ashe-Jepson et al. 2023). En áreas tropicales, las especies más claras, como *A. maerula*, pueden beneficiarse del aumento de las temperaturas, ya que les permite ganar calor y activarse más rápidamente. No obstante, además de calentarse más lentamente, las más claras también son menos capaces de perder calor a temperaturas ambientales altas en comparación con las más oscuras (Watt, 1968; Khazan et al. 2022), y se ha encontrado que estas especies de colores claros tienen una tolerancia térmica menor que las más oscuras en el trópico, lo que las expone a un mayor riesgo de sobrecalentamiento con el aumento de las temperaturas (Ashe-Jepson et al. 2023). En este sentido, se ha demostrado que diversas especies poseen estrategias de termorregulación específicas, determinadas por aspectos comportamentales y morfológicos. Estos mecanismos podrían reducir su vulnerabilidad frente al aumento de la temperatura, lo que sugiere que las especies neotropicales no son necesariamente más susceptibles al calentamiento climático que las especies de regiones templadas (Laird-Hopkins et al. 2023).

También se ha descubierto que aspectos similares de la morfología de los Papilionoidea que afectan la amortiguación térmica influyen en la tolerancia térmica, por ejemplo, una relación positiva entre la tolerancia térmica y la masa corporal, como es el caso de *Bicyclus anynana* (Butler, 1879) (Klockmann et al. 2017), una especie de Nymphalidae que se encuentra principalmente en el este de África, desde el sur de Sudán hasta Eswatini y que habita principalmente en áreas boscosas, vuela cerca del suelo (Molleman et al. 2008) y los machos, tienden a tener una envergadura alar de 35 a 40 mm y las hembras de 45 a 49 mm (Brakefield, et al. 2009). En esta especie se reportó que individuos grandes tienen una mayor tolerancia térmica que los individuos pequeños y un tamaño corporal grande también puede resultar en fluctuaciones reducidas en la temperatura corporal, lo que implica que los individuos más grandes pueden tener una mayor capacidad para mantener la temperatura corporal dentro de límites tolerables y una mayor capacidad de amortiguación térmica (Klockmann et al. 2017), lo que podría estar sucediendo en la especie *A. maerula*, y posiblemente también en *A. clorinde*.

Conclusiones

Finalmente, el presente estudio corrobora la monofilia del género *Anteos*, y se propone la relación filogenética de (*A. maerula* + *A. menippe*) + *A. clorinde*. Adicionalmente, se presentan los primeros registros de *A. maerula* para algunos Páramos y Bosques Alto Andinos en la Cordillera Oriental en Colombia, permitiendo aumentar el rango de distribución altitudinal de *A. maerula* desde el nivel del mar hasta los 3.532 m., y de *A. clorinde* a 2.873 m. También, se encontró que *A. maerula* tiene un rango de temperatura más amplio que *A. menippe* y *A. clorinde*, lo que le permitiría dispersarse en diferentes tipos de hábitats al emplear el amortiguamiento térmico y la tolerancia térmica como estrategias para hacer frente a las fluctuaciones de temperatura. Sin embargo, es necesario realizar estudios más profundos en la especie y el género en general, para poder conocer mejor su autoecología, sus relaciones sistemáticas y sus patrones biogeográficos.

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Conflicto de interés

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Referencias

Ahumada-C., D., Segovia-Paccini, A., Ortega-Echeverría, C., Andrade-C., M. G., & Navas-S, G. R. (2020). Extension of geographical distribution of three common species of diurnal butterflies (Lepidoptera: Papilionoidea) from the Colombian Caribbean. *Intropica, 15*(1), 55-58. http://dx.doi.org/10.21676/23897864.3422

Ashe-Jepson, E., Cobo, S. A., Basset, Y., Bladon, A. J., Kleckova, I., Laird-Hopkins, B. C., Mcfarlane, A., Sam, K., Savage, A. F., Zamora, A. C., Turner, E. C., & Lamarre, G. P. (2023). Tropical butterflies use thermal buffering and thermal tolerance as alternative strategies to cope with temperature increase. *The Journal of Animal Ecology, 92*(9), 1759-1770. http://dx.doi.org/10.1111/1365-2656.13970 PMid:37438871 PMCid:PMC10953451

Arenas-Jaramillo, J. G., Moreno-Niño, A. C., & Giraldo, G. (2009). Estudio de las mariposas en la Institución Educativa Las Damas del municipio de Calamar (Guaviare, Colombia), una estrategia en la búsqueda de conciencia ambiental. *Bio-grafía, 2*(2), 79-95. https://doi.org/10.17227/20271034.vol.2num.2bio-grafia79.95

Beccaloni, G. W., Viloria, A. L., Hall, S. K., & Robinson, G. S. (2008). *Catalogue of the hostplants of the Neotropical butterflies*. Sociedad Entomológica Aragonesa.

Biomatters, LTD (2013). *Geneious v. 7.1.3.* http://www.geneious.com

Bladon, A. J., Lewis, M., Bladon, E. K., Buckton, S. J., Corbett, S., Ewing, S. R., Hayes, M. P., Hitchcock, G. E., Knock, R., Lucas, C., McVeigh, A., Menéndez, R., Walker, J. M., Fayle, T. M., & Turner, E. C. (2020). How butterflies keep their cool: Physical and ecological traits influence thermoregulatory ability and population trends. *The Journal of Animal Ecology, 89*, 2440-2450. https://doi.org/10.1111/1365-2656.13319 PMid:32969021

Boom-Urueta, C., Seña-Ramos, L., Vargas-Zapata, M., & Martínez-Hernández, N. (2013). Mariposas Hesperioidea y Papilionoidea (Insecta: Lepidoptera) en un fragmento de bosque seco tropical, Atlántico, Colombia. *Boletín Científico Museo Historia Natural, 17*(1), 149-167.

Braby, M. F., Vila, R., & Pierce, N. E. (2006). Molecular phylogeny and systematics of the Pieridae (Lepidoptera: Papilionoidea): higher classification and biogeography. *Zoological Journal of the Linnean Society, 147*(2), 239-275. https://doi.org/10.1111/j.1420-9101.2006.01109.x

Braby, M. F., & Trueman, J. W. H. (2006). Evolution of larval host plant associations and adaptive radiation in pierid butterflies. *Journal of Evolutionary Biology, 19,* 1677-1690. https://doi.org/10.1111/j.1420-9101.2006.01109.x PMid:16910997

Brakefield, P. M., Beldade, P., & Zwaan, B. J. (2009). The African butterfly *Bicyclus anynana*: a model for evolutionary genetics and evolutionary developmental biology. *Cold Spring Harbor Protocols*, (5), pdb-emo122. https://doi.org/10.1101/pdb.emo122. PMid:20147150

Camero, É., & Calderón, A. M. (2007). Comunidad de mariposas diurnas (Lepidoptera: Rhopalocera) en un gradiente altitudinal del cañón del río Combeima, Tolima, Colombia. *Acta Biológica Colombiana, 12*(2), 95-110.

Constantino, L. M. (2004). Pieridae. Género *Anteos*. in J. F. LeCrom, J. Llorente-Bousquets, L. M. Constantino & J. A. Salazar (Eds.). *Mariposas de Colombia* (Vol. 2). Carlec Ed.

Delgadillo, I., & Góngora, F. (2009). Colecciones Biológicas: Estrategias didácticas en la enseñanza-aprendizaje de la Biología. *Bio-grafía, 2*(3), 131-140. https://doi.org/10.17227/20271034.vol.2num.3bio-grafia131.140

DeVries, P. J. (1987). Papilionidae, Pieridae, Nymphalidae. *The Butterflies of Costa Rica and Their Natural History* (Vol. 1). Princeton University Press.

Díaz-Suárez, V., Mahecha, O., Andrade, M. G., & Pyrcz, T. W. (2022). Perturbación antrópica afectando a los patrones de diversidad en Satyrinae de montaña Pronophilina Reuter, 1896 en un bosque altoandino en Colombia (Lepidoptera: Nymphalidae). *SHILAP Revista de lepidopterología, 50*(200), 709-728. https://doi.org/10.57065/shilap.263.

Esri (2023). *ArcGIS Pro (Versión 3.1)* [Software GIS]. Environmental Systems Research Institute, Inc. Esri Press. https://www.esri.com/en-us/arcgis/products/arcgis-pro

Fick, S. E., & Hijmans, R.J. (2017). WorldClim 2: new 1km spatial resolution climate surfaces for global land areas. *International Journal of Climatology, 37*(12), 4302-4315. https://doi.org/10.1002/joc.5086

GBIF.org (21 February 2025). *GBIF Occurrence Download*. https://doi.org/10.15468/dl.kqprj3

Giraldo, J. M., López, G. A., Dias, L. G., & Rivera, F. A. (2012). Biological collections: an alternative for genetic diversity studies. *Boletín Científico Museo Historia Natural*, *16*(1), 143-155.

Gilchrist, G. W. (1990). The consequences of sexual dimorphism in body size for butterfly flight and thermoregulation. *Functional Ecology, 4*(4), 475-487. https://doi.org/10.2307/2389315

Godman, F., & Salvin, O. (1887-1901). Insecta. Lepidoptera. Rhopalocera. *Biologia Centrali Americana Zoology* (Vol. II). R. H. Porter Editor.

Gómez-Díaz, D. M. (2016). Mariposas (Lepidoptera: Papilionoidea: Serie Papilioniformes) del campus de la Universidad de los Llanos, sede Barcelona, Villavicencio (Meta, Colombia). [Trabajo de Grado Pregrado, Universidad de los Llanos]. Repositorio institucional. https://repositorio.unillanos.edu.co/entities/publication/578e3d-0d75-4254-ad0c-435ecce4f4

Google (2023). Google Earth (Versión 7.3) [Software de computadora]. Google LLC. https://www.google.com/earth/

Henao-Bañol, E. R., & Gantiva-Q., C. H. (2020). Mariposas (Lepidoptera: Hesperioidea-Papilionoidae) del bosque seco tropical (BST) en Colombia. Conociendo la diversidad en un ecosistema amenazado. *Boletín Científico Museo Historia Natural, 24*(1), 150-196. https://doi.org/10.17151/bccm.2020.24.1.10

Henao-Bañol, E. R., Salazar-Escobar, J. A., Burbano, G., & Rodríguez-Mahecha, J. V. (2022). Mariposas de un sector sur de la vertiente este de la Cordillera Oriental del municipio de Piamonte, Cauca (Lepidoptera). *Boletín Científico Museo Historia Natural, 26*(2), 209-248. https://doi.org/10.17151/bccm.2022.26.2.11

Hernández-Mejía, B. C., Flores-Gallardo, A., & Llorente-Bousquets, J. (2014). Morfología del Corion en la Subfamilia Coliadinae (Lepidoptera: Pieridae) Chorionic Morphology in the Coliadinae Subfamily (Lepidoptera: Pieridae). *Southwestern Entomologist, 39*(4), 853-886. https://doi.org/10.3958/059.039.0416

Hijmans, R. J., Bivand, R., Forner, K., Ooms, J., Pebesma, E., & Summer, M. D. (2022). *Package 'terra'. Maintainer*. https://rspatial.org/

Hoang, D. T., Chernomor, O., von Haeseler, A., Minh, B. Q., & Vinh, L. S. (2018). UFBoot2: improving the ultrafast bootstrap approximation. *Molecular Biology and Evolution, 35*, 518-522. https://doi.org/10.1093/molbev/msx281 PMid:29077904 PMCid:PMC5850222

IPCC (2013). Summary for Policymakers. In T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. Allen, J. Boschung & P. Midgley (Eds.). *Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

IPCC (2014). Climate change 2014: *Mitigation of climate change. Contribution of working group 3 to the fifth assessment report of the intergovernmental panel on climate change*. In O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K., Seyboth & J. Minx (Eds.). Cambridge University Press.

Katoh, K., Rozewicki, J., & Yamada, K. D. (2019). MAFFT online service: multiple sequence alignment, interactive sequence choice and visualization. *Briefings in Bioinformatics, 20*(4), 1160-1166, https://doi.org/10.1093/bib/bbx108 PMid:28968734 PMCid:PMC6781576

Kalyaanamoorthy, S., Minh, B. Q., Wong, T. K. F., von Haeseler, A., & Jermiin, L. S. (2017). Model Finder: Fast model selection for accurate phylogenetic estimates. *Nature Methods, 14*, 587-589. https://doi.org/10.1038/nmeth.4285 PMid:28481363 PMCid:PMC5453245

Karger, D. N., Conrad, O., Böhner, J., Kawohl, H., Soria-Auza, R. W., Zimmermann, N. E., Linder, H. P., & Kessler, M. (2017). Climatologies at high resolution for the Earth land surface areas. *Scientific Data, 4*, 170122, https://doi.org/10.1038/sdata.2017.122 PMid:28872642 PMCid:PMC5584396

Kemp, D. J., & Krockenberger, A. K. (2004). Behavioural thermoregulation in butterflies: the interacting effects of body size and basking posture in *Hypolimnas bolina* (L.) (Lepidoptera: Nymphalidae). *Australian journal of Zoology*, 52(3), 229–239. https://doi.org/10.1071/ZO03043

Khazan, E. S., Haggard, J., Ríos-Málaver, I. C., Shirk, P., & Scheffers, B. R. (2022). Disentangling drivers of thermal physiology: Community-wide cold shock recovery of butterflies under natural conditions. *Biotropica, 54*(1), 205-214. https://doi.org/10.1111/btp.13046

Klockmann, M., Günter, F., & Fischer, K. (2017). Heat resistance throughout ontogeny: Body size constrains thermal tolerance. *Global Change Biology, 23*, 686-696. https://doi.org/10.1111/gcb.13407 PMid:27371939

Klots, A. B. (1929). The genus *Anteos* Hübner (Lepidoptera, Pieridae). *Bulletin of the Brooklyn Entomological Society, 24*, 134-142.

Klots, A. B. (1931-1933). A generic classification of the Pieridae (Lepidoptera) together with a study of the male genitalia. *Entomologica Americana, 12*, 139-242.

Laird-Hopkins, B., Ashe-Jepson, E., Basset, Y., Cobo, S. A., Eberhardt, L., Freiberga, I., Hellon, J., Hitchcock, G. E., Daniel Linke, Lamarre, G. P. A., McFarlane, A., Savage, A. F., Turner, E. C., Zamora, A. C., Sam, K., & Bladon,

A. J. (2023). Thermoregulatory ability and mechanism do not differ consistently between Neotropical and temperate butterflies. *Global Change Biology, 29*, 4180-4192. https://doi.org/10.1111/gcb.16797 PMid:37315654 PMCid:PMC10946725

Lamas, G. (2004). *Atlas of Neotropical Lepidoptera.Checklist: Part 4A: Hesperioidea - Papilionoidea*. Association for Tropical Lepidoptera.

LeCrom, J., Llorente, J., Constantino, L., & Salazar, J. (2004). Pieridae. *Mariposas de Colombia* (Vol. 2). CARLEC Ltda.

Meineke, E. K., Davies, T. J., Daru, B. H., & Davis, C. C. (2019). Biological collections for understanding biodiversity in the Anthropocene. *Philosophical Transactions of the Royal Society B, 374*(1763), 20170386. https://doi.org/10.1098/rstb.2017.0386 PMid:30455204 PMCid:PMC6282082

Méndez-Zambrano, M. A., & Fajardo-Medina, G. E. (2024). Habitat Suitability in High Andean Butterflies: The Role of Land Cover in the Occurrence and Conservation of Species. *Neotropical Entomology, 53*(4), 759-772. https://doi.org/10.1007/s13744-024-01178-x PMid:38980501

Mercado-Gómez, Y., Mercado-Gómez, J., & Giraldo-Sánchez, C. E. (2018). Mariposas en un fragmento de bosque seco tropical en Montes de María (Colombia). *Ciencia en Desarrollo, 9*(2), 35-45. https://doi.org/10.19053/01217488.v9.n2.2018.7595

Minh, B. Q., Nguyen, M. A. T., & von Haeseler, A. (2013). Ultrafast approximation for phylogenetic bootstrap. *Molecular Biology and Evolution, 30(*5), 1188-1195. https://doi.org/10.1093/molbev/mst024 PMid:23418397 PMCid:PMC3670741

Minh, B. Q., Schmidt, H. A., Chernomor, O., Schrempf, D., Woodhams, M. D., von Haeseler, A., & Lanfear, R. (2020), IQ-TREE 2: New models and efficient methods for phylogenetic inference in the genomic era. *Molecular Biolology and Evolution, 37*, 1530-1534. https://doi.org/10.1093/molbev/msaa015 PMid:32011700 PMCid:PMC7182206

Molleman, F., Ding, J., Wang, J. L., Brakefield, P. M., Carey, J. R., & Zwaan, B. J. (2008). Amino acid sources in the adult diet do not affect life span and fecundity in the fruit-feeding butterfly *Bicyclus anynana*. *Ecological Entomology, 33*(4), 429-438. https://doi.org/10.1111/j.1365-2311.2008.00986.x PMid:19081752 PMCid:PMC2600556

Montero-A., F., & Ortiz-P., M. (2013). Aporte al conocimiento para la conservación de las mariposas (Hesperioidea y Papilionoidea) en el Páramo del Tablazo, Cundinamarca (Colombia). *Boletín Científico Museo Historia Natural, 17*(2), 197-226.

Moreno, G. P., & Acuña-Vargas, J. C. (2015). Caracterización de lepidópteros diurnos en dos sectores del santuario de flora y fauna los flamencos (San Lorenzo de Camarones, la Guajira). *Boletín Científico Museo Historia Natural, 19*(1), 221-234. https://doi.org/10.17151/bccm.2015.19.1.16

Murillo-Ramos, L., Hernández-Mejia, C., & Llorente-Bousquets, J. (2016). The phylogenetic position of *Aphrissa* (Lepidoptera: Pieridae: Coliadinae) within its relatives the ancient American Catopsilias. *Zootaxa, 4147*(5), 538-550. https://doi.org/10.11646/zootaxa.4147.5.2 PMid:27515633

Murillo-P., A. M., Mahecha-J., O., Díaz-S., V., Andrade-C., M. G., & Pyrcz, T. W. (2024). Effects of anthropogenic climate change on the potential distribution of the genus *Pronophila* Doubleday, [1849] in Colombia (Lepidoptera: Satyrinae, Pronophilina). *SHILAP Revista de lepidopterología, 52*(208), 737-759. https://doi.org/10.57065/shilap.1017

Negret, Á. (1988). Voos migratórios de Pieridae (Lepidoptera) no Distrito Federal, Brasil. *Revista Brasileira de Zoologia, 5*, 109-117. https://doi.org/10.1590/S0101-81751988000100009

Nieves-Uribe, S., Castro-Gerardino, J., Flores-Gallardo, A., & Llorente-Bousquets, J. (2016). Corion en los Géneros *Anteos* y *Rhabdodryas* (Pieridae: Coliadinae): su Significado e Implicaciones. *Southwestern Entomologist, 41*(2), 485-504. https://doi.org/10.3958/059.041.0218

Ospina-López, L. A., García-Pérez, J. F., Villa-Navarro, F. A., & Reinoso-Flórez, G. (2010). Mariposas Pieridae (Lepidoptera: Papilionoidea) de la Cuenca del Río Coello (Tolima), Colombia. *Actualidades Biológicas, 32*(93), 173-188. https://doi.org/10.17533/udea.acbi.13813

Pertuz-Méndez, L. A. (2022). *Los anélidos marinos (Phylum Annelida) del Centro de Colecciones Científicas de la Universidad del Magdalena* [Trabajo de Grado Pregrado, Universidad del Magdalena]. Repositorio institucional.

Pyrcz, T., Mahecha-J., O., Boyer, P., Lachowska-Cielik, D., Cerdeña, J., Farfán, J., Garlacz, R., Lorenc-Brudecka, J., Bálint, Z., Fåhraeus, C., Zając-Garlacz, K., Espeland, M. (2024). ¿A snow-dwelling tropical butterfly? An unprecedented discovery of a new genus of the *Pedaliodes* clade in an extreme, high-altitude Andean environment (Lepidoptera: Nymphalidae: Satyrinae). *Zoological Journal of the Linnean Society, 202*(2), zlae112, https://doi.org/10.1093/zoolinnean/zlae112

R Core Team (2023). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing.

https://www.R-project.org/

Rambaut, A. (2018). *FigTree v. 1.4.4: Tree Figure Drawing Tool*. https://github.com/rambaut/figtree/releases.

Ramos-Artunduaga, J., Londoño-Carvajal, C. A., & Marín-Uribe, M. A. (2021). Mariposas asociadas a bosques en Solano, Caquetá, Amazonia Colombiana (Lepidoptera: Papilionoidea). *Biota colombiana*, *22*(2), 56-69. https://doi.org/10.21068/c2021.v22n02a03

Ratnasingham, S., & Hebert, P. D. (2007). BOLD: The Barcode of Life Data System (http://www. barcodinglife.org). *Molecular Ecology Notes, 7*, 355-364. https://doi.org/10.1111/j.1471-8286.2007.01678.x PMid:18784790 PMCid:PMC1890991

Ríos-Málaver, C. (2007). Riqueza de especies de mariposas (Hesperioidea y Papilionoidea) de la quebrada "El Águila" Cordillera Central (Manizales, Colombia). *Boletín Científico Centro de Museos Museo de Historia Natural, 11*, 272-291.

Robinson, G. S., Ackery, P. R., Kitching, I. J, Beccaloni, G. W., & Hernández, L. M. (2010). HOSTS - *A Database of the World's Lepidopteran Hostplants*. Natural History Museum. http://www.nhm.ac.uk/hosts

Romo, H., Sanabria, P., & García-Barros, E. (2013). Predicción de los impactos del cambio climático en la distribución sobre las especies de Lepidoptera. El caso del género *Boloria* Moore, 1900 en la Península Ibérica (Lepidoptera: Nymphalidae). *SHILAP Revista de lepidopterología, 41*(162), 267-286.

Salazar, J. (2018). Novedades en historia natural. *Boletín Científico Museo Historia Natural, 22*(1), 199-205.

Sandoval-Bernal, A., Ríos-Guzmán, G., Ramírez-Restrepo, L., & Navas-S., G. R. (2022). Diversidad de mariposas (Papilionoidea) en paisajes urbanos de la ciudad de Cartagena de Indias, Colombia. In A. Sandoval-Bernal & G. Ríos-Guzmán (Eds.). *Especies silvestres que nos acompañan en el distrito de Cartagena de Indias*. Universidad de Cartagena. https://hdl.handle.net/11227/15982

SiB Colombia. (2025). *Sistema de Información sobre Biodiversidad de Colombia*. Instituto Humboldt. https://sibcolombia.net

Simmons, J., & Muñoz, Y. (2005). *Cuidado, manejo y conservación de las colecciones biológicas*. Univesidad Nacional de Colombia.

Torres, R. (1986). Contribución al estudio Faunístico de los Piéridos de Colombia (Lepidoptera: Pieridae) [Tesis Maestría, ICA, Universidad Nacional de Colombia]. Repositorio institucional.

Torres, G. A. (2010). *Diversidad de las mariposas (Lepidóptera: Papilionidae, Pieridae, Lycaenidae, Riodinidae, Hesperiidae) del enclave de bosque seco conformado por los cañones de los ríos Chicamocha, Suárez y Sogamoso, Santander, Colombia* [Tesis de pregrado, Universidad Industrial de Santander]. Repositorio institucional.

Urbano, P., Mahecha, O., Suárez, E., Izquierdo, V., & Díaz, V. (2018). Variación temporal del ensamblaje de mariposas asociadas a la Cuenca de la Calaboza, Yopal, Casanare, Colombia (Lepidoptera: Papilionoidea). *SHILAP Revista de lepidopterología, 46*(184), 533-550. https://doi.org/10.57065/shilap.745

Watt, W. B. (1968). Adaptive significance of pigment polymorphisms in *Colias* butterflies. I. Variation of melanin pigment in relation to thermoregulation. *Evolution, 22*(3), 437-458. https://doi.org/10.2307/2406873 PMid:28564757

Wei, F., Huang, W., Fang, L., He, B., Zhao, Y., Zhang, Y., Zhang, Y., Shau, Z., Su, Ch., & Hao, J. (2023). Spatio-Temporal Evolutionary Patterns of the Pieridae Butterflies (Lepidoptera: Papilionoidea) Inferred from Mitogenomic Data. *Genes, 14*(1), 72. https://doi.org/10.3390/genes14010072 PMid:36672814 PMCid:PMC9858963

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Tabla I. Números de Acceso de las secuencias del marcador molecular COI obtenidas de BOLD y NCBI e incluidas en el estudio.

Género	Especie	Numero de Acceso	País	Sitio de Recolecta
Anteos	*clorinde*	ASARD2102-12	Costa Rica	San José, Mora
Anteos	*clorinde*	DMAZ214-10	Estados Unidos	Arizona, Cochise
Anteos	*clorinde*	JAGWI324-11	República Dominicana	La Descubierta, Sierra Neiba
Anteos	*clorinde*	JAGWI325-11	República Dominicana	Villa Nizao, Barahona, Sierra Bahoruco
Anteos	*clorinde*	JAGWI326-11	República Dominicana	La Descubierta, Sierra Neiba
Anteos	*clorinde*	JAGWI328-11	República Dominicana	La Descubierta, Sierra Neiba
Anteos	*clorinde*	JAGWI330-11	Cuba	Sancti Spiritus, La Jiquima, Fomento
Anteos	*clorinde*	JAGWI331-11	Cuba	Sancti Spiritus, La Jiquima, Fomento
Anteos	*clorinde*	JDMUS007-18	México	Sin Información
Anteos	*clorinde*	LNOA175-16	Argentina	Jujuy, Departamento Ledesma
Anteos	*clorinde*	LNOA432-16	Argentina	Salta, Departamento Anta
Anteos	*clorinde*	LNOA477-16	Argentina	Salta, Departamento Anta
Anteos	*clorinde*	LNOA501-16	Argentina	Salta, Departamento Anta
Anteos	*clorinde*	LNOA522-16	Argentina	Salta, Departamento Anta
Anteos	*clorinde*	LYPIE147-09	México	Quintana Roo
Anteos	*clorinde*	LYPIE150-09	México	Quintana Roo
Anteos	*clorinde*	LYPIE151-09	México	Campeche
Anteos	*clorinde*	LYPIE152-09	México	Quintana Roo
Anteos	*clorinde*	MHAPA081-05_	Costa Rica	Guanacaste, Área de Conservación
Anteos	*clorinde*	TBGS007-09_	Costa Rica	Guanacaste, Santa Cecilia de la Cruz
Anteos	*clorinde*	TBGS008-09	Costa Rica	Guanacaste, Santa Cecilia de la Cruz
Anteos	*maerula*	ASARD2921-12	Costa Rica	Heredia, Sarapiqui
Anteos	*maerula*	GBCAB42382-24	Jamaica	Sin Información
Anteos	*maerula*	JAGWI321-11	Puerto Rico	Toro Negro, Cordillera Central
Anteos	*maerula*	JAGWI322-11	República Dominicana	Valle Nuevo Constanza
Anteos	*maerula*	JAGWI323-11	República Dominicana	PN A Bermúdez Anton Sape
Anteos	*maerula*	LNAUU1420-15	Estados Unidos	Texas, Hidalgo
Anteos	*maerula*	LNAUW456-17	Estados Unidos	Texas
Anteos	*maerula*	LPYPC052-08_	México	Yucatán
Anteos	*maerula*	LYPIE153-09	México	Quintana Roo
Anteos	*maerula*	LYPIE155-09_	México	Campeche, Calakmul
Anteos	*maerula*	LYPIE156-09	México	Campeche, Calakmul
Anteos	*maerula*	LYPIE157-09	México	Campeche, Calakmul
Anteos	*maerula*	LYPIE158-09_	México	Campeche, Calakmul
Anteos	*maerula*	LYPIE159-09	México	Campeche, Calakmul

Anteos	*maerula*	LYPIE160-09_	México	Quintana Roo
Anteos	*maerula*	LYPIE163-09	México	Yucatán
Anteos	*maerula*	MHAPA010-05	Costa Rica	Guanacaste, Área de Conservación
Anteos	*maerula*	MHAPA079-05	Costa Rica	Guanacaste, Área de Conservación
Anteos	*maerula*	PRMAR1018-21	Puerto Rico	Coamo
Anteos	*maerula*	PRMAR1019-21_	Puerto Rico	Coamo
Anteos	*menippe*	ANDIV1609-23	Perú	Madre de Dios
Anteos	*menippe*	ANDIV1612-23	Perú	Madre de Dios
Colias	*dimera*	SACOL028-16	Colombia	Boyacá
Colias	*dimera*	SACOL033-16	Ecuador	Tungurahua, Ambato
Catopsilia	*gorgophone*	ANICT739-11	Australia	Queensland
Catopsilia	*scylla*	ANICT740-11	Australia	Western Australia
Catopsilia	*pomona*	BKKP160-18	Tailandia	Bangkok
Phoebis	*sennae*	BBLWU269-09	Estados Unidos	Oklahoma, Marshall
Phoebis	*hersilia*	BCIBT490-11	Panamá	Panamá
Phulia	*nymphula*	GBGL3677-06	Chile	Salar De Suriri
Zerene	*cesonia*	ABLCU787-09	México	Coahuila Saltillo
Zerene	*eurydice*	ABLCU828-09	Estados Unidos	California Los Ángeles

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Oxypteryx dubiella Huemer & Šumpich, sp. nov., a new species of Aristoteliinae from Spain (Lepidoptera: Gelechiidae)

Peter Huemer & Jan Šumpich

Abstract

Oxypteryx dubiella Huemer & Šumpich, sp. nov. (Gelechiidae, Aristoteliinae), is described from specimens collected in south and east of Spain (provinces Alicante, Almeria, Valencia). The new species differs from related congeneric taxa by several characters of male and female genitalia, as well as by the highly divergent DNA barcode (cytochrome c oxidase subunit 1). Adults, and male and female genitalia are figured. Considering the isolated position within *Oxypteryx* Rebel, 1911 and in absence of a suprageneric revision of Aristoteliinae the generic combination is tentative.

Keywords: Lepidoptera, Gelechiidae, Aristoteliinae, *Oxypteryx dubiella*, description, new species, Spain.

Oxypteryx dubiella Huemer & Šumpich, sp. nov., una nueva especie de Aristoteliinae procedente de España (Lepidoptera: Gelechiidae)

Resumen

Oxypteryx dubiella Huemer & Šumpich, sp. nov. (Gelechiidae, Aristoteliinae) se describe a partir de especímenes recolectados en el sur y este de España (provincias de Alicante, Almería y Valencia). La nueva especie se diferencia de los taxones congéneres relacionados por varios caracteres de los genitales masculinos y femeninos, así como por el código de barras de ADN altamente divergente (subunidad 1 de la citocromo c oxidasa). Se ilustran los adultos y la genitalia del macho y de la hembra. Teniendo en cuenta la posición aislada dentro de *Oxypteryx* Rebel, 1911y la ausencia de una revisión supragenérica de Aristoteliinae, la combinación genérica es provisional.

Palabras clave: Lepidoptera, Gelechiidae, Aristoteliinae, *Oxypteryx dubiella*, descripción, nueva especie, España.

Introduction

With around 5600 described species, Gelechiidae are a lepidopteran group that occurs on all continents except for Antarctica. In Europe, the family is overproportionally diverse with around 920 species. For a long time, it was considered to be particularly difficult from a taxonomic point of view, but the inventory of species has been massively advanced in recent decades, both regionally and on a continental basis, so that at least certain tribes or even subfamilies are now easily identifiable (Huemer & Karsholt, 1999, 2010). Meanwhile, in addition to classical morphologically based methods, the implementation of genetic analyses, in particular DNA barcoding, has become established for reliable species delimitation. Despite these efforts, however, around 100 taxa that have already been sampled are considered possible cryptic species that require further integrative taxonomic investigations (Huemer et al. 2020).

Here we present one of the previously undescribed species. Due to its affiliation to the as yet unrevised subfamily Aristoteliinae, its generic classification appeared problematic. However, in contrast to other recently described Gelechiidae genera (e.g. Bidzilya & Karsholt 2008; Corley et al. 2020), we refrain from introducing a new generic unit and hope for a future, comprehensive revision of the Aristoteliinae. The newly described species, previously only known from Spain, is morphologically and genetically closely related to *Oxypteryx* Rebel, 1911, but differs significantly in some characteristics. However, as the species delimitation is completely unambiguous, we would like to make the taxon available despite the deficits mentioned.

Material and methods

In total, we examined 229 individuals of the new *Oxypteryx* available for morphological and partially for genetic analysis. Species identification is based on the phenotypic characteristics of adults (wing markings) and is partly confirmed by dissections and DNA barcoding.

Male genitalia preparation implemented the so-called unrolling technique as introduced for the preparation of complex male genitalia in Gelechiidae by Pitkin (1986).

Tissue samples (single hind leg) from six *O. dubiella* Huemer & Šumpich, sp. nov. were prepared according to prescribed standards to obtain DNA barcode sequences of a 658 bp segment of the mitochondrial COI gene (cytochrome c oxidase subunit 1). The material was successfully processed at the Canadian Centre for DNA Barcoding (CCDB, Biodiversity Institute of Ontario, University of Guelph) using the standard high-throughput protocol described in deWaard et al. (2008). In addition, 37 private barcode sequences from 17 species in the Barcode of Life Data Systems (BOLD; Ratnasingham & Hebert, 2007; Ratnasingham, 2018) with *Aristotelia subericinella* (Duponchel, [1843]) as out-group were used for analysis. All barcodes range between 635 and 658 bp. Further details including complete voucher data and images can be accessed in the public dataset DS-OXYPTSPN “New Oxypteryx from Spain” in BOLD.

All sequences were assigned to Barcode Index Numbers (BIN), algorithm-based operational taxonomic units that provide an accurate proxy for the true species. BINs were automatically calculated for records in BOLD that comply with the DNA Barcode standard (Ratnasingham & Hebert, 2013).

Degrees of intra- and interspecific variation of DNA barcode fragments were calculated using the Kimura two-parameter model on the platform of BOLD systems v. 4.0. (https://boldsystems.org). A Neighbor-Joining tree was constructed using the Kimura two-parameter model in MEGA11 (Kumar et al. 2021).

Photographs of adults were taken with a Canon 750D camera fitted with a Canon MP-E-65 mm lens (J. Šumpich), genitalia photographs with a Zeiss Axiolab 5 microscope, mounted with an Olympus OM-D Mark III camera (P. Huemer). Stacked photographs were edited using Helicon Focus 4.8 and Adobe Photoshop 6.0.

The present study based on material from the following collections

MNCN	Museo Nacional de Ciencias Naturales, Madrid, Spain
NMPC	National Museum of the Czech Republic, Prague, Czech Republic
RCZT	Research collection of Zdeno Tokár, Močovice, Czech Republic
TLMF	Tiroler Landesmuseum Ferdinandeum, Hall, Austria
ZMUC	Zoological Museum, Natural History Museum of Denmark, Copenhagen, Denmark

Results

Molecular analysis

Molecular analysis is based on full DNA barcodes of 658 bp for 5 specimens of *O. dubiella* sp. nov.*,* and a shorter sequence of 550 bp. Furthermore, 37 sequences of 17 European species are considered for analysis.

The sequences grouped into 20 and strongly divergent clusters, each with different BINs, representing 18 species, with two genetically variable species (*O. libertinella* (Zeller, 1872), *O. nigritella* (Zeller, 1847). The *O. dubiella* sp. nov. sequences were assigned to a unique cluster (Figure 1).

The mean intraspecific p-distance of *O. dubiella* sp. nov. is 0.19%, maximum p-distance is 0.48% (BIN:BOLD:AAV7596) (n=7). The minimum p-distance to the nearest neighbor, *Teleiodes luculella* (Hübner, 1813) (BIN:BOLD:AEG5539; n=4), is 10.42%.

Taxonomy

Oxypteryx dubiella Huemer & Šumpich, sp. nov.

https://zoobank.org/9BB626DB-2FE6-4702-BE86-C832B45B2FC6

Type material: Holotype ♀, SPAIN, Valencia El Saler, Albufera, 5 m 39º19,67'N, 00º18,47'W, 21-V-2004, leg. Huemer; genitalia slide P. Huemer GEL 1356♀ (TLMF).

Paratypes: 95 ♂, 7 ♀, same data as holotype, genitalia slide P. Huemer GEL 1355♀, DNA barcode ID TLMF Lep 03844; 3 ♂, ditto, but 16-V-2004; 6 ♂, ditto, but 18-V-2004; Alicante, Sierra de Crevillente, 5 km NE Albatera, 450 m, 14 ♂, 38º15,22'N, 00º54,86'W, 23-V-2004, P. Huemer leg.; 6 ♂, ditto, but 24-V-2004, DNA barcode IDs TLMF Lep 03237, TLMF Lep 03238; 14 ♂, ditto, but 26-V-2004, genitalia slide P. Huemer GEL 1354♂, DNA barcode IDs TLMF Lep 03239, TLMF Lep 03841, TLMF Lep 03842, TLMF Lep 03843. Alicante 44 ♂, 28 ♀, 8 km N Albatera, 270 m, 38º15' N, 0º52' W, 28-IV-2008, DNA barcode ID TLMF Lep 25227, J. Šumpich leg. (NMPC); 2 ♂, 1 ♀, ditto, but gen. prep ZT 14983, 14991 and 14984), Z. Tokár leg.; 3 ♂, 3 ♀, ditto, but 5-V-2008, gen. prep ZT 10950, 10951, 10952, 10953, 14994. Almeria, Sierra de Alhamilla, Nijar env., 560 m, 1 ♀, 30-IV-2008, gen. prep ZT 10966, Z. Tokár leg. (all RCZT, ZMUC). Valencia, Santa Pola, Playa del Pinet, 5 m, 1 ♂, 38º9,51'N, 00º37,54'W, 22-V-2004, P. Huemer leg. (all TLMF, MNCN).

Diagnosis: At first glance, the new species resembles unrelated Gelechiidae such as *Pragmatodes* sp., *Apatetris* sp., *Ptocheuusa* sp. or *Ephysteris* sp. Within the genus *Oxypteryx*, the whitish base colour of the forewings with fine dark mottling and four obscure light brown spots is unique. The male genitalia are vaguely similar to *O. helotella* (Staudinger, 1859), *O. parahelotella* (Nel, 1995) and *O. marieae* Huemer, 2020 (Huemer, 2020; Nel, 1995), but differ in the club-shaped uncus and the shape of the valva and sacculus. The female genitalia are characterised by extremely long posterior and anterior apophyses, a largely membranous antrum and prominent appendages of the signum.

Description: Adult **(**Figures 2-5). Head white-scaled, with increasingly speckled brown towards the crown; proboscis white; labial palps white, 2nd segment with weak distal brush, brown scaling of varying extent on the outside and partly also on the inside, 3rd segment slightly shorter than 2nd segment, white with brown scales, especially on the outside; antenna white with dark brown rings. Thorax and patagia covered with white scales tipped with dark brown, legs white with extensive dark brown scaling. Forewing length: ♂ 3.0-4.1 mm, ♀ 3.8-4.0 mm; upper side of forewing white, numerous white scales tipped light brown, four weakly developed ochre spots, two in the fold and two in and at the end of the cell, fringe white with distinct dark dividing line; underside of forewing cream white. Upper side of hindwing light grey, pearlescent, fringe long, light grey; underside of hindwing white. Abdomen white. No substantial differences between sexes.

Variation: In general, the variability of external appearance is very low. In some specimens, the ochre spots may be more pronounced on a light background (Figure 4), sometimes dark forms occur, on which the ochre spots are almost not evident (Figures 3, 5).

Male genitalia (Figures 6-7): Uncus massive, club-shaped, finely spined throughout; tegumen broad, with strongly sclerotised posterior edge bearing long setae; pedunculi broadly rounded; valva sub-rectangular, especially distally with some medium-length setae, apex broad and straight-cut, ventroapical with tooth-shaped projection; sacculus basally broader than valva, lobed, apically pointed, covered with some setae particularly at edges; saccus triangular, distally evenly tapered; phallus about as long as genital capsule, massive, very broad basally, distally increasingly tapered, postmedially with tooth-like appendage.

Female genitalia (Figures 8-9): Papillae anales short, oblong; apophysis posterior long,ca. 1.8 mm; segment VIII ca. 0.5 mm long, membraneous, without structures, posterior edge sclerotizted with long setae; apophysis anterior nearly length of apophysis posterior, ca. 1.7 mm; ostium bursae hardly discernible, membranous; ductus bursae without sclerotized antrum, long, membraneous, anteriorly gradually dilated without a clear transition to corpus bursae; corpus bursae leongated sub-obval; Signum with irregualry shaped oblong basael plate, three very long and strong thorn-like processes and ca. one dozen of small spines (Figure 9).

Biology: Hostplant and early stages are unknown. Adults have been collected from late April to the end of May at light. The observations come from both sandy coastal areas and steppic inland habitats and range from sea level to an altitude of around 450 meters (Figure 10).

Distribution: Spain (Alicante, Almeria, Valencia).

Etymology: The species name is derived from the latin adjective *dubius* (=doubtful) and refers to the doubtful generic assignment.

Discussion

New descriptions of species that cannot be assigned to undisputed genera are always a particular taxonomic challenge and, due to the lack of available conceptual frameworks, require a certain willingness to compromise on the part of the taxonomists involved. The existing desire for an unambiguous classification of species into undisputed genera cannot always be realized, even for Lepidoptera in well-studied Europe. A good example are parts of the family Gelechiidae, which are still insufficiently revised, particularly several genera of the subfamilies Aristoteliinae and Anomologinae. Although some species-rich genera such as *Bryotropha* Heinemann, 1870 , *Ptycerata* Ely, 1910, *Megacraspedus* Zeller, 1839, *Dirhinosia* Rebel, 1905 and *Ivanauskiella* Ivinski & Piskunov, 1980 have been revised in the recent past (Bidzilya & Karsholt, 2021; Bidzilya et al. 2023; Huemer & Karsholt, 2018; Karsholt & Rutten, 2005; Tokár & Gozmány, 2005), other genera such as *Aproaerema* Durrant, 1897, *Isophrictis* Meyrick, 1917, *Aristotelia* Hübner, [1825], *Metzneria* Zeller, 1839and also *Oxypteryx* remain insufficiently known. Apart from comprehensive descriptions of the species composition in these genera, there is still a lack of phylogenetic analysis at the genus level that takes global aspects into account. In many cases, even well-known European species can only be correctly assigned to a genus after intensive research, as was recently the case with *Tiranimia epidolella* Chrétien, 2015 and *Lanceoptera panochra* Janse, 1960 (Karsholt et al. 2023). Even the isolated introduction of new genera in the recent past has not provided a fundamental improvement (Bidzilya & Karsholt, 2008; Nel et al. 2022; Varenne et al. 2017). The acute lack of phylogenetically based generic revisions therefore urgently needs to be remedied. However, since only very few resources are available for such time-consuming revisionary work, the systematic survey and formal description of previously unrecognized species diversity is at risk. We have therefore - 20 years after sampling efforts of an unknown taxon preliminary and incorrectly identified as *Ptocheuusa* sp. (Huemer & Wieser, 2010) - opted for assigning a new species to an available genus despite all reservations, and conversely, in the absence of a global revision of the Aristoteliinae, refraining from introducing a further genus.

Oxypteryx dubiella is a genetically isolated species whose phylogenetic relationships are doutbful. Its closest neighbour in the DNA barcode, *Teleiodes luculella* (Hübner, [1813]), is assigned to the tribe Litini within Gelechiinae, and does not appear to be closely related due to the enormous genetic distance of approximately 10% and the entire morphology. In fact, our tentative assignment to the Aristoteliinae in general and the genus *Oxypteryx* in particular is based exclusively on morphological characteristics, especially the genital armature of both sexes, even though genetic data and the phenotypic appearance of the species cast doubt on the genus assignment.

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Conflict of Interest

The authors declare that there is no known financial interest or personal relationship that could have influenced the work presented in this article.

References

Bidzilya, O., & Karsholt, O. (2021). A review of the Palearctic *Ptycerata* Ely, 1910 (= *Caulastrocecis* Chrétien, 1931, syn. nov.) based on morphology (Lepidoptera, Gelechiidae). *Zootaxa*, *5026*(2), 151-181. https://doi.org/10.11646/zootaxa.5026.2.1 PMid:34810935

Bidzilya, O., Karsholt, O., & Šumpich, J. (2023). A revision of the genus *Ivanauskiella* (Lepidoptera: Gelechiidae).

Acta Entomologica Musei Nationalis Pragae, *63*(1), 135-164. https://doi.org/10.37520/aemnp.2023.007

deWaard, J. R., Ivanova, N. V., Hajibabaei, M., & Hebert, P. D. N. (2008). Assembling DNA Barcodes: Analytical Protocols. In C. C. Martin (Ed.). *Methods in Molecular Biology: Environmental Genomics* (pp. 275-293). Humana Press Inc. https://doi.org/10.1007/978-1-59745-548-0_15 PMid:18642605

Hobern, D., Sattler, K., & Lee, S. (2025). Catalogue of World Gelechiidae (version 1.1.25.114). In Bánki, O., Roskov, Y., Döring, M., Ower, G., Hernández Robles, D. R., Plata Corredor, C. A., Stjernegaard Jeppesen, T., et al., *Catalogue of Life* (Version 2025-05-13). Catalogue of Life, Amsterdam, Netherlands. https://doi.org/10.48580/dgqdn-4th

Huemer, P. (2020). *Oxypteryx marieae* sp. n. - eine neue Schmetterlingsart (Lepidoptera) aus der Fenner Schlucht (Südtirol, Italien). *Wissenschaftliches Jahrbuch der Tiroler Landesmuseen*, *13*, 349-355.

Huemer, P., & Karsholt, O. (1999). Gelechiidae I (Gelechiinae: Teleiodini, Gelechiini). In P. Huemer, O. Karsholt & L. Lyneborg (Eds.). *Microlepidoptera of Europe* (Vol. 3). Apollo Books. https://doi.org/10.1163/9789004629028

Huemer, P. & Karsholt, O. (2010). Gelechiidae II (Gelechiinae: Gnorimoschemini). In P. Huemer, O. Karsholt & M. Nuss (Eds.). *Microlepidoptera of Europe* (Vol. 6). Apollo Books. https://doi.org/10.1163/9789004260986

Huemer, P., & Karsholt, O. (2018). Revision of the genus *Megacraspedus* Zeller, 1839, a challenging taxonomic tightrope of species delimitation (Lepidoptera, Gelechiidae). *ZooKeys, 800*, 1-278. https://doi.org/10.3897/zookeys.800.26292 PMid:30532621 PMCid:PMC6284011

Huemer, P., & Karsholt, O. (2020). Commented checklist of European Gelechiidae (Lepidoptera). *ZooKeys*, *921*, 65-140. https://doi.org/10.3897/zookeys.921.49197 PMid:32256151 PMCid:PMC7109147

Huemer, P., Karsholt, O., Aarvik, L., Berggren, K., Bidzilya, O., Junnilainen, J., Landry, J-F., Mutanen, M., Nupponen, K., Segerer, A., Sumpich, J., Wieser, Ch., Wiesmair, B., & Herbert, P. D. N. (2020). DNA barcode library for European Gelechiidae (Lepidoptera) suggests greatly underestimated species diversity. *ZooKeys*, *921*, 141-157. https://doi.org/10.3897/zookeys.921.49199 PMid:32256152 PMCid:PMC7109146

Huemer, P., & Wieser, C. (2010). Beitrag zur Faunistik der Schmetterlinge (Lepidoptera) in der Region Valencia (Spanien) - Teil II. *Denisia*, *29*, 139-164.

Karsholt, O., Baldizzone, G., & Gomboc, S. (2023). Overview of the Gelechiidae moths (Lepidoptera) of Krk Island, Croatia: Diversity, distribution, and ecological insights. Panoramica sui microlepidotteri della famiglia Gelechiidae (Lepidoptera) dell'Isola di Krk, Croazia: Diversità, distribuzione e aspetti ecologici. *Gortania*, *45*, 95-124.

Karsholt, O., & Rutten, (2005). The genus *Bryotropha* Heinemann in the Western Palaearctic (Lepidoptera: Gelechiidae). *Tijdschrift voor Entomologie*, *148*, 77-207. https://doi.org/10.1163/22119434-900000168

Nel, J. (1995). Sur quelques espèces nouvelles ou peu connues de Gelechiidae observées au Mont Ventoux (Vaucluse) et en Basse-Provence. Quatrième contribution à la connaissance des Gelechiidae du sud de la France (Lepidoptera). *Alexanor*, *19*(1), 37-45.

Nel, J., Varenne, T., & Bassi, G. (2022). *Huemeria* gen. nov. et description de *Huemeria campicolella tyrrhenica* ssp. nov. (Lepidoptera, Gelechiidae, Isophrictini). *Revue de l'Association Roussillonnaise d'Entomologie*, *31*(2), 114-119.

Pitkin, L. M. (1986) A technique for the preparation of complex male genitalia in Microlepidoptera. *Entomologist's Gazette*, *37*, 173-179.

Ratnasingham, S. (2018). *BOLD Barcode of Life Data System, version 4*. http://www.boldsystems.org.

Ratnasingham, S., & Hebert, P. D. N. (2007). BOLD: The Barcode of Life Data System (http://www. barcodinglife.org). *Molecular Ecology Notes, 7*, 355-364. https://doi.org/10.1111/j.1471-8286.2007.01678.x Mid:18784790 PMCid:PMC1890991

Ratnasingham, S., & Hebert, P. D. N. (2013). A DNA-based registry for all animal species: The Barcode Index Number (BIN) system. *PLoS ONE, 8*(7), e66213. https://doi.org/10.1371/journal.pone.0066213. PMid:23861743 PMCid:PMC3704603

Tamura, K., Stecher, G., & Kumar, S. (2021). MEGA11: Molecular Evolutionary Genetics Analysis version 11. *Molecular Biology and Evolution*, *38*, 3022-3027. https://doi.org/10.1093/molbev/msab120. PMid:33892491 PMCid:PMC8233496

Varenne, T., Huemer, P., & Nel, J. (2017). *Chimericorsa nioloensis* gen. nov., sp. nov., découvert en Corse. *Chimericorsa nioloensis* gen. nov., sp. nov., from Corsica (Lepidoptera, Gelechiidae, Anomologinae). *Revue de l'Association Roussillonnaise d'Entomologie*, *26*(3), 126-134.

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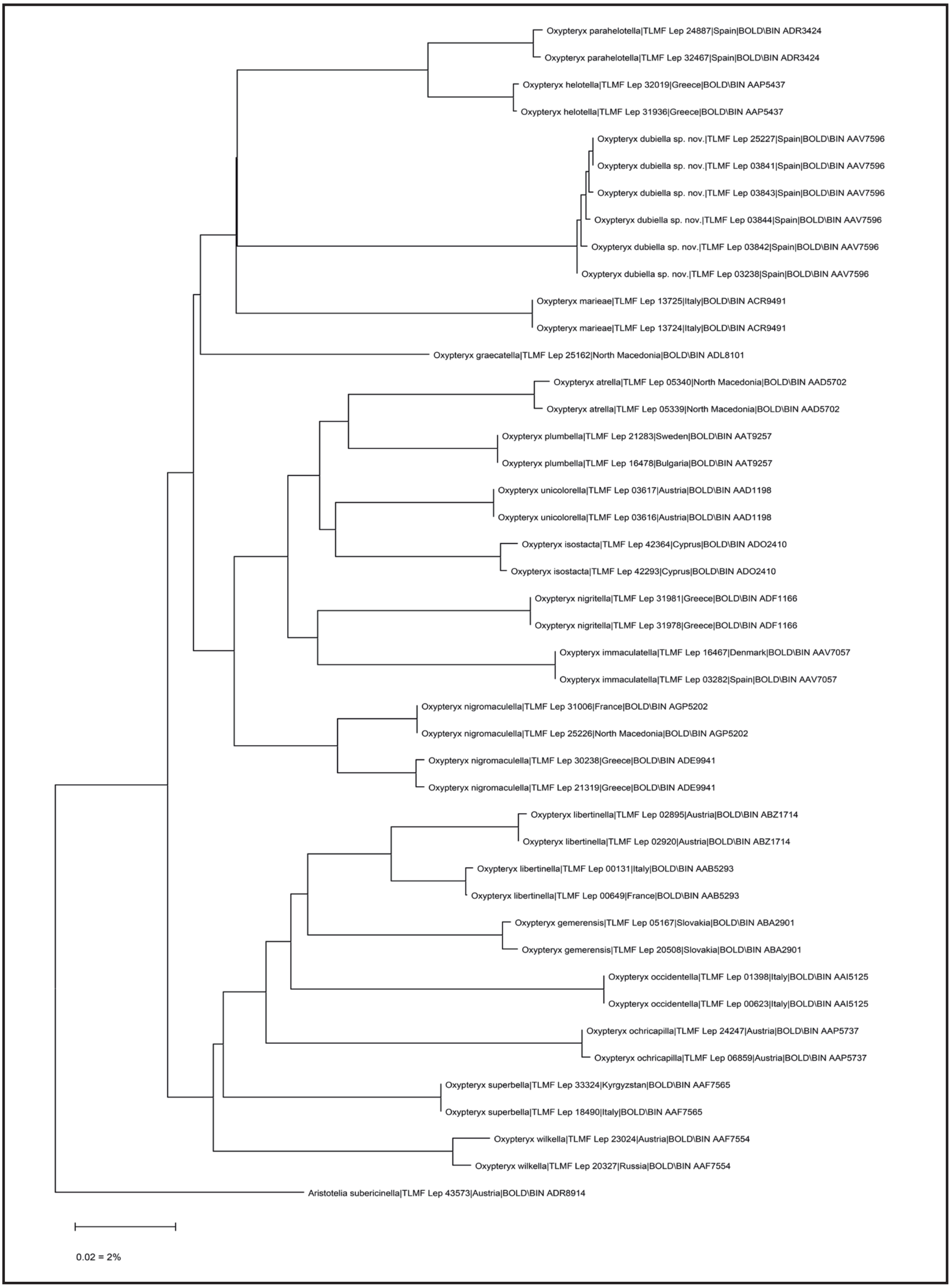
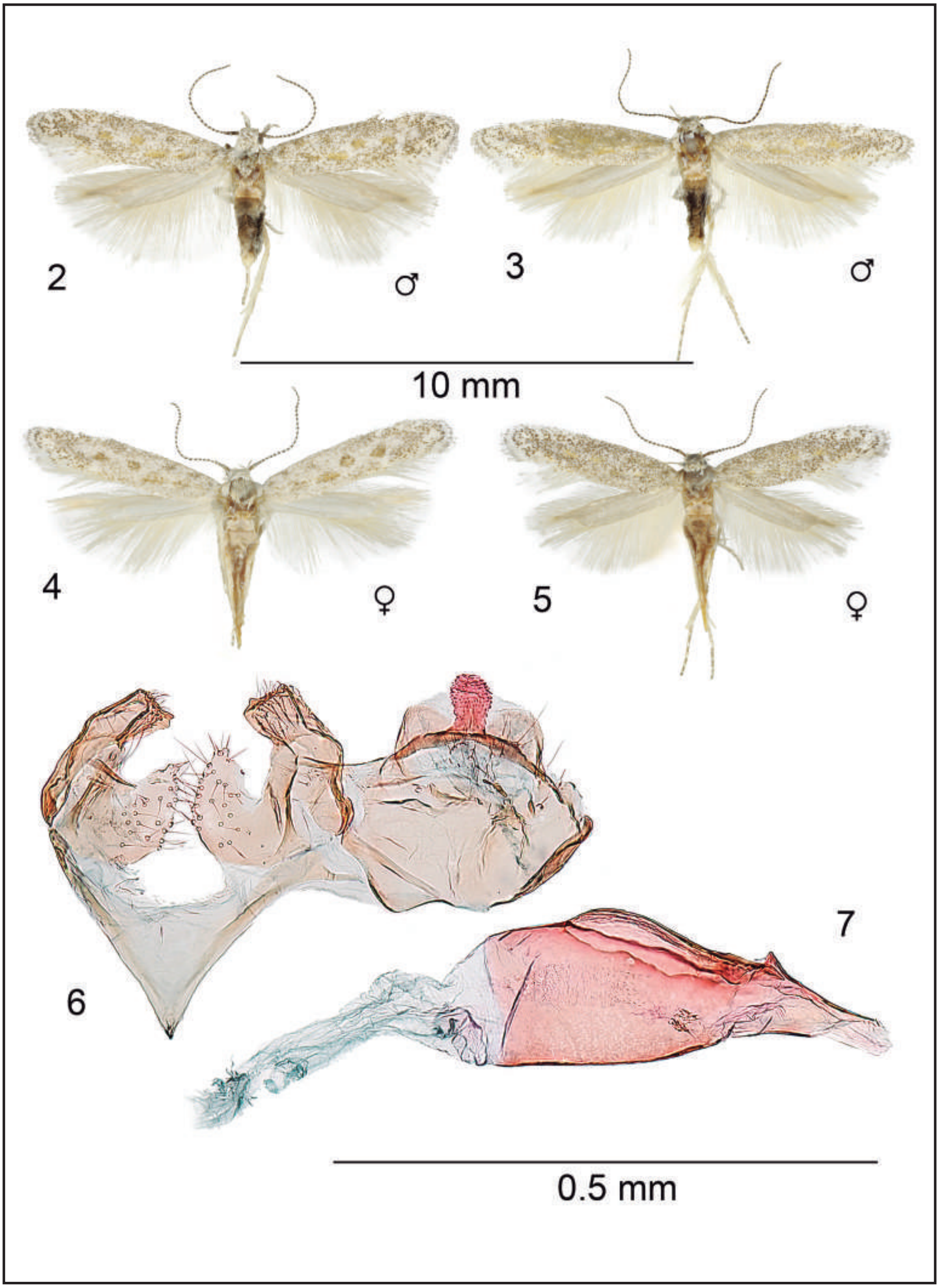
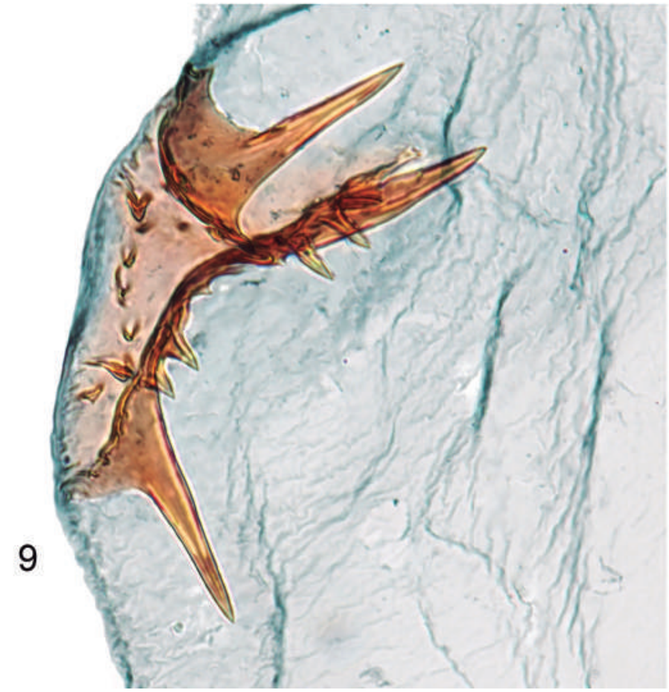
Figure 1. Neighbor-Joining tree of *Oxypteryx* spp. (Kimura 2-parameter, built with MEGA11 (Kumar et al. 2021), rooted for *Aristotelia subericinella* (Duponchel, [1843]) as out-group; Source: DNA Barcode data from BOLD (Barcode of Life Database; Ratnasingham 2018).

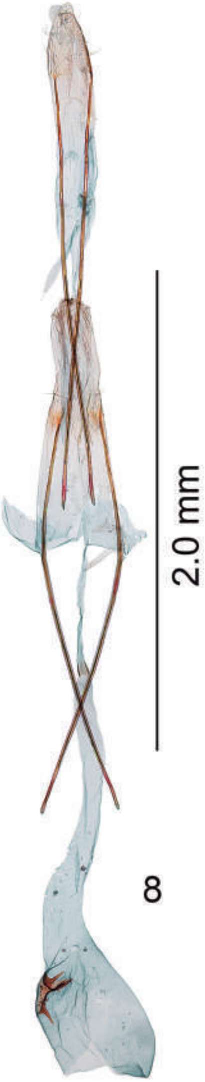


Figures 2-7. *Oxypteryx dubiella* Huemer & Šumpich, sp. nov., Spain, paratypes. **2-5.** Adults. **6-7.** Male genitalia, gen. slide GEL 1354. **6.** Unrolled view. **7.** Phallus.



Figures 8-10. 8-9. Female genitalia, holotype, gen. slide GEL 1356. **8.** General view. **9.** Detail of signum. **10.** Steppe habitats north of Albatera (Alicante, Spain), type locality in 2008 year.





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REVISIÓN DE PUBLICACIONES
BOOK REVIEWS

T. Revilla
Pyraloidea de la España peninsular e Islas Baleares
223 páginas, 73 láminas color
Formato 30,3 x 21’5 cm
La Imprenta CG, Paterna, Valencia, 2025
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Tenemos en nuestras manos, un interesante libro sobre la fauna de Pyraloidea de España peninsular e islas Baleares, faltando la interesante fauna canaria. Actualmente, la superfamilia Pyraloidea Latreille, 1809 está separada en dos familias Pyralidae Latreille, 1809 y Crambidae Latreille, 1810.

Después de unas palabras del autor, le siguen los agradecimientos, la introducción y un interesante capítulo sobre la diversidad.

Ya dentro de la parte más importante del libro, sistemática, trata todas las especies consideradas en el área de estudio, incluidas las últimas especies descubiertas en primer lugar, nos habla de los Pyraloidea, sus familia y subfamilias, con interesantes anotaciones; de cada especie nos da el nombre científico, dados sobre descripción, planta nutricia y distribución, es importante considerar que en algunas especies problemáticas, nos presenta fotografías de los adultos y /o genitalia, indicando las principales diferencias, que son muy útiles.

Todos los ejemplares están fotografiados, a lo largo de 28 láminas a todo color y 45 láminas con las genitalias de los machos y de las hembras, que, sin lugar a duda, forman una parte importante de la obra y esencial para poder identificar las especies más problemáticas, finalizando con una bibliografía y un índice específico.

Es interesante el capítulo sobre “Especies descartadas de la España peninsular y Baleares”, donde se citan y aclara la situación de algunas especies dudosas o mal identificadas, que, de momento, no deberían de pertenecer a nuestra fauna.

No podemos terminar estas líneas, sin felicitar al autor por este extenso y detallado trabajo realizado y a la Editorial por la excelente presentación del libro, obra que no puede faltar en cualquier biblioteca que se precie.

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Comparative Ultrastructure of Antennal and Mouthpart Sensilla in Larval Instars of *Amata bicincta* (Kollar, [1844]) and *Areas galactina* (Hoeven, 1840) (Lepidoptera: Erebidae)

Harsimrat Kaur Dulai & Amritpal Singh Kaleka

Abstract

This study compares the ultrastructural development of antennal and mouthpart sensilla across larval instars of *Amata bicincta* (Kollar, [1840]) and *Areas galactina* (van der Hoeven, 1840) (Lepidoptera: Erebidae) using scanning electron microscopy (SEM). *A. bicincta* exhibits five larval instars, while *A. galactina* has eight. Key findings include species-specific sensilla reductions and modifications: *A. bicincta* loses antennal sensillum B3 after the first instar, and its spinneret transitions to a broad, leaf-like structure. *A. galactina* retains B5 in later stages but loses B3 entirely, and its spinneret becomes conical in the final instar. Additional variations include transient appearances and disappearances of galeal sensilla (MSB, LSB/CSB) in *A. galactina*. These results underscore the utility of larval ultrastructure in taxonomic and sensory ecology studies, as well as the importance of examining all larval stages.
Keywords: Lepidoptera, Erebidae, *Amata*, *Areas*, larvae, ultrastructure, sensilla, SEM, taxonomy, India.

Ultraestructura comparativa de las sensillas antenales y bucales en los estadios larvarios de *Amata bicincta* (Kollar, [1844]) y *Areas galactina* (Hoeven, 1840) (Lepidoptera: Erebidae)

Resumen

Este estudio compara el desarrollo ultraestructural de las sensillas antenales y bucales a lo largo de los estadios larvarios de *Amata bicincta* (Kollar, [1844]) y *Areas galactina* (Hoeven, 1840) (Lepidoptera: Erebidae) mediante microscopía electrónica de barrido (SEM). *A. bicincta* presenta cinco estadios larvarios, mientras que *A. galactina* tiene ocho. Entre los hallazgos más destacados se encuentran reducciones y modificaciones de las sensillas específicas de cada especie: *A. bicincta* pierde la sensilla antenal B3 después del primer estadio, y su hilera se transforma en una estructura ancha similar a una hoja. *A. galactina* conserva la B5 en estadios posteriores, pero pierde la B3 por completo, y su hilera se vuelve cónica en el estadio final. Otras variaciones incluyen la aparición y desaparición transitorias de sensillas galeales (MSB, LSB/CSB) en *A. galactina*. Estos resultados subrayan la utilidad de la ultraestructura larvaria en los estudios taxonómicos y de ecología sensorial, así como la importancia de examinar todas las etapas larvarias.
Palabras clave: Lepidoptera, Erebidae, *Amata*, *Areas*, larvas, ultraestructura, sensillas, SEM, taxonomía, India.

Introduction

Lepidoptera larvae exhibit diverse morphological adaptations, with sensilla on antennae and mouthparts playing crucial roles in sensory ecology. Detailed studies across larval instars are essential for understanding species-specific adaptations and refining taxonomic classifications (Kaleka & Dulai, 2024). This study examines *Amata bicincta* (Kollar, 1840) and *Areas galactina* (van der Hoeven, 1840), two Erebidae with poorly documented larval stages. By comparing sensilla development across instars, we aim to:

1. Characterize the ontogenetic trajectories of antennal and mouthpart sensilla in both species.
2. Identify species-specific adaptations linked to ecological niches and feeding strategies.
3. Evaluate spinneret morphology as a taxonomic marker, contributing to ongoing phylogenetic studies.

By integrating SEM-based analysis, we extend the work of Kaleka & Dulai (2024) on Lymantriinae larvae, emphasizing the utility of larval ultrastructure in taxonomic identification.

Materials and Methods

Collection and Rearing: Larvae of *A. bicincta* (five instars) and *A. galactina* (eight instars) were collected from localities Kullu, Himachal Pradesh and reared on host plants under controlled conditions (25ºC, 70% humidity, 14:10 light-dark cycle). Identification was done on basis of adult morphological characters.

SEM Preparation: Heads of each instar were fixed in Carnoy's solution (3:1 ethanol: acetic acid) for 3-12 hours, post-fixed in 2% glutaraldehyde (4ºC, overnight), and dehydrated through a graded ethanol series (30-100%). Samples were critical-point dried, gold-coated, and imaged using a scanning electron microscope (JEOL) JSM-6100 in the Instrumentation Centre, Punjabi university, Patiala, India.

Sensilla Analysis: Sensilla were identified using Schneider (1964) and Zacharuk (1985, 1991). Metric data (length, distribution) were extracted using ImageJ software. Statistical analyses were conducted using ANOVA F test to record the level of significance.

Developmental Trajectory of Sensilla in *Amata bicincta*: Larvae (Figures 1-5) across five larval instars, *Amata bicincta* exhibits dynamic sensilla modifications on antennae and mouthparts, reflecting ontogenetic adaptations. Antennal sensilla progress from an initial eight sensilla in the first instar (B1-B6, C1-C2, Sty) to a reduced count in later stages: sensillum B3 disappears by the fifth instar, likely due to compensatory elongation of B1-B2, while B6 becomes obscured by B4's growth (Figures 1A-B). The terminal segment retains four sensilla (B4-B6, Sty) in early instars but loses B6 by the fourth instar, mirroring *Maeoproctis latifascia*'s regression of B5-B6 in later stages1. Mouthpart sensilla show stability in labral (C1-C12) and mandibular (C1-C2) chaetica but dynamic maxillary palp patterns: medial sensillum M2 disappears by the fourth instar, and apical sensilla (A2-A3) shorten progressively, contrasting with *Artaxa vitellina*'s retention of all maxillary sensilla1. The spinneret transitions from spindle-shaped in early instars to a broad, leaf-like structure in the fifth, akin to *A. vitellina*'s elongation1.

These shifts align with lepidopteran trends where sensilla reductions correlate with niche-specific foraging, e.g., loss of M2 may reflect tactile over chemosensory reliance in later instars, as seen in foliage-feeding *M. latifascia*1. The conserved labral chaetica (C1-C12) supports Erebidae taxonomy, while spinneret divergence (leaf-like vs. spindle-shaped) underscores species-level adaptations in silk-spinning behavior1. Such ontogenetic patterns provide taxonomic markers and ecological insights, paralleling findings in *A. vitellina* and *M. latifasci.*

Developmental Patterns in *Areas galactina* Larvae (Figures 6-10): Across eight larval instars, *Areas galatina* exhibits dynamic sensilla modifications on antennae and mouthparts, reflecting ontogenetic and ecological adaptations. Antennal sensilla show progressive reductions: sensillum B3 is absent after the first instar, while B6 is not observed in the first and seventh instars but present in others. In the final instar, sensillum B5 reappears. Mouthpart sensilla display dynamic galeal patterns, including the transient presence of medial sensillum basiconicum (MSB) in the third instar. Additionally, sensilla LSB/CSB on the galea are present only in the first four instars. The labrum and mandibles have stable chaetica (C1-C12) and (C1-C2) respectively, and the maxillary palp maintains similar sensilla counts across instars. The spinneret transitions from spindle-shaped to a conical, prominent structure in the final stage.

These shifts align with lepidopteran trends where sensilla reductions correlate with niche-specific foraging. The transient presence of MSB and the loss of LSB/CSB may indicate a shift in feeding strategies. The conserved labral chaetica (C1-C12) supports erebid taxonomy, while spinneret divergence underscores species-level adaptations in silk-spinning behavior. Such ontogenetic patterns provide taxonomic markers and ecological insights.

Discussion

Antennal Sensilla Development: *A. bicincta*: Antennal sensilla show progressive reductions: sensillum B3 disappears after the first instar, likely due to compensatory elongation of B1-B2, while B6 is obscured in later stages (e.g., seventh instar) by positional shifts of B4. *A. galactina*: B3 is absent after the first instar, while B6 is not observed in the first and seventh instars but present in others. Sensillum B5 reappears in the final instar (Table 1).

Table 1. Metrical analysis of sensilla of antennae of different aged instars of *Amata bicincta* (represented as mean length ± SD micrometers)

Sensilla type	1st instar	2nd instar	3rd instar	4th instar	5th instar
B1	6.69 1.18	10.66±0.55	16.26 0.70	35.5±1.24	49.11±0.30
B2	6.54 0.21	9.09±0.84	12.97 1.09	30.15±1.07	289.30±14.28
B3	2.51 0.36	4.47±0.16	5.95 0.29	9.08±0.42	Not seen
B4	4.97 0.19	10.68±0.73	18.23 0.39	23.21±1.03	413.08±5.98
B5	3.17 0.41	7.09±0.12	4.20±0.23	5.03±0.33	14.09±0.23
B6	2.21 0.13	3.78±0.15	3.61±0.17	Not seen	5.22±0.86

Mouthpart Sensilla Development: *A. bicincta*: Medial sensillum basiconicum (MSB) appears transiently in the third instar, while LSB/CSB on the galea diminish by the fourth instar. The maxillary palp loses M2 by the fourth instar *A. galactina*: Transient presence of MSB in the third instar. The spinneret transitions from spindle-shaped to a conical, prominent structure in the final stage (Table 2).

Table 2. Metrical analysis of mouthparts and its sensilla of different aged instars of *Amata bicinata* (represented as mean length ± SD micrometers).

Name of structures	1st instar	2nd instar	3rd instar	4th instar	5th instar
Distal segment of Mxp	8.55±0.57	10.11±0.43	16.28±0.42	16.09±2.60	18.18±2.23
Galea					
ST1	7.46±0.51	9.37±0.25	10.74±0.64	33.61±0.90	22.40±1.39
ST2	3.07±0.48	6.91±0.45	7.79±1.14	32.87±0.96	15.20±0.51
ST3	8.46±0.53	3.55±0.82	12.01±0.15	14.60±0.13	23.24±0.92
Sensilla of Maxillary Palp					
A1	1.93±0.09	2.13±0.13	2.94±0.18	2.51±0.15	4.00±0.2
A2	2.09±0.05	1.90±0.24	2.56±0.15	2.08±0.38	0.97±0.09

A3	1.35±0.05	1.73±0.23	2.46±0.23	2.07±0.19	2.75±0.07
L1	2.34±0.08	1.34±0.14	2.55±0.06	2.59±0.08	1.54±0.24
L2	1.05±0.09	1.36±0.03	2.60±0.09	3.07±0.26	1.47±0.005
L3	1.02±0.03	1.14±0.02	2.06±0.17	3.63±0.36	2.21±0.05
M1	1.29±0.19	1.47±0.14	1.62±0.23	2.28±0.40	1.22±0.22
M2	1.14±0.13	1.98±0.29	1.16±0.28	Not seen	Not seen
Sensilla of Labial palp					
C	4.84±0.61	2.57±0.19	5.62±0.80	7.27±0.22	7.37±0.46
Sty	15.37±0.41	11.26±1.27	9.99±0.99	12.23±0.56	11.26±1.27

Taxonomic Implications: Consistent sensilla chaetica (C1-C12) on both species' labrums support their Erebidae classification. However, *A. galactina*'s missing galeal sensilla basiconica distinguish it from *A. bicincta*, echoing subfamily-level differences in Lymantriinae (Grimes & Neunzig, 1986a).

Table 3. Metrical analysis of sensilla of antennae of different aged instars of *Areas galactina* (represented as mean length ± SD micrometers).

Sensilla type	**1st instar**	**2nd instar**	**3rd instar**	**4th instar**	**5th instar**	**6th instar**	**7th instar**	**8th instar**
B1	28.19±1.64	31.68±1.92	48.96±0.61	44.45±2.60	46.91±2.14	44.76±5.46	39.47±0.87	43.82±9.16
B2	8.47±0.81	25.04±2.26	19.12±0.27	48.95±4.07	25.82±1.72	26.50±3.62	47.39±0.24	24.16±0.73
B3	3.36±0.31	Not seen	Not seen	Not seen	Not seen	Not seen	Not seen	Not seen
B4	15.64± 0.29	21.96±2.00	24.69±0.80	26.25±1.31	36.24±2.64	34.23±0.45	42.30±1.35	35.47±0.61
B5	5.47±0.83	10.24±0.83	7.46±0.37	8.61±0.17	7.33±0.16	6.82±0.78	9.91±1.48	5.02±0.11
B6	Not seen	7.69±0.49	5.77±0.75	3.90±0.67	5.20±3.07	5.28±0.25	Not seen	3.32±0.99

Table 4. Metrical analysis of mouthparts and its sensilla of different aged instars of *Areas galactina* (represented as mean length ± SD micrometers).

Name of structures	**1st instar**	**2nd instar**	**3rd instar**	**4th instar**	**5th instar**	**6th instar**	**7th instar**	**8th instar**
Distal segment of Mxp	9.43±1.39	8.54±0.27	16.10± 0.16	34.74± 2.13	48.74± 2.94	92.48± 5.48	98.83± 1.90	126.92± 0.56
Galea								
ST1	11.97±0.13	11.61±0.51	62.47± 0.15	86.43±3.45	126.78± 0.41	152.54± 0.25	202.79± 0.74	187.94± 2.89

ST2	9.69±0.55	13.29±1.81	56.30± 1.69	93.63± 2.93	117.27± 1.79	149.59± 1.13	206.39± 0.41	347.71± 12.93
ST3	14.73±0.3	16.55±1.95	38.62± 0.21	29.54± 2.06	141.71± 1.27	Not seen	197.13± 0.22	255.93± 5.74
Sensilla of Maxillary Palp								
A1	2.13±0.28	3.48±0.37	5.43± 0.34	5.24±0.20	5.88± 0.39	7.88±1.07	8.41± 0.65	8.47± 1.44
A2	1.55±0.10	2.93±0.22	4.80± 0.09	5.14±0.17	4.55± 0.17	5.64±0.22	4.45± 0.60	5.99± 0.42
A3	1.66±0.34	3.49±0.28	3.71±0.11	3.76±0.11	4.13± 0.01	7.2± 0.19	5.85± 0.71	7.25± 1.53
L1	1.15±0.05	1.36±0.32	4.23±0.31	3.49± 0.22±	4.42±0.41	6.96± 0.79	4.36± 0.91	4.68± 0.49
L2	1.09±0.10	1.64±0.16	2.78± 0.42	2.61±0.53	2.92± 0.17	8.81± 2.23	5.30± 0.11	4.63±0.40
L3	1.32±0.07	1.68±0.05	4.64±0.46	2.68±0.45	4.11±0.64	5.08±0.10	5.52±1.26	8.39± 0.57
M1	1.20±0.10	1.95±0.22	2.47±0.28	3.29±0.03	2.13± 0.01	5.70± 0.21	5.77± 0.29	5.13± 0.48
M2	0.77±0.04	2.54±0.15	2.39±0.64	4.46± 0.57	2.46± 0.62	5.19± 0.41	4.14 0.42	8.82± 0.66
Sensilla of Labial palp								
C	5.93±0.34	8.83±0.04	12.59± 0.82	10.03± 1.05	19.19± 0.82	16.74± 0.11	19.68± 0.44	11.56± 1.09
Sty	11.37±1.04	14.21± 0.02	29.97± 0.22	37.82± 1.98	41.82± 1.63	57.34± 2.61	59.33± 1.46	23.07± 0.155

Conclusion

Ontogenetic sensilla patterns in *A. bicincta* and *A. galactina* reveal species-specific adaptations, with B3 loss and spinneret divergence serving as taxonomic markers. These findings align with Lepidoptera trends, underscoring larval morphology's utility in sensory ecology and systematics. Further studies are needed to determine any phylogenetic implications or relationships (Kaleka & Dulai, 2024).

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Conflict of Interest

The authors declare that there is no known financial interest or personal relationship that could have influenced the work presented in this article.

References

Fanger, H., & Naumann, C. M. (2001). The morphology of the last instar larva of *Aglaope infausta* (Lepidoptera: Zygaenidae: Chalcosiinae). *European Journal of Entomology, 98*(2), 201-218. https://doi.org/10.14411/eje.2001.038

Grimes, L. R., & Neunzig, H. H. (1986a). Morphological survey of the maxillae in last-stage larvae of the suborder Ditrysia (Lepidoptera): Palpi. *Annals of the Entomological Society of America, 79*, 491-509. https://doi.org/10.1093/aesa/79.3.491

Grimes, L. R., & Neunzig, H. H. (1986b). Morphological survey of the maxillae in last-stage larvae of the suborder Ditrysia (Lepidoptera): Mesal lobes (laciniogaleae). *Annals of the Entomological Society of America, 79*, 510-526. https://doi.org/10.1093/aesa/79.3.510

Kaleka, A. S., & Dulai, H. K. (2024). Comparative analysis of sensilla on antennae and mouthparts of larvae in two species of Ditrysian moths (Lepidoptera). *Journal of Advanced Zoology, 45*(2), 188-205. https://doi.org/10.53555/jaz.v45i1.2915

Li, Y., Du, X., Liu, F., Li, Y., & Liu, T. X. (2018). Ultrastructure of the sensilla on antennae and mouthparts of larval and adult *Plutella xylostella* (Lepidoptera: Plutellidae). *Journal of Integrative Agriculture, 17*(6), 1409-1420. https://doi.org/10.1016/S2095-3119(17)61844-6

Lin, R. J., Braby, M. F., & Hsu, Y. F. (2019). The immature stages, biology, and phylogenetic relationships of *Rotunda rotundapex* (Lepidoptera: Bombycidae). *Journal of Insect Science, 19*(2), 19. https://doi.org/10.1093/jisesa/iez025 PMid:30953584 PMCid:PMC6451653

Schneider, D. (1964). Insect antennae. *Annual Review of Entomology, 9*, 103-122. https://doi.org/10.1146/annurev.en.09.010164.000535

Shields, V. D. C. (2009). Fine structure of the galeal styloconic sensilla of larval *Lymantria dispar* (Lepidoptera: Lymantriidae). *Annals of the Entomological Society of America, 102*(6), 1116-1125. https://doi.org/10.1603/008.102.0621 PMid:21057591 PMCid:PMC2971561

Song, Y., Sun, H.-Z., & Wu, J.-X. (2014). Morphology of the sensilla of larval antennae and mouthparts of the oriental fruit moth, *Grapholita molesta*. *Bulletin of Insectology, 67*, 193-198.

Zacharuk, R. Y. (1980). Ultrastructure and function of insect chemosensilla. *Annual Review of Entomology, 25*(1), 27-47. https://doi.org/10.1146/annurev.en.25.010180.000331

Zacharuk, R. Y. (1985). Antennae and sensilla. In G. A. Kerkut & L. I. Gilberty. *Comprehensive Insect Physiology, Biochemistry and Pharmacology* (pp. 29-63). Pergamon Press.

Zacharuk, R. Y., & Shields, V. D. C. (1991). Sensilla of immature insects. *Annual Review of Entomology, 36*(1), 331-354. https://doi.org/10.1146/annurev.en.36.010191.001555

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Figure 1. Morphology and structure of sensilla on antennae in all larval instars of *Amata bicincta.*

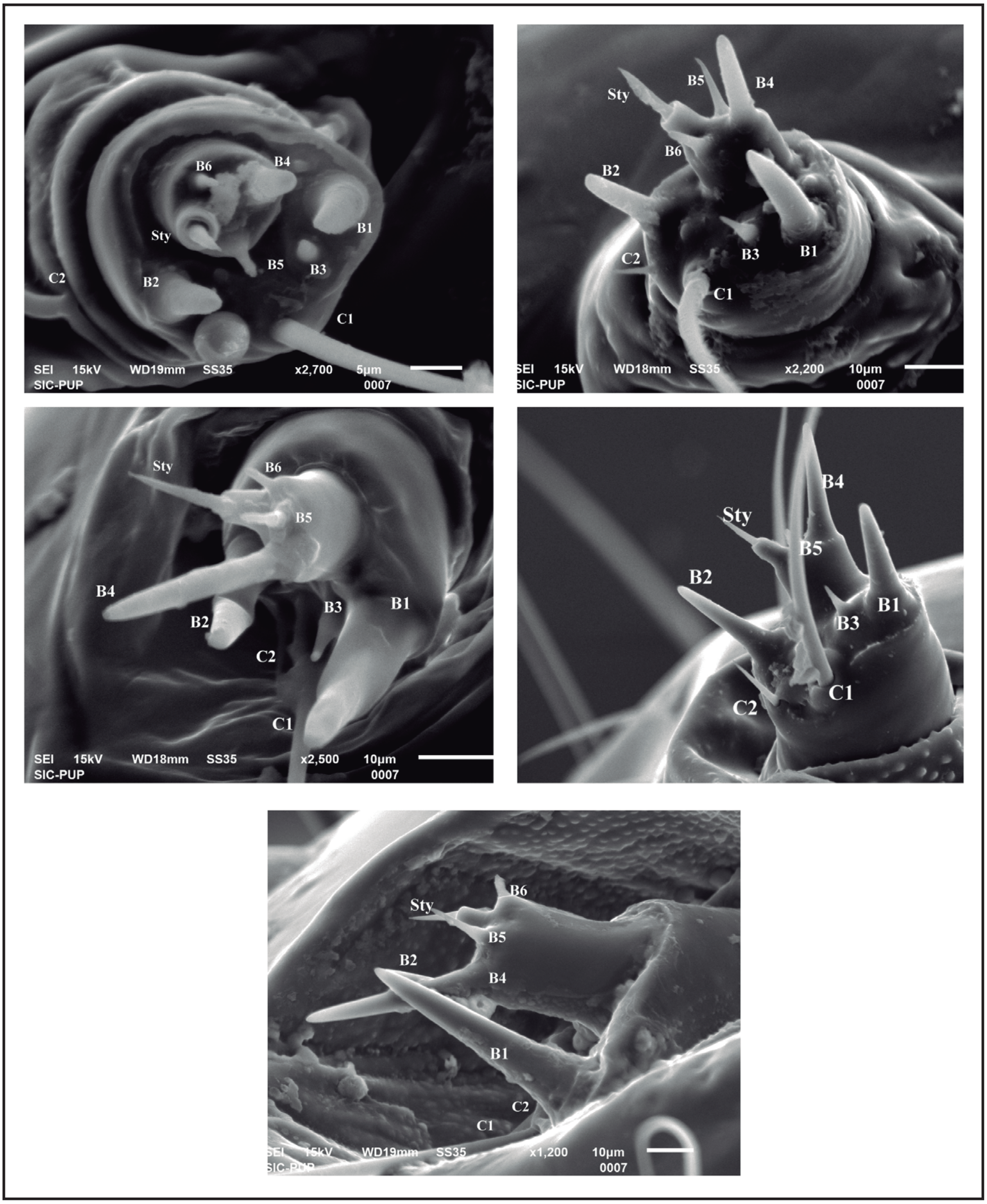


Figure 2. Morphology and structure of sensilla on labrum and mandibles in all larval instars of *Amata bicincta.*

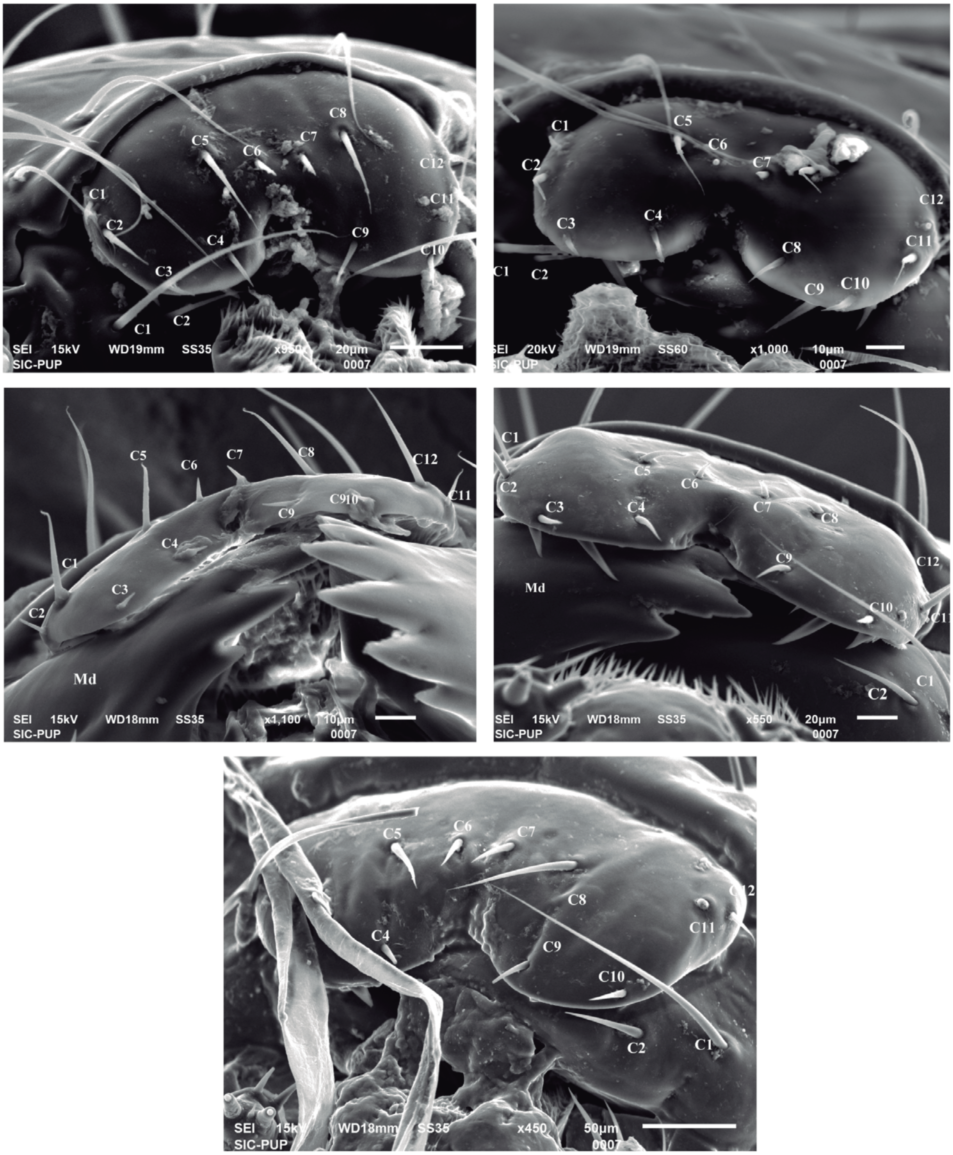


Figure 3. Morphology and structure of sensilla on galea in all larval instars of *Amata bicincta.*

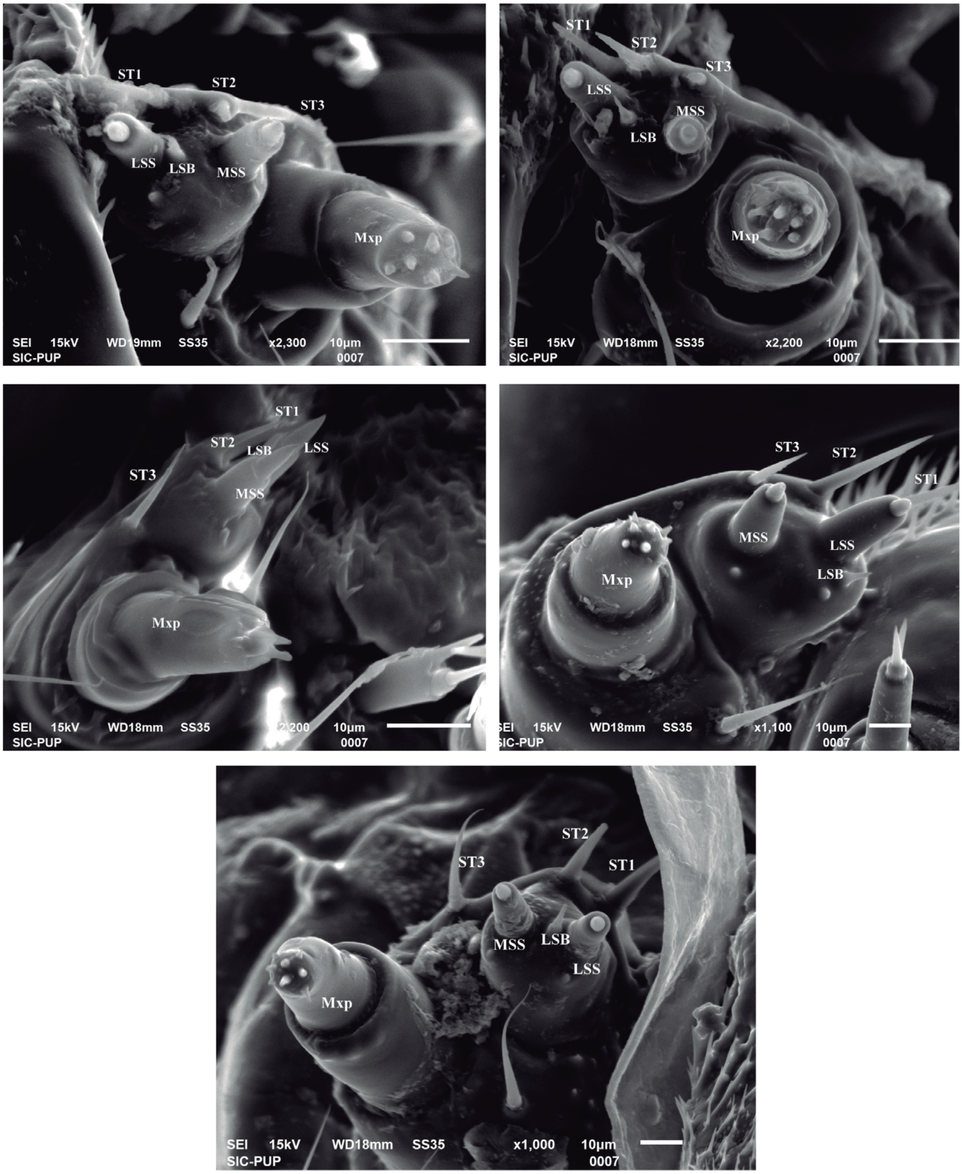


Figure 4. Morphology and structure of sensilla on maxillary palps in all larval instars of *Amata bicincta.*

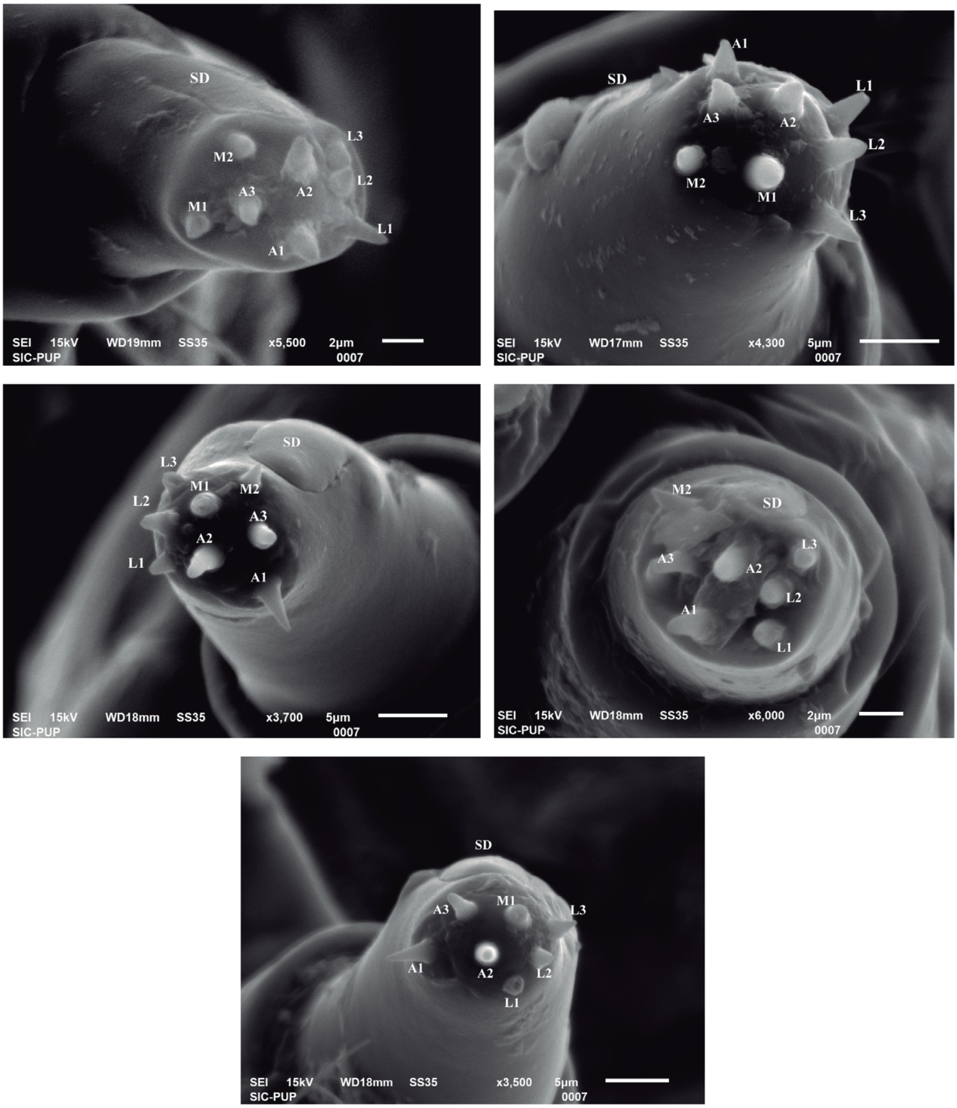


Figure 5. Morphology and structure of sensilla on labial palps in all larval instars of *Amata bicincta*.

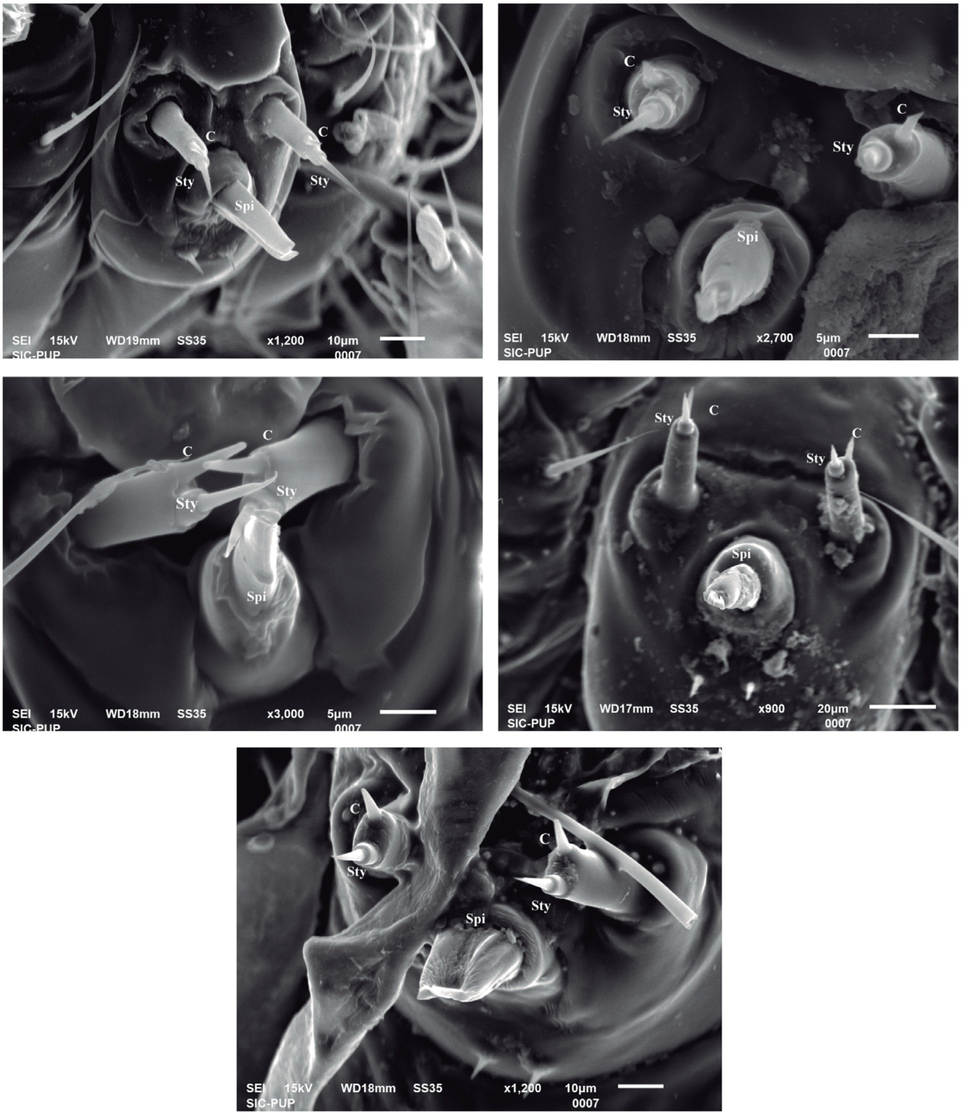


Figure 6. Morphology and structure of sensilla on antennae in all larval instars of *Areas galactina.*

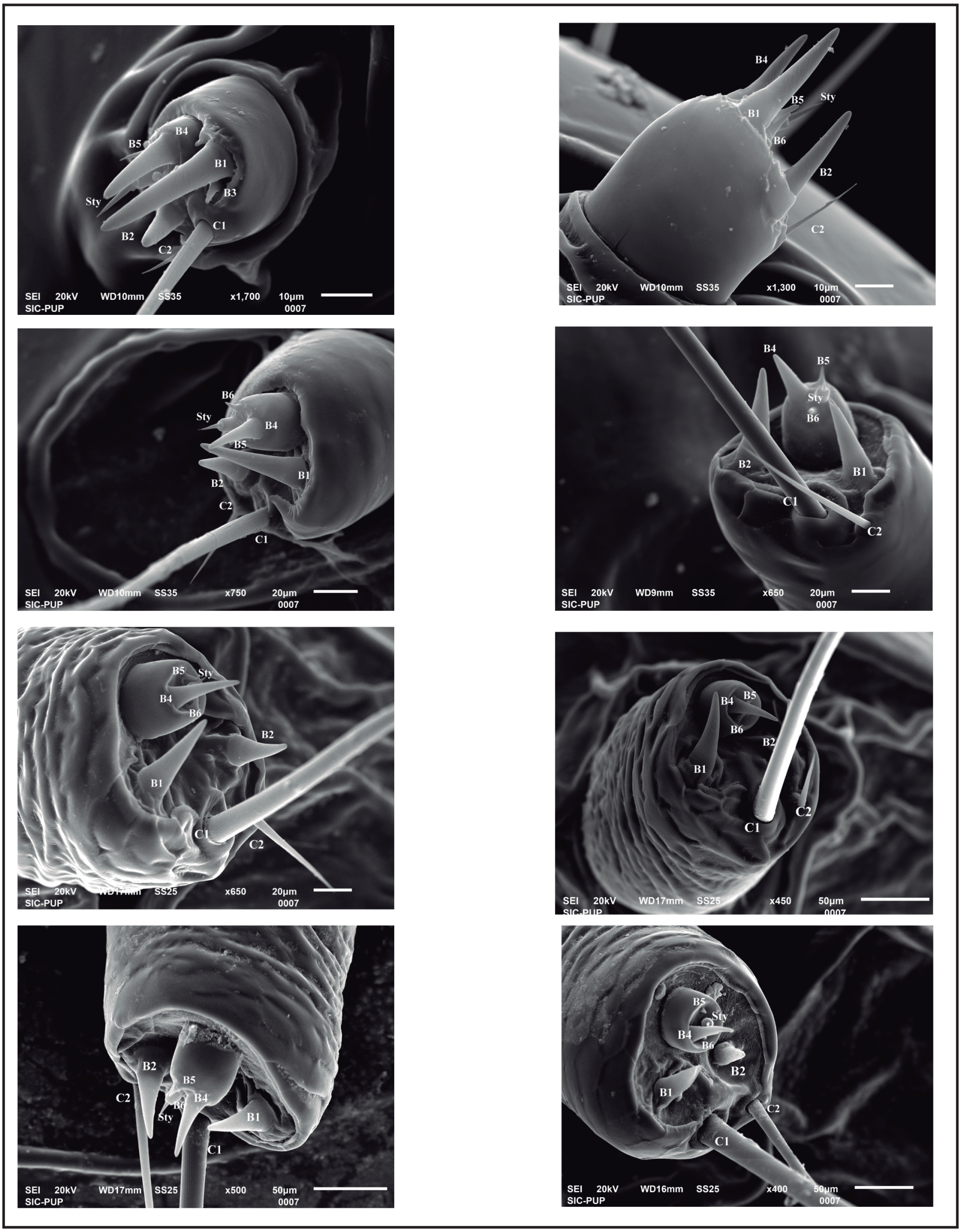


Figure 7. Morphology and structure of sensilla on labrum and mandibles in all larval instars of *Areas galactina.*

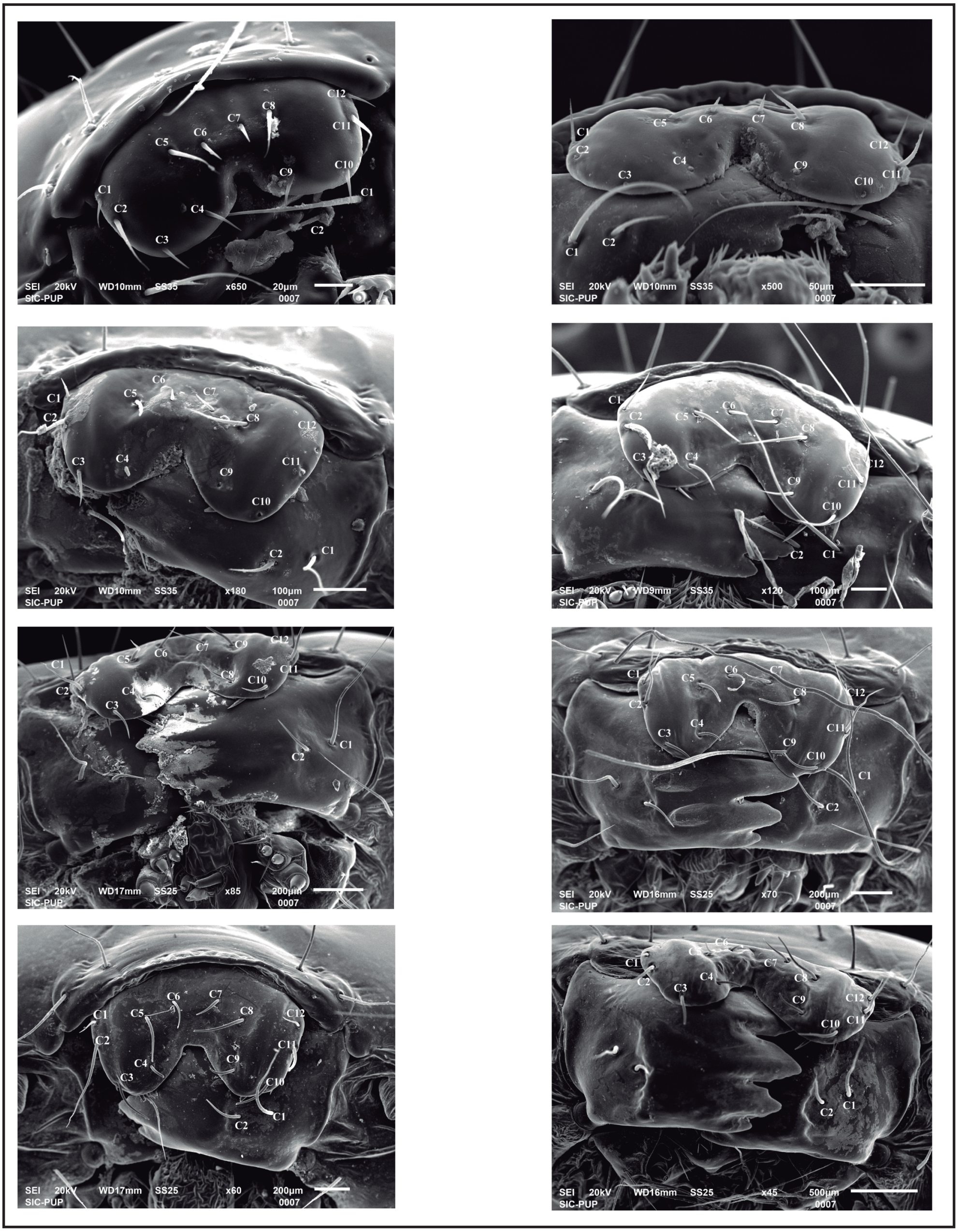


Figure 8. Morphology and structure of sensilla on galea in all larval instars of *Areas galactina.*

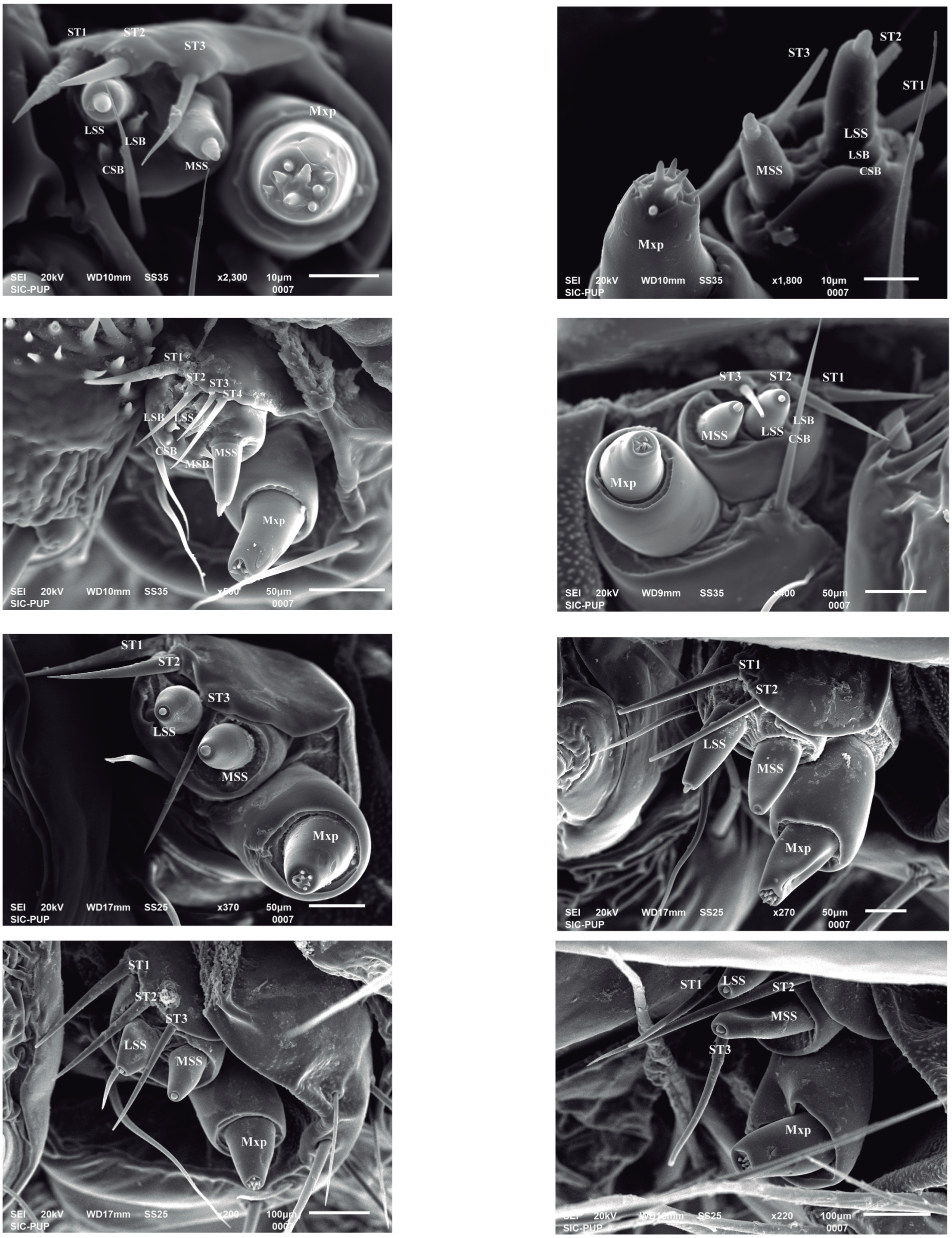


Figure 9. Morphology and structure of sensilla on maxillary palps in all larval instars of *Areas galactina.*

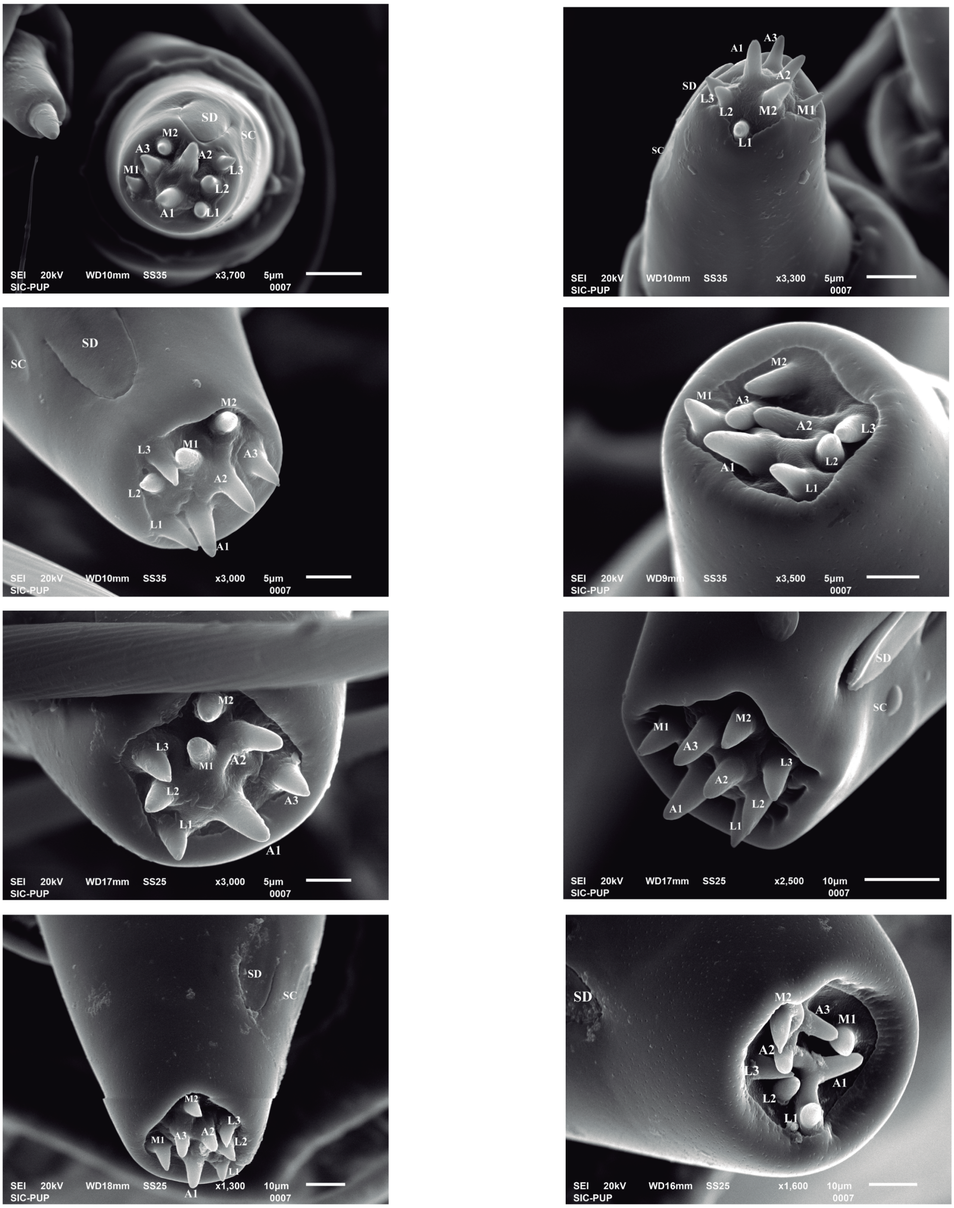
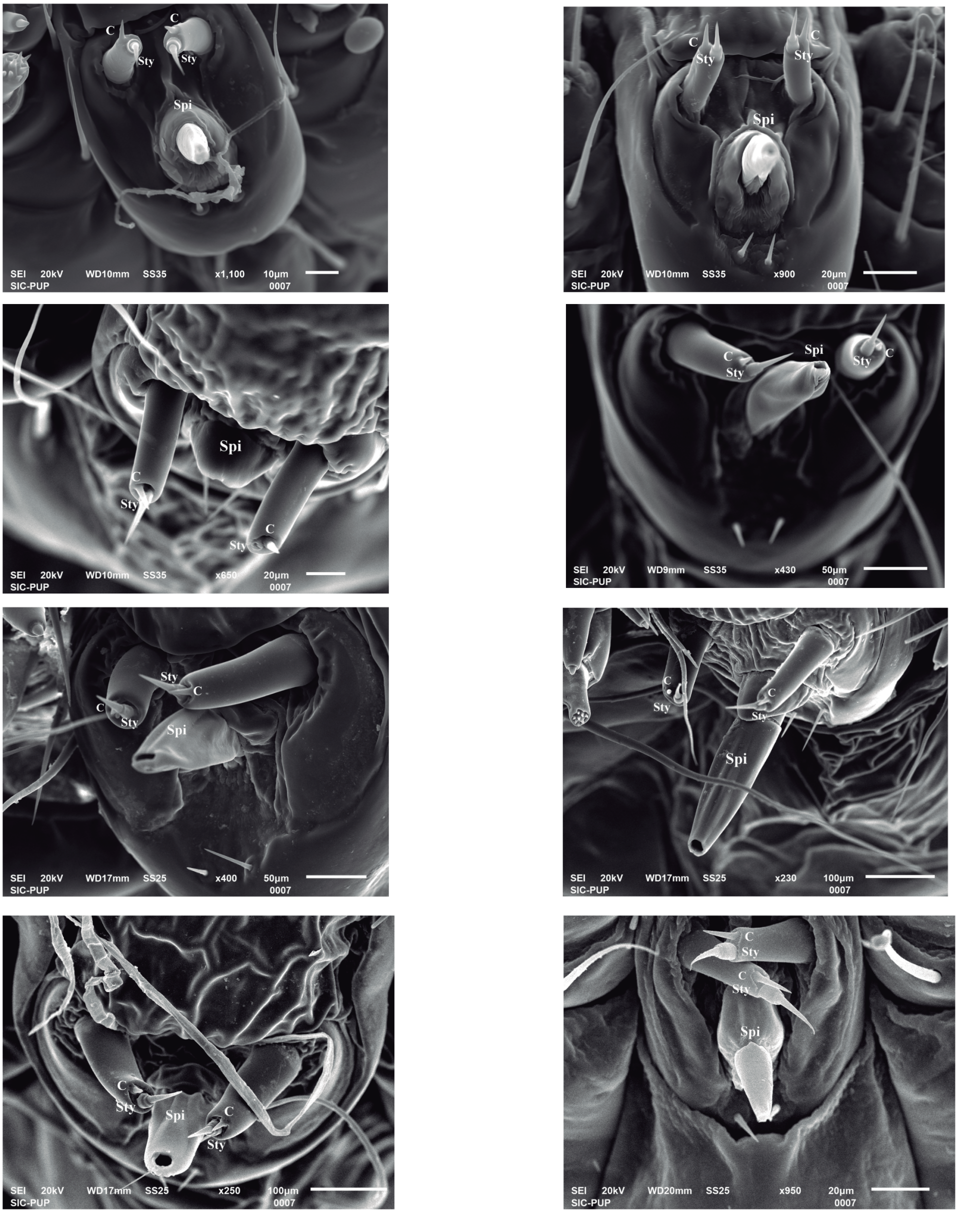


Figure 10. Morphology and structure of sensilla on labial palps in all larval instars of *Areas galactina.*



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Tenemos en nuestras manos, un interesante libro sobre la fauna presente en la península ibérica, así como de las Islas Baleares y Canarias, tratando tanto la fauna diurna (con 257 especies) y una parte de la fauna nocturna (con 400 especies), trabajo realizado a lo largo de más de una treintena de años. Si bien queda lejos de las casi 5.000 especies conocidas en el área de estudio, no es baladí, esta excelente aportación.

Después de unas palabras del autor, el prólogo, la introducción, los agradecimientos y un interesante capítulo sobre las amenazas para las mariposas diurnas.

Ya dentro de la parte más importante del libro, que está profundamente ilustrado a todo color, nos hace una introducción a cada una de las familias consideradas. De cada especie nos presenta fotografías de los adultos, el mapa de distribución y, en muchos casos, los estadios larvarios y la pupa y la planta nutricia.

Al finalizar cada familia, nos presentan una lámina o varias láminas, con todas las especies consideradas, debidamente preparadas, lo que facilita la identificación de cada una de ellas

Es muy interesante, que el autor nos muestra fotografías enteras o partes, de las diferentes especies más problemáticas, lo que ayuda a su identificación, como pasa con el género *Pieris* Schrank, 1801, *Melanargia* Meigen, 1828, *Erebia* Dalman, 1816, etc., aunque falta tratar el complejo de especies canarias del grupo de *Pararge xiphioides* (Staudinger, 1871) formado por cuatro especies.

Ya en la parte que trata las especies de actividad nocturna, Heterocera, nos da unas pinceladas, sobre el estudio y cría., como poder capturarlas y un índice de las especies consideradas que abarcan 19 familias y de cada una de las especies estudiadas, presenta el mismo patrón que con los Rhopalocera, finalizando la obra con una bibliografía.

No podemos terminar estas líneas, sin felicitar al autor por este extenso y detallado trabajo realizado a lo largo de tantos años y que, sin duda, ayudará a todos los que deseen introducirse en el estudio de los Lepidoptera y a la Editorial por la excelente presentación del libro, obra que no puede faltar en cualquier biblioteca que se precie.

El precio de este libro es de 60,00 euros más gastos de envío y los interesados lo pueden pedir a:

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First record of *Choreutis nemorana* (Hübner, [1799]) from Western Ukraine with a distributional checklist of the family in Ukrainian fauna (Lepidoptera: Choreutidae)

Viktor Yepishin & Ruslan Mishustin

Abstract

The *Choreutis nemorana* (Hübner, [1799]) was discovered in Western Ukraine for the first time. The larvae of this species were found on *Ficus carica* L. in the city of Uzhhorod (Transcarpathian region). The adults were bred in laboratory conditions. Most of the life stages of *Choreutis nemorana* are illustrated. A distributional checklist of the Choreutidae family in Ukraine is provided.
Keywords: Lepidoptera, Choreutidae, Transcarpathian region, *Ficus carica*, Ukraine.

Primer registro de *Choreutis nemorana* (Hübner, [1799]) en el oeste de Ucrania con una lista de distribución de la familia en la fauna ucraniana (Lepidoptera: Choreutidae)

Resumen

La especie *Choreutis nemorana* (Hübner, [1799]) fue descubierta por primera vez en el oeste de Ucrania. Las larvas de esta especie se encontraron en *Ficus carica* L. en la ciudad de Uzhhorod (región de Transcarpatia). Los adultos se criaron en condiciones de laboratorio. Se ilustran la mayoría de las etapas de la vida de *Choreutis nemorana*. Se proporciona una lista de distribución de la familia Choreutidae en Ucrania.
Palabras clave: Lepidoptera, Choreutidae, región de Transcarpatia, *Ficus carica*, Ucrania.

Introduction

The family Choreutidae Stainton, 1854, is represented in Ukraine by 13 species. *Anthophila fabriciana* (Linnaeus, 1767) and *Choreutis pariana* (Clerck, 1759) are found throughout Ukraine. *Millieria dolosalis* (Heydenreich, 1851) and *Tebenna micalis* (Mann, 1857) are found in Southern Ukraine. *Anthophila abhasica* Danilevsky, 1969, *Prochoreutis pseudostellaris* Budashkin, 2003 and *Tebenna chingana* (Danilevsky, 1969) are known only from Crimea. *Tebenna bjerkandrella* (Thunberg, 1784) and *Choreutis diana* (Hübner, [1822]) are found in the Carpathians.

Until now the *Choreutis nemorana* (Hübner, [1799]) was known only from southern Ukraine (Odesa region, Mykolaiv region, Kherson region and Crimea). In 2024, the larvae of this species were found on *Ficus carica* L. in Uzhhorod city (Transcarpathian region). Due to the wide distribution of this species in Europe, the most likely route of entry was from Slovakia or Hungary (GBIF 2025).

Material and Methods

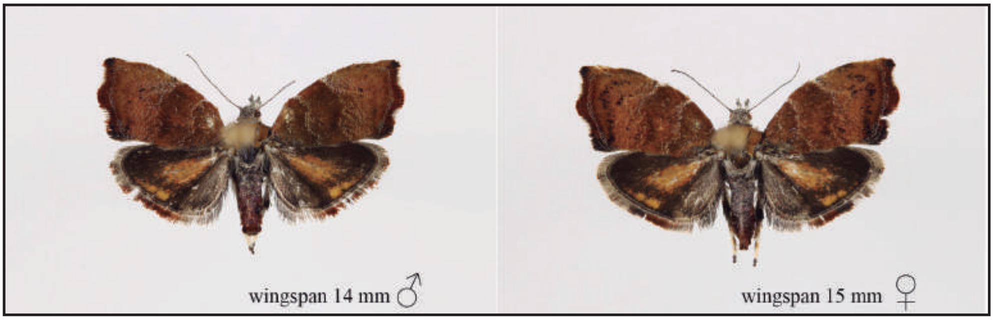
The material for this research was obtained by the second author in a garden in Uzhhorod, Transcarpathian region. The larvae were collected from the leaves of *Ficus carica* L. in late August. They were kept under laboratory conditions in cages containing the same fig branches until pupation. The imago specimens are stored in the private research collection of V. Yepishin. Preimaginal stages, imagoes and pinned specimens were photographed with a Canon EOS 600D digital camera equipped with a Canon macro lens EF-S 60 mm and macro rings.

Results

Choreutis nemorana (Hübner, [1799]) (Figures 1-13)
Tortrix nemorana Hübner, [1799]. *Samml. eur. Schmett.,* [7], pl. 1, fig. 3
Type locality: [EUROPE]
Asopia incisalis Treitschke, 1829, *in* Ochsenheimer. *Schmett. Eur., 7*, 157-159
Type locality: AUSTRIA

Material examined: Ukraine, Transcarpathian (Zakarpattia) Region, Uzhhorod City, ex larvae on *Ficus carica*, 9 ♂, 6 ♀, 26-VIII-2024, leg. R. Mishustin.

Figure 1. Male and female of *Choreutis nemorana*.



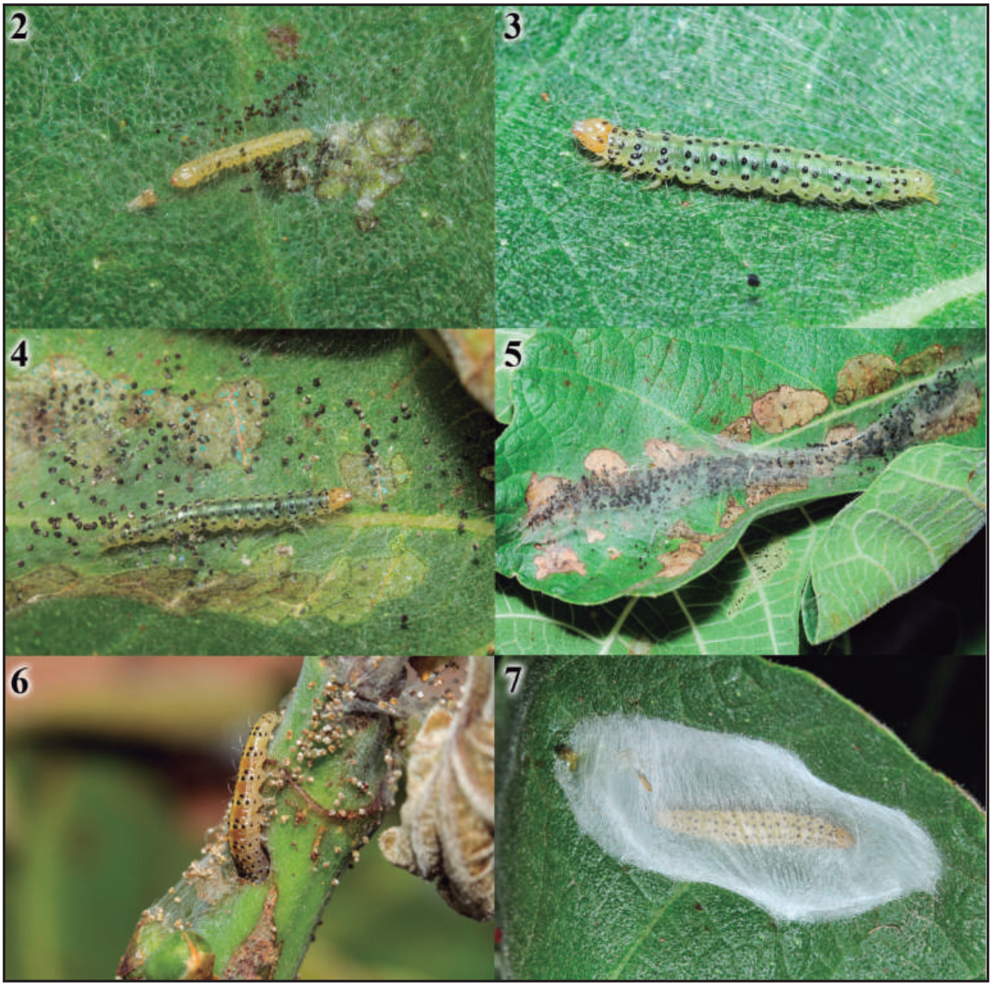
Distribution: Europe except for North, Tunisia, Turkey, the Caucasus, Iraq, Iran, Uzbekistan, Turkmenistan, China (Amsel, 1955; Danilevsky & Kuznetzov, 1973; Diakonoff, 1986; Seven, 1991; Zouba, 2010; De Prins et al. 2014).

Biology: Larvae of various ages, from very young (second instar) to those ready to pupate (i.e., last instar) (Figures 2-3), were observed on fig leaves in the city of Uzhhorod on August 26, 2024. The larvae developed on cut fig branches placed in water under laboratory conditions at a temperature of 24-25ºC. The larvae live on the upper side of the leaves under a not very dense silk with impurities of its excrement, the silk forms a "shelter" (Figure 4), where the larva quickly hides in case of danger. Caterpillars feed on leaves, skeletonizing them (Figure 5). Sometimes caterpillars can damage stems (Figure 6), obviously in the absence of other, more suitable parts of the food plant (leaves, fruits). The first larvae began to pupate on August 28 and the last completed pupation on September 8. The cocoon (Figure 7) is built on the upper side of the leaves or in other places, but not where the silk shelter was built and in a new place. The cocoon consists exclusively of silk, is very dense and 3-layered (Figure 8). Adults emerge after 12-16 days. They emerge from the cocoon a few hours after dawn (9-12 a.m. local time). Imagoes spread their wings and are very quickly able to fly (Figures 12-13). Even while spreading their wings, imagoes can move very quickly in jumping movements in case of danger.

Distributional checklist of the Choreutidae Stainton, 1854, in Ukraine

The reports signed as "[?]" are discussed in the "Remarks" section for the corresponding species. To avoid multiplying the number of similar links, the reports from online citizen science databases include the numbers of specific observations. By substituting these numbers at the end of the corresponding link, you can go to the page of the respective observation. For UkrBIN database the link is https://ukrbin.com/show_image.php?imageid=178622 and for iNaturalist - https://www.inaturalist.org/observations/190523953 (both links already include observation numbers).

Figures 2-7. Larval stages of *Choreutis nemorana*. **2.** Second instar larva. **3.** The fully grown larva. **4.** The caterpillar in a silk "shelter". **5.** Leaf damage. **6.** Stem damage. **7.** Building a cocoon (the first, outer layer is ready).



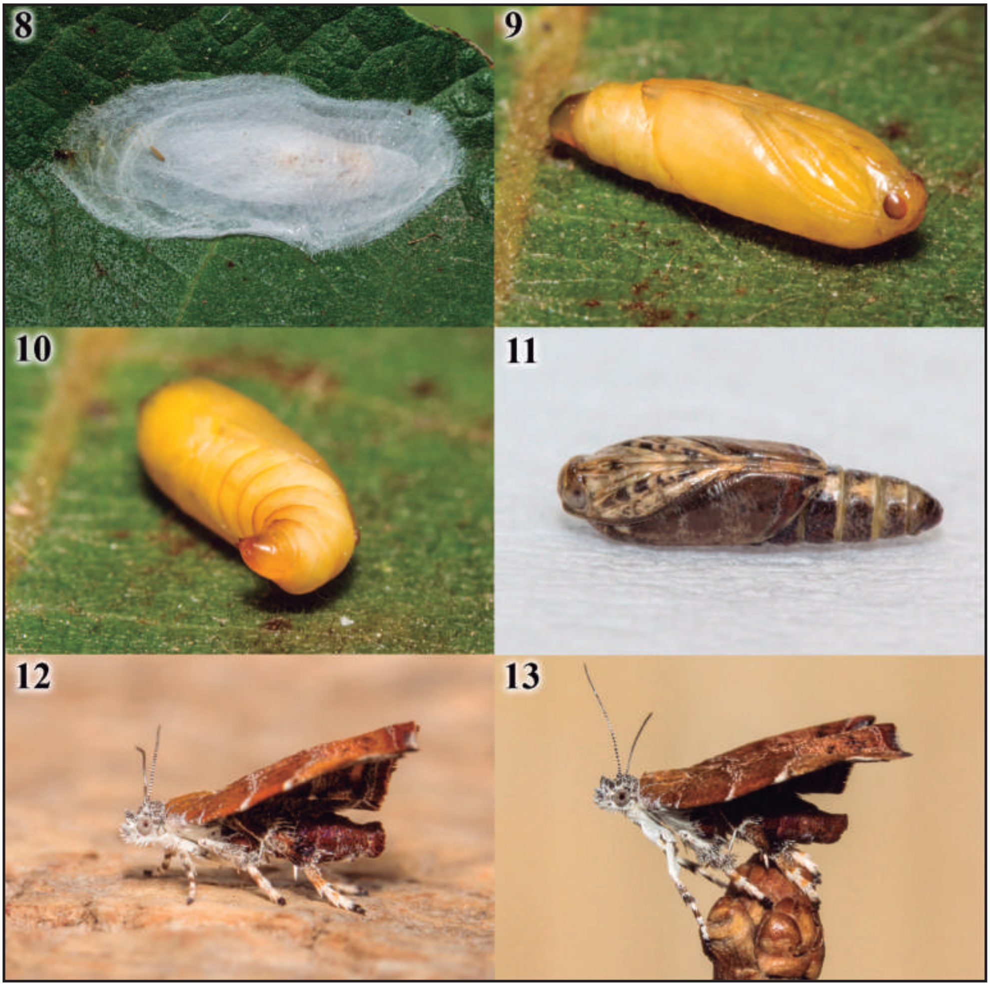
Choreutidae Stainton, 1854
Millieriinae Heppner, 1982
Millieria Ragonot, 1874

Millieria dolosalis (Heydenreich, 1851)

Kyiv reg., O. Bidzilya, ex larvae on *Aristolochia clematitis* L. (pers. comm.). Cherkasy reg. [?], UkrBIN (2025) (# 255709). Poltava reg. [?], UkrBIN (2025) (# 354550). Odesa reg., UkrBIN (2025) (# 152854). Zaporizhzhia and Donetsk regs (Kamiani Mohyly Reserve), Bidzilya et al. (2001, p. 81) (*Milliereia*). Luhansk reg.: Demyanenko et al. (2021, p. 36). Crimea, Savchuk & Kajgorodova (2020, p. 260); Savchuk 2025.

Remark: The observations from Cherkasy and Poltava regions are represented only by traces of vital activity on the host plant *Aristolochia clematitis* Linnaeus, 1753. Therefore, there is no certainty that these traces relate specifically to *Millieria dolosalis*.

Figures 8-13. Pupae and imagoes of *Choreutis nemorana*. **8.** Coccoon. **9.** Pupa shortly after pupating. **10.** Cremaster of pupa. **11.** Pupa shortly before imago emerges. **12.** Emerged male. **13.** Emerged female.



Choreutinae Stainton, 1854

Anthophila Haworth, 1811
Anthophila abhasica Danilevsky, 1969

Ivano-Frankivsk reg., Diakonoff (1986, p. 90, pl. 2, fig. 18). Crimea, Budashkin (2003, p. 44); Savchuk (2025).

Anthophila fabriciana (Linnaeus, 1767)

Rivne reg., iNaturalist (2025) (## 190523953; 167579124; 186869695; 165688433). Zhytomyr reg., Ljubomudrov (1917, p. 41) (*Simaethis*); UkrBIN (2025) (# 255346). Kyiv reg., Zhikharev (1928, p. 257) (*Choreutis*); Budashkin (2003, p. 44); iNaturalist (2025) (## 109999049; 121067330; 167183313; 253996093). Chernihiv reg., iNaturalist (2025) (# 238999067). Lviv reg., Brunicki (1913, p. 63) (*Simaethis*); Schille (1930, p. 152) (*Simaethis*); Andrianov (2025); iNaturalist (2025) (## 121969529; 190046422; 121729606; 120125108). Lviv and Transcarpathian regs (the Mount Pikui), Nowicki (1860, pp. 117-118) (*alternalis* Tr.). Ternopil reg., Toll (1939, p. 164) (*Simaethis*). Vinnytsia reg., UkrBIN (2025) (# 204671). Cherkasy reg., iNaturalist (2025) (## 119923638; 130445528; 132291296; 181037484). Poltava reg., UkrBIN (2025) (# 237789). Transcarpathian reg., Danilevsky (1969, p. 927); UkrBIN (2025) (# 178622). Ivano-Frankivsk reg., Danilevsky (1969, p. 927); Bidzilya et al. (2006, p. 28); iNaturalist (2025) (# 85887477). Chernivtsi reg., Hormuzaki (1907, p. 78) (*Simaethis*). Crimea, Danilevsky (1969, p. 927); Budashkin (2003, p. 44); Savchuk (2025).

Prochoreutis Diakonoff & Heppner, 1980
Prochoreutis myllerana (Fabricius, 1794)

Zhytomyr reg., Ksenzhopolskiy (1915, p. 11) (*Choreutis*). Kyiv reg., Zhikharev (1928, p. 256) (*Choreutis*). Lviv reg., Nowicki (1860, p. 118) (*Choreutis scintilulalis* Tr.). Ternopil reg., Świątkiewicz (1926, p. 130) (*Choreutis*); Toll (1939, p. 164) (*Choreutis*). Cherkasy reg., Diakonoff (1986, p. 109); UkrBIN (2025) (# 353272). (Kharkiv reg., Karolinskiy et al. (2017, p. 9). Kherson reg., Diakonoff (1986, p. 130) (*stellaris* [misidentification, see “Remark” to *Prochoreutis stellaris*]); Budashkin (2003, p. 48).

Prochoreutis sehestediana (Fabricius, [1777])

Ivano-Frankivsk reg., Diakonoff (1986, p. 112). Crimea: Budashkin (2003, p. 49).

Prochoreutis stellaris (Zeller, 1847)

Kharkiv reg., Karolinskiy et al. (2021, p. 58). Crimea, Budashkin (2003, p. 54).

Remark: The report of *P. stellaris* from Kherson region (“Kakhovka”) in Diakonoff (1986, p. 130) should be attributed to *P. myllerana* due to misidentification, as pointed out by Budashkin (2003, p. 48).

Prochoreutis pseudostellaris Budashkin, 2003

Crimea: Budashkin (2003, p. 54); Savchuk (2025).

Tebenna Billberg, 1820
Tebenna bjerkandrella (Thunberg, 1784)

Ivano-Frankivsk reg., Swiatkiewicz (1926, p. 131) (*Choreutis*); Schille (1930, p. 151) (*Choreutis*); Bidzilya et al. (2006, p. 28) [the report is in question]. Chernivtsi reg.: iNaturalist (2025) (## 224293420; 225406282).

Tebenna micalis (Mann, 1857)

Odesa reg.: UkrBIN (2025) (## 94624; 94633). Kherson reg., Budashkin (2003, p. 48). Zaporizhzhia reg., Budashkin (2003, p. 48). Crimea, Budashkin (2003, p. 48, 2004, p. 342); Savchuk & Kajgorodova (2015, p. 178); iNaturalist (2025) (# 145700161); Savchuk 2025.

Tebenna chingana (Danilevsky, 1969)

Crimea: Budashkin (1997, p. 15, 2003, p. 48, 2004, p. 342); Savchuk (2025).

Choreutis Hübner, [1825]
Choreutis diana (Hübner, [1822])

"Polissia", Kostjuk & Gershenson (1988, pp. 262-263). Ivano-Frankivsk reg., Swiatkiewicz (1924, p. 98) (*Simaethis*). Chernivtsi reg., Hormuzaki (1907, p. 78) (*Lutschina*)

Choreutis pariana (Clerck, 1759)

Volyn reg., Zdun (1961, p. 49) (*Anthophila*). Rivne reg., UkrBIN (2025) (# 304848). Zhytomyr reg., Ksenzhopolskiy (1915, p. 11) (*Simaethis*); iNaturalist (2025) (# 137946040). Kyiv reg., Ljubomudrov (1917, p. 41) (*Simaethis*); Zhikharev (1928, p. 256) (*Simaethis*); Sovinskij (1938, p. 83) (*Simaethis*); Danilevsky & Kuznetzov (1973, p. 15) (*Hemerophila*); UkrBIN (2025) (# 96728). Chernihiv reg., Shreiner (1906, p. 26) cit. after Sovinskij (1938, p. 83) (*Simaethis*) [?]; iNaturalist (2025) (# 232706029). Lviv reg., Nowicki (1860, p. 117) (*parialis* Tr.); Brunicki (1913, p. 63) (*Simaethis*); Swiatkiewicz (1924, p. 98) (*Simaethis*); Bublyk (1959, p. 153) (*Simaethis*); iNaturalist (2025) (# 248903673). Ternopil reg., Toll (1939, p. 164) (*Simaethis*). iNaturalist (2025) (# 302842725). "Podillia", Sovinskij (1938, p. 83) (*Simaethis*) [?]. Khmelnytskyi reg., Chranewytsch (1927, pp. 11-13) (*Simaetis*). Vinnytsia reg., iNaturalist (2025) (# 98269291). Cherkasy reg., Grossheim & Pjatakova (1928, p. 18) (*Hemerophila*). Poltava reg., Sovinskij (1938, p. 83) (*Simaethis*); Danilevsky & Kuznetzov (1973, p. 15) (*Hemerophila*). Kharkiv reg., Sovinskij (1938, p. 83) (*Simaethis*) [?]. Transcarpathian reg., Fasulati & Sikura (1956, p. 74) (*Simaethis*); UkrBIN (2025) (## 251451; 178664; 161974). Transcarpathian and Ivano-Frankivsk regs (the Mount Hoverla), Budashkin (2003, p. 45). Ivano-Frankivsk reg., iNaturalist (2025) (# 243298066). Chernivtsi reg., Hormuzaki (1907, p. 78) (*Simaethis*). Dnipropetrovsk reg., Alberti & Soffner (1962, p. 195) (*Simaethis*); Apostolov (1981, p. 43) (*Simaethis*); iNaturalist (2025) (# 183241624). Odesa reg., Sovinskij (1938, p. 83) (*Simaethis*) [?]. Zaporizhzhia reg., Budashkin (2003, p. 45). Donetsk reg., Sovinskij (1938, p. 83) (*Simaethis*). Crimea, Porchinskiy (1885) cit. after Chranewytsch (1927, p. 11); Chranewytsch (1927, p. 11) (*Simaetis*); Danilevsky & Kuznetzov (1973, p. 15) (*Hemerophila*); Budashkin (2003, p. 45).

Remark: The reports from Chernihiv, Kharkiv and Odesa regions in Sovinskij (1938) in question because the author does not provide exact localities. Since the publication of the paper, the borders of the regions have changed and now it is impossible to accurately determine the affiliation of these reports to the modern administrative division of Ukraine.

Choreutis nemorana (Hübner, [1799])

Transcarpathian reg., **first record**. Odesa reg., iNaturalist (2025) (## 100221687; 170461216; 229117124). Mykolaiv reg., iNaturalist (2025) (# 303674737). Kherson reg., iNaturalist (2025) (# 216525171). Crimea, Danilevsky & Kuznetzov (1973, p. 11) (*Hemerophila*); Budashkin (2004, p. 342); iNaturalist (2025) (## 27680649; 38543652; 49170916; 53264117; 55803296; 85743445; 86436180; 103034345; 103379805; 125901809; 131604602; 180920426; 184101231; 194578381; 195750209; 195753128); Savchuk (2025).

Remark: While this manuscript was under review, a new observation from a novel locality in the Transcarpathian region was added to the iNaturalist website (Tiachiv city, # 292930911).

Conclusions

Thereby, 13 species of the family Choreutidae are present in the fauna of Ukraine. The novel record from the Transcarpathian region complements existing information about the distribution of *Choreutis nemorana* in Ukraine and Eastern Europe.

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Conflict of Interest

The authors declare there is have no known financial interest or personal relationship that could have influenced the work presented in this article.

References

Alberti, B., & Soffner, J. (1962). Zur Kenntnis der Lepidopteren-Fauna Sud- und Südostrußlands. *Mitteilungen der Münchner Entomologische Gesellschaft E.V., 52*, 146-198.

Amsel, H. G. (1955). Irakische Kleinschmetterlinge. *Beiträge zur naturkundlichen Forschung in Südwestdeutschland, 14*(2), 119-129.

Andrianov, O. (2025). *My lepidoptera collection*. https://lepidoptera.com.ua/CHOREUTIDAE/Choreutidae.htm

Apostolov, L. G. (1981). *Harmful entomofauna of forest biogeocenoses of the Region of Central Prydniprovia*. Vyshcha Shkola.

Bidzilya, A. V., Budashkin, Yu. I., Zhakov, A. V., Klyuchko, Z. F., & Kostjuk, I. Yu. (2001). Fauna of the Lepidoptera of "Kamiani Mohyly" Reserve and its taxonomic structure. In *"Karadag. History, biology, archeology" - Collection of scientific papers dedicated to the 85-th anniversary of the T. I. Vyazemsky Karadag biological station*. Sonat.

Bidzilya, O., Budashkin, Ju., Kljuchko, Z., Kostjuk, I., & Kullberg, J. (2006). A contribution to the knowledge of Lepidoptera of the south-eastern part of the Ukrainian Karpathian. *Proceedings of Zoological Museum of Kiev Taras Shevchenko National University, 4*, 21-52.

Brunicki, J. (1913). Spis motyli zebranych w powiecie stryjskim. *Sprawozdanie Komisji fizyograficznej, 47*(II), 52-90.

Bublyk, I. M. (1959). The most important insect pests of the garden of Lviv Region. In *"Problems of entomology in Ukraine" - Collection of scientific papers*. Vydavnytstvo Akademii Nauk Ukrainskoi RSR.

Budashkin, Yu. I. (1997). A New and Little-Known species of Choreutid-Moths (Lepidoptera, Choreutidae) from Altai, Caucasus and Crimea. *Journal of the Ukrainian Entomological Society, 3*(1), 13-18.

Budashkin, Yu. I. (2003). New Data on Taxonomy and Distribution of Palaearctic Choreutid-Moths (Lepidoptera, Choreutidae). *Proceedings of Zoological Museum of Kiev Taras Shevchenko National University, 1*(1), 43-56.

Budashkin, Yu. I. (2004). The results of a twenty-year stationary study of the lepidopteran fauna of the Karadag natural reserve. In *"Karadag" - Collection of scientific papers, 1*. Simferopol.

Chranewytsch, W. (1927). "Microlepidoptera" Podoliens (vor allem des Kamjanetz-Podolischen Kreises). *Mitteilungen des Landwirtschaftlichen Instituts in Kamjanetz-Podilskyj, 4* (separate print), 1-20.

Danilevsky, A. S. (1969). New species of Glyphipterygid Moth (Lepidoptera, Glyphipterygidae) of the fauna of the USSR. *Revue d'Entomologie de l'URSS, 48*(4), 919-932.

Danilevsky, A. S., & Kuznetzov, V. I. (1973). A review of the Glyphipterygid moths of the genus *Hemerophila* Hb. (Lepidoptera, Glyphipterygidae) of the fauna of the USSR. *Académie Des Sciences de l'URSS. Horae Societatis Entomologicae Unionis Soveticae, 56*, 8-17.

De Prins, W., Baugnée, J.-Y., Georis, A., Spronck, R., & Spronck, R. (2014). *Choreutis nemorana* (Hübner, 1799)

(Lepidoptera: Choreutidae) well established in Belgium. *Phegea, 42*(2), 29-32.

Demyanenko, S. O., Bidzilya, O. V., & Karolinskiy, E. A. (2021). New records of Lepidoptera (Insecta) of Severodonetsk (Luhansk Region, Ukraine) and its environs. *The Kharkov Entomological Society Gazette, 29*(1), 20-52. https://doi.org/10.36016/KhESG-2021-29-1-3

Diakonoff, A. (1986). Glyphipterigidae. *Microlepidoptera Palaearctica* (Vol. 7). G. Braun.

Fasulati, K. K., & Sikura, A. I. (1956). Ecological review of garden pests in Transcarpathia. *Scientific Notes. Zoology. Uzhgorod State University, 16*, 67-92.

GBIF (Global Core Biodata Resource) (2025). *Choreutis nemorana* (Hübner, 1799). https://www.gbif.org/species/7675186

Grossheim, N. A., & Pjatakova, V. L. (1928). A preliminary list of orchard pests of Mleev experiment station district (1923-1927). *Bulletin of Mleev horticultural experimental station, 5*, 2-30.

Hormuzaki, K. von (1907). Die Schmetterlinge (Lepidoptera) der Bukowina. III. Teil: Familien Pyralidae bis Micropterygidae. *Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien, 57*, 34-104.

Hübner, J. ([1796-1834]). *Sammlung europäischer Schmetterlinge 7*. Augsburg.

iNaturalist (2025). *Choreutidae of Ukraine*. https://www.inaturalist.org/observations?place_id=8860&taxon_id=67432

Karolinskiy, E. A., Demyanenko, S. O., Bidzilya, O. V., Budashkin, Yu. I., Guglya, Yu. O., Kavurka, V. V., & Mushinskiy, V. G. (2021). On the fauna of Lepidoptera (Insecta) of the National Nature Park "Dvorichanskyi" (Kharkiv Region, Ukraine) and its environs. Contribution 5. *The Kharkov Entomological Society Gazette, 29*(1), 53-63. https://doi.org/10.36016/KhESG-2021-29-1-4

Karolinskiy, Ye. A., Demynenko, S. A., Zhakov, A. V., & Mushinskiy, V. G. (2017). On the fauna of Lepidoptera (Insecta) of the National Nature Park 'Dvorichanskyi' (Kharkiv Region, Ukraine) and its environs. *The Kharkov Entomological Society Gazette, 25*(1), 5-47. https://doi.org/10.36016/KhESG-2019-27-1-1

Kostjuk, Yu. A., & Gershenson, Z. S. (1988). The Family Choreutidae. In V. P. Vasilev (editor). *Pests of agricultural crops and forest plantations. Harmful arthropods, vertebrates* (Vol. 2, pp. 262-263). Urozhay.

Ksenzhopolskiy, A. (1915). Microlepidoptera okrestnostey goroda Zhitomira, Volynskoy gubernii. *Prilozhenie k Tomu XI Trudov Obshchestva Issledovateley Volyni*. Elektricheskaya tipografiya nasl. M. Denenmana.

Ljubomudrov, I. (1917). The Tortricid- and Tineid-Moths of the government Kiev. *Contributions to the knowledge the fauna of South West Russia, 2*, 34-46.

Nowicki, M. S. (1860). *Enumeratio lepidopterorum Haliciae orientalis*. Typis Instituti Stauropigiani. https://doi.org/10.5962/bhl.title.66986

Porchinskiy, I. A. (1885). *Insects that harm fruit gardens in Crimea*. Selskoe Khozyaystvo i Lesovodstvo.

Savchuk, V. V. (2025). *Lepidoptera of Crimea*. https://lepido.ru/index.htm

Savchuk, V. V., & Kajgorodova, N. S. (2015). New records of Lepidoptera in Crimea. *Caucasian Entomological bulletin, 11*(1), 175-182. https://doi.org/10.23885/1814-3326-2015-11-1-175-182

Savchuk, V. V., & Kajgorodova, N. S. (2020). New data on the fauna and bionomics of Lepidoptera of Crimea. Part II. *Caucasian Entomological bulletin, 16*(2), 255-264. https://doi.org/10.23885/181433262020162-255264

Schille, F. (1930). Jan Romaniszyn i Fryderyk Schille Fauna Motyli Polski (Fauna Lepidopterorum Poloniae). In *Prace Monograficzne Komisji Fizjograficznej* (Vol. 2). Polska Akademja Umiejetnosci.

Seven, S. (1991). Trakya Lepidoptera Faunasi Uzerine Bibliyografik Arabian alar. *Priamus, 6*(1/2), 1-95.

Shreiner, Ya. F. (1906). *The main insects harmful to fruit growing (especially in the North) and methods of their extermination*. St. Petersburg.

Sovinskij, V. V. (1938). Ueber die Tineiden (s. lat.) des zentralen Teils des Kiewer Gebiets. *Travaux du Musée Zoologique, 21-22*, 3-95.

Swiatkiewicz, M. (1924). Motyle rzadsze i nowe dla Polski zebrane w ostatnich latach. *Polskie Pismo Entomologiczne, 3*(1-4), 94-100.

Swiatkiewicz, M. (1926). Motyle rzadsze i nowe dla Polski z okolic Podola. *Polskie Pismo Entomologiczne, 5*(1-4), 126-132.

Toll, S. (1939). Microlepidoptera zebrane w latach 1934-1937 w powiatach zaleszczyckim i borszczowskim na Podolu. *Sprawozdanie komisji fizjograficznej, 72*, 133-221.

Treitschke, F. (1829). *Die Schmetterlinge von Europa (Fortsetzung des Ochsenheimer'schen Werks), I–VI*. Gerhard Fleischer.

UkrBIN (2025). *Choreutidae*. https://ukrbin.com/index.php?id=6758

Zdun, V. I. (1961). Materials on the fauna of fruit tree pests of Western Volyn. *Scientific Notes, 9*, 45-51.

Zhikharev, I. (1928). Shkidlyvi ta inshi luskokryltsi (Lepidoptera) Darnytskoi lisovoi dosvidnoi dachi. *Trudy z Lisovoi Dosvidnoi Spravy na Ukraini, 9*, 231-330.

Zouba, A. (2010). First Report of *Choreutis nemorana* (Lepidoptera: Choreutidae) in Tunisia. *The African Journal of Plant Science and Biotechnology, 4*(2), 96-97.

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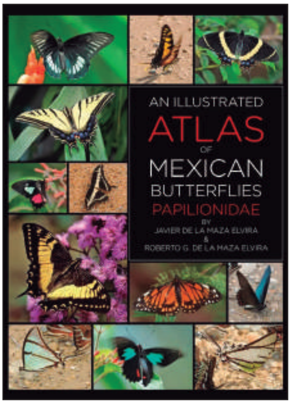
REVISIÓN DE PUBLICACIONES
BOOK REVIEWS

J. de la Maza Elvira & R. G. de la Maza Elvira
An Illustrated Atlas of Mexican Butterflies Papilionidae
152 páginas
Formato 36,0 x 27,0 cm
Colección De la Maza de Lepidoptera de México, México, 2022
ISBN: 978-607-8619-77-1



Tenemos en nuestras manos, un interesante libro sobre la fauna de Papilionidae Latreille, 1802, presentes en México, como resultado de la investigación realizada por los autores durante 50 años, siendo uno de los libros más completos sobre esta familia en el área de estudio. Si bien hemos de lamentar el fallecimiento de uno de los autores Javier de la Maza Elvira, (2023), que, afortunadamente, pudo ver el libro publicado.

En este trabajo los autores tratan 73 especies, representadas a tamaño natural, que suponen el 12% de la fauna mundial, de los géneros *Baronia* Salvin, 1893, *Parnassius* Latreille, 1803, *Eurytides* Hübner, [1821], *Eurygraphium* Möhm, 2002, *Neographium* Möhn, 2002, *Protesilaus* Swainson, [1832], *Mimoides* Brown, 2002, *Battus* Scopoli, 1777, *Parides* Hübner, [1819], *Heraclides* Hübner, [1819], *Calaides* Hübner, [1819], *Troilides* Hübner, [1825], *Priamides* Hübner, [1819], *Papilio* Linnaeus, 1758, *Pterourus* Scopoli, 1777 y *Pyrrhosticta* Butler, 1872.

Después de una introducción, los autores nos hablan de la Papilionidae, acompañados de dos láminas con los ciclos biológicos de diversas especies y sus estados inmaturos.

Ya dentro de la parte central del libro, se tratan todas y cada una de las especies, así como las subespecies más destacadas, indicando si es o no endémica en México, su distribución y su correspondiente mapa, su planta nutricia, el estado de polimorfismo, principalmente de las hembras y alguna otra información interesante a destacar. Todas las especies y subespecies consideradas están representadas a todo color y en su tamaño natural, finalizando con una lista detalladas de todas las especies y subespecies presentes en el área de estudio, una destacada bibliografía y una interesante reseña de los autores.

Si ya es importante las aportaciones científicas de este libro, se ven incrementadas con la descripción de una nueva especie *Neographium tlahuica* R. & J. de la Maza y once nuevas subespecies, así como destacadas nuevas combinaciones.

No podemos terminar estas líneas, sin felicitar a los autores por este extenso y detallado trabajo y que, sin duda, ayudará a todos los interesados en esta interesante familia presente en América central y a la Editorial por la excelente presentación del libro, obra que no puede faltar en cualquier biblioteca que se precie.

El precio de este libro es de 738,75 pesos mexicanos más gastos de envío y los interesados lo pueden pedir a:

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New addition to the Distribution of two species of *Curetis* Hübner, [1819] from southern West Bengal, India (Lepidoptera: Papilionoidea, Lycaenidae)

Aniruddha Singhamahapatra, Arnab Kumar Samanta, Pradeep Nayak, Sandip Das, Anitava Roy & Subhajit Roy

Abstract

The present study extends the distributional range of two *Curetis* Hübner, [1819] species in the southern part of West Bengal state, India. This study reports *Curetis saronis* Moore, 1877 for the first time from the coastal mangrove forests of India. *Curetis bulis* (Westwood, 1852) is reported for the first time from the Chhotanagpur plateau region of India and is the first report from West Bengal outside the Himalayan ranges.
Keywords: Lepidoptera, Papilionoidea, Lycaenidae, *Curetis*, Sundarban, Purulia, Chhotanagpur, West Bengal, India.

Nueva adición a la distribución de dos especies de *Curetis* Hübner, [1819] del sur de Bengala Occidental, India (Lepidoptera: Papilionoidea, Lycaenidae)

Resumen

El presente estudio amplía el área de distribución de dos especies de *Curetis* Hübner, [1819] en la parte meridional del estado de Bengala Occidental, India. Este estudio informa de la presencia de *Curetis saronis* Moore, 1877 por primera vez en los manglares costeros de la India. Curetis bulis (Westwood, 1852) se cita por primera vez en la región de la meseta de Chhotanagpur de la India y es el primer informe de Bengala Occidental fuera de las cordilleras del Himalaya.
Palabras clave: Lepidoptera, Papilionoidea, Lycaenidae, *Curetis*, Sundarban, Purulia, Chhotanagpur, Bengala Occidental, India.

Introduction

The genus *Curetis* Hübner, [1819] is the only genus from subfamily Curetinae (Family: Lycaenidae) (Eliot, 1990), 6 of which are distributed in India (Varshney & Smetacek, 2015). Of these six, *Curetis siva* (C. & R. Felder, [1865]) is known to be endemic to the Sahyadri mountains of south-western India, and *Curetis naga* Evans, 1954 (previously considered as a subspecies of *Curetis acuta* Moore, 1877) is known to be restricted to the mountainous region of Naga Hills of Nagaland, India, adjacent Yunnan in south China (Huang, 2003) and possibly in Myanmar (Savela, 2016). All the remaining four species are known to be distributed in the state of West Bengal (Varshney & Smetacek, 2015). However, the state of West Bengal is peculiar in the sense that it is the only state in the biogeographically megadiverse country of India which includes both parts of the Himalayan Mountain range and has a coastline with mangrove forest. It also includes a part of the Chhotanagpur plateau and the Rarh region (which is a transitional zone between the plateau and the flood plains of the Gangetic basin) in its south-western part.

Materials and Methods

AKS, out of his virgin interest in nature, found an individual of *Curetis* species, which was basking on a pumpkin leaf grown outside his rural house in a neighbourhood of Namkhana, South 24 Parganas district, on the edge of Sundarban in southern West Bengal the morning on 14-XI-2022. The observation was photographed using the Samsung Galaxy A13 mobile phone of AKS and was uploaded in iNaturalist (Samanta, 2024) with the initial misidentification of *Curetis thetis* (Drury, [1773]), which is the commoner, but soon it was rectified by peers as the yellow on the upper side of the wings clearly indicated it to be a female of *Curetis saronis* Moore, 1877. The authors, particularly SR, SD and AS, are conducting opportunistic surveys in various parts of the state for around a decade, particularly focusing to fill up the Wallacean and Eltonian shortfalls regarding the knowledge of Papilionoidea in West Bengal. As part of that, they visited the location on 26-XI-2022, and along with AKS, visited the mangroves in the outskirts of the nondescript neighbourhood, which outgrew on the banks of the Bhagirathi-Hooghly River, and found around 9 individuals of *Curetis saronis*, along with three individuals of *Curetis thetis*, which is otherwise the most common member of the genus throughout most of the country and the state. Individuals of the species were repeatedly sighted henceforth by AKS in that mangrove stretch till February 2023. Though the species was not sighted in the locality in the winter of 2023-2024 in spite of regular surveys by AKS, three individuals of the species were observed again by SR, along with SD and AKS, in a planted Casuarina Forest adjacent to the Bonbibi temple in the heavily touristed Bakkhali sea beach, South 24 Parganas district, around 27 kilometres south of the previous location on 30-XII-2023.

As part of the state-wide Papilionoidea survey, AS and AR, along with PKN, visited Garh Panchakot hill in Purulia district in western part of southwest Bengal on 29-VII-2023, and among various other Lepidoptera, observed and photographed a *Curetis* species mud puddling on the ground in a sunny day. The individual was later identified as *Curetis bulis* (Westwood, [1851]), but later confirmed to be *Curetis acuta* Moore, 1877 with the help of available literature and consultation with various experts in social media platforms. However, an upper wing photograph of a male individual from the photo archive of AR was identified as *Curetis bulis* (Westwood, [1851]), which was photographed from the same study site (Garh Panchakot hill) on 05-IV-2023, a few months prior.

Lepidoptera nets or traps were not used and none of the individuals were collected. The individuals were photographed with Nikon D7500, Nikon D5300 with Nikon AF-P 70-300 lens, Canon R7 camera with Canon 100-400 Rf lens. Field guides and published literature were used to verify the identification and hitherto known distribution range of the species.

To study the temporal and spatial distribution of the *Curetis* spp. found across the state of West Bengal, occurrence data of the genus was extracted (GBIF, 2024) using appropriate filters. Photographic data stored in the WikiCommons (Anonymous, 2024a) as part of the Wiki Loves Butterfly Project across the North-East India, and IFoundButterflies (Kunte et al., 2024) website are also added to our data, omitting the duplicate data already considered from GBIF, through checking the dates of observation and co-ordinates, using SQL query. Considering the importance of social media platforms, particulary Facebook, to gather biodiversity data generated by citizens (Barman et al. 2022), data from Facebook groups, particularly Butterfly of West Bengal facebook group, dedicated to butterflies of the study area, was also extracted, which significantly filled in some sampling gaps of data in GBIF, at the same time generating a lot of redundant data. The redundant data resulting from observations of same individual in multiple databases were eliminated along with those where multiple photos of same individual were posted as different observational records. The data related to the museum specimens were also omitted. The existing and novel observational records were plotted using ESRI® ArcMap™ 10.8.0.12790 (ESRI, 2020) installed, as part of ESRI® ArcGIS Desktop 10.8. India Street Map, a subset of the World Street Map (ESRI, 2017) is used as the basemap to plot the records.

Study Area

The state of West Bengal (Figure 1) is eastern India, mostly the lower part of Gangetic plain, also covers parts of various other biogeographic zones including Himalaya in its north, coastal mangroves in its south and extension of Deccan plateau in the south-west (Rodgers & Panwar, 1988). The western districts of Purulia, Jhargram and western parts of Bankura, Birbhum and Paschim Bardhaman district in the state, along with neighbouring Jharkhand state, Mayurbhanj and Sundargarh districts of Odisha state and Jashpur district of Chhattisgarh state encompass the north-eastern extension of the Deccan Plateau, which is known as Chhotanagapur Plateau. The region is interspersed with residual remnant hillocks and hill ranges and hosts dry deciduous forests (Roy et al. 2022), fragmented in parts due to industrialisation and mining activities.

Southern parts of South 24 Parganas, and the south-eastern fringe of North 24 Parganas on the eastern bank of Bhagirathi-Hooghly River cover the Sundarban, world’s largest mangrove forest, most of which lies in neighbouring Bangladesh. The northern districts of Darjeeling and Kalimpong along with northern fringes of Alipurduar district in the state is located within the Himalayan mountainous region, while the remaining part of the state is very densely populated fertile alluvial flood plain centred around the Ganga River and its tributaries and distributaries.

Results

Order Lepidoptera Linnaeus, 1758
Family Lycaenidae Leach, 1815
Genus *Curetis* Hübner, [1819]

Curetis saronis Moore, 1877

Curetis saronis is larger than the more common *Curetis thetis*, having average wingspan 46 mm compared to 44 mm of the latter (Kehimkar, 2016). The female of *Curetis saronis* is readily identifiable from other sympatric species of the genus by the golden yellow discal area (Figure 2), instead of white, in the upperside of both the wings (Moore, 1884; Bingham, 1907; Evans, 1932). The male of *Curetis saronis* can be distinguished from *Curetis thetis* by as the upper side of the former has significantly larger black costal and terminal border (Bingham, 1907; Eliot, 1990), as evident from Figure 3. The underside of *Curetis saronis* is quite like *Curetis thetis*, except the fact that the faint discal band of black lunules is better defined and the subterminal series of black dots is also better marked than *C. thetis* (Bingham, 1907).

Curetis bulis (Westwood, [1851])

Males of *Curetis bulis* can be differentiated with *Curetis acuta* from the upper forewing (Figure 4) by the lack of a black tooth in the cell end and by absence of orange above the base of vein 5 in its upper forewing (van der Poel & Smetacek, 2022). The orange area in the forewing extends into the space 6, which is typical for *Curetis acuta* (Ek-Amnuay, 2012). From the underwing, *Curetis bulis* and *Curetis acuta* are quite similar, but *Curetis bulis* can be identified by the central band in the under hindwing not in line with bar at cell end, while the faint central band is in line with bar at cell-end for *Curetis acuta* (Kehimkar, 2016). However, given the obscurities and the variations in description of the underwings (Chapman, 1915; Ek-Amnuay, 2012), distinguishing these only from the underwing is tricky (Figure 5) and not recommended without close observation of their upper wings. It may be worth noting that the individual photographed at Garh Panchakot hill on 29-VII-2023 was initially misidentified as *Curetis bulis* based on under wing photographs, but later an accidental flight shot clicked by AR helped to conclude its identity as *Curetis acuta* from the presence of the black tooth in the cell end and the extension of orange in space 6, similar to the one in Figure 3a. In contrast, the individual shown in Figure 4 is identified to be *Curetis bulis* male through restricted presence of orange in the upper wings and the lack of prominent teeth in upper forewings.

Discussion

Of the four *Curetis* species distributed in the state of West Bengal, *Curetis thetis*, is the most common and distributed (Figure 6) almost throughout the state, barring the alpine regions. The apparent absence of *C. thetis* in central part of West Bengal (Figure 1) is nothing more than a result of sampling gaps and lack of observers and recorders in citizen science portals and social media, and the similarity of the landscape, human interference and other environmental parameters are a clear indicator that the species should be quite commonly present in this region too. *Curetis bulis* and *C. saronis* were known in the state only from the forests of Himalayan foothills adjacent to the state of Assam. *Curetis acuta* is also found mostly in the deciduous forests of the western plateau region along with the foothills of Himalayas in the northern part of the state.

Curetis saronis Moore, 1877

Originally described from Port Blair in the Andaman islands of India, the species is distributed throughout the south-east Asian countries of Myanmar (Bingham, 1907), Thailand (Godfrey, 1927; Pinratana, 1981; Ek-Amnuay, 2012), Malaysia (Druce, 1896; Bingham, 1907; Sulaiman et al. 2022), Indonesia (Druce, 1896), Singapore (Khew, 2015), Cambodia (Chartier & Kosterin, 2022), Laos (Motono & Negishi, 1989) and Vietnam (Inoué & Kawazoé, 1965) along with India and Bangladesh. While a significant part of its distribution is in the low elevations of montane rainforests (north-eastern India in the states of Assam, Meghalaya, Arunachal Pradesh (Kehimkar, 2016); Sylhet of Bangladesh (Moore, 1884; Larsen, 2004), Arakan state of Myanmar (Bingham, 1907), Cambodia, Tenasserim, Kinabalu, in Malaysia, a large area of its distribution is in the mangrove forests (Andaman and Nicobar islands of India (Moore, 1877; Chapman, 1915; Evans, 1932); Sundarbans of Bangladesh (Larsen, 2004); Thailand, Singapore (Tan, 2010), Labuan of Malaysia and Banjarmasin in Indonesia (Druce, 1896)). While the species is locally common in certain montane evergreen forests of south-east Asia, it is rare throughout the Indian subcontinent.

In India, apart from the Andaman and Nicobar Islands where it is quite a commoner, it is distributed only in the lower slopes of montane rainforests from the states of Assam, Arunachal Pradesh, Meghalaya and West Bengal, where it is quite uncommon (van Gasse, 2018; Anonymous, 2024b). In West Bengal, the species was reported from the foothills of the Himalayan range in Buxa Tiger Reserve of Alipurduar district (in the north-eastern part of the state) by Subhajit Mazumder in 2015 (Sinha et al., 2019; Anonymous, 2024). The observational report presented here is the first report of the species from southern part of West Bengal and is the second report overall from the state. The new sighting from Namkhana, around 575 kilometres (aerial distance) south of Alipurduar, indicates the presence of species from the Sundarbans of West Bengal. *Curetis saronis* is also reported from northern hilly regions of Sylhet (adjacent to the hilly regions of Meghalaya and Assam in India) and tentatively listed from the Sundarbans in the neighbouring country of Bangladesh (Larsen, 2004). This report is thus the first report of the species from the Indian part of Sundarbans and the first sighting of the species from mangrove forests of mainland India, extending its range in the country beyond the Andaman archipelago and the mountainous rainforests of the north-eastern part of the country.

Apart from *Pongamia pinnata* (L.) Pierre, which is the common host plant of all the four *Curetis* species (Robinson et al. 2010) distributed in West Bengal, *Derris trifoliata* Lour., a mangrove associate, deciduous climber, is documented as its host plant (Tan, 2010). The plant is distributed along the coasts of East Africa including Madagascar all along tropical and subtropical Asia to tropical Australia and is found in sandy beaches, mangroves and coastal swamps (Tomlinson, 1986). The abundance and biomass of this mangrove associate plant is known to have increased in recent years (Zhang et al., 2021). The presence of this mangrove associate plant in the mangroves of both Namkhana and Bakkhali should be a factor for the presence of *Curetis saronis* in this region. The report of the species from the Indian Sundarbans, bolsters the faunal diversity of Sundarban Biosphere Reserve.

Curetis bulis (Westwood, [1851])

Originally described from Shimla of Himachal Pradesh in India, the species is distributed through India (Varshney & Smetacek, 2015), Nepal (van Gasse, 2018; van der Poel & Smetacek, 2022), Bhutan (Wangdi & Sherub, 2015), Bangladesh (Larsen, 2004), Myanmar (Moore, 1879), Thailand (Pinratana, 1981; Ek-Amnuay, 2012), Vietnam (Metaye, 1957; Inoué & Kawazoé, 1965), China (Fruhstorfer, 1908; Chou, 1994; Zhang et al. 2013), Cambodia (Chartier & Kosterin, 2022), Laos (Motono & Negishi, 1989).

In India, the species is known to be distributed across the Himalayan range from Jammu and Kashmir (Sheikh et al. 2021), Himachal Pradesh, Uttarakhand, Arunachal Pradesh, Assam, Meghalaya, Nagaland, Sikkim and northern West Bengal (Varshney & Smetacek, 2015; Kehimkar, 2016) where it is fairly common (van Gasse, 2018) and uncommon (van Gasse, 2018) in Eastern Ghats (the states of Andhra Pradesh (Rao et al. 2004) and Odisha (Paria et al. 2018)) and Satpura hills of Madhya Pradesh (Bingham, 1907). Though fairly common in the Himalayan ranges, it is yet to be recorded from the states of Tripura and Mizoram (van Gasse, 2018). However, previous studies from the Purulia district (Mukherjee et al. 2023), and its neighbouring districts of Bankura (Mukherjee & Mondal, 2020), Jhargram (Mandal & Ray, 2023) in West Bengal and in the states of Jharkhand

(Morrison-Godfrey, 1948; Verma, 2009; Singh, 2010; Reddy et al. 2023), Mayurbhanj district of Odisha (Payra et al. 2016; Boruah et al. 2018) could not find evidence of the species from the Chhotanagpur Plateau. The Kuldiha wildlife sanctuary situated in Balasore district of Odisha is the nearest location of the species where it was previously sighted (Paria et al. 2018), which is, however, geographically part of the Eastern Ghat hills (Reddy et al. 2014) and not part of the Chhotanagpur Plateau (Singh, 2012). This is thus the first report of the species from the Chhotanagpur Plateau.

Of its known host plants (Robinson et al. 2010), *Pongamia pinnata*, the common host plant of all the *Curetis* spp. is quite common and distributed throughout West Bengal, excepting the coniferous and alpine vegetation of the Himalayan slopes. *Neustanthus phaseoloides* (Roxb.) Benth., also known to be its host plant, is quite common in the deciduous forests of Garh Panchakot and other forested regions in the Deccan plateau. *Ougeinia oojeinensis* Hochreutiner, though not common in the area, is also distributed in Purulia and its surrounding districts (Das Das et al. 1992). Thus, all the three known host plants are distributed in the Chhotanagpur plateau region, which establishes a potential of its distribution in the plateau region too.

It is interesting to note that *Curetis acuta* is quite common in the study site, and has been observed multiple times from Garh Panchakot Conservation Area by SR and AR. It is also quite common in the Ajodhya Hills of this district (Mukherjee et al. 2023) and is reported from the surrounding districts of Bankura (Mukherjee & Mondal, 2020) and Jhargram (Dwari & Mondal, 2020). However, *Curetis thetis* has not been observed in the Garh Panchakot hills and is quite rare also in the Ajodhya hills of Purulia. It may thus be quite feasible that in spite of commonness in the availability of at least one of the host plants (*Pongamia pinnata*) in the rural and urban human habitats, *Curetis acuta* and *Curetis bulis* are rare or unavailable as they do not face stiff competition from *Curetis thetis*.

Conclusion

While some Papilionoidea surveys have been conducted in the Chhotanagpur Plateau region, various new observational reports from this region including this report of *Curetis bulis* is a testimony to sampling gaps in this region. The sympatry and syntopy of *Curetis bulis* and *Curetis acuta* in the region and their localised allopatry with *Curetis thetis* may be indicative of the dominance of *Curetis thetis* in habitats suffering from anthropogenic interferences.

The presence of *Curetis saronis* in two different spots of Sundarbans confirms the presence of the species in the Indian part of Sundarbans along with previous reports from the Bangladesh part of Sundarbans. The presence of this species in the mangroves of Ganga-Brahmaputra delta indicates that it might also be distributed in the mangroves of the Mahanadi delta situated nearby in Odisha and thorough study of Bhitarkanika National Park is necessary to ascertain the south-western boundary of its range. The repeated observations of *Curetis saronis* in winter and absence of it beyond the winter in the patch indicates that it may undergo seasonal migration. Only detailed studies throughout its distributional range can provide conclusive evidence on the migratory status and patterns of this species.

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Conflict of Interest

The authors declare that there is no known financial interests or personal relationships that could have influenced the work presented in this article.

References

Anonymous (2024a). *Category: Curetis*. Wikimedia Commons. https://commons.wikimedia.org/wiki/Category:Curetis.

Anonymous (2024b). *Curetis saronis* Moore, 1877 – Saronis Sunbeam. In K. Kunte, S. Sondhi & P. Roy. *Butterflies of India* (Vol. 4.12). https://www.ifoundbutterflies.org.

Barman, N., Basu Roy, A., Basu Roy, R., & Barve, V. (2022). Understanding the importance of social media as a citizen science platform by using tiger sighting photographs from Facebook. *Biodiversity Information Science and Standards, 6*, e93924. https://doi.org/10.3897/biss.6.93924

Boruah, B., Das, G. N., Payra, A., Gogoi, M. J., Dash, S. K., Tamuly, T., Sethy, J., Mishra, R. K., & Rout, S.D. (2018). Assessment of butterfly (Lepidoptera, Rhopalocera) diversity in Manchabandha and Budhikhamari Reserve Forest, Mayurbhanj, Odisha, India. *Asian Journal of Conservation Biology, 7*(1), 51-65. https://www.ajcb.in/journals/full_papers_july_2018/AJCB-Vol7-No1-Boruah%20et%20al.pdf

Chapman, T. A. (1915). An analysis of the genus *Curetis*, chiefly based on an examination of the specimens in the Zoological Museum. *Novitates Zoologicae, 22*(1), 80-104, pl. 3-19. https://doi.org/10.5962/bhl.part.1913

Chartier, G., & Kosterin, O. E. (2022). An annotated checklist of the butterflies (Lepidoptera: Papilionoidea) of Cambodia. *Cambodian Journal of Natural History, 2022*(2), 99-126. https://www.fauna-flora.org/wp-content/uploads/2023/05/FFI_Dec2022_Cambodian_Journal_Natural_History.pdf

Chou, I. (1994). *Monographia Rhopalocerorum Sinensium.* Henan Science and Technology Publishing House. [In Chine]

Corbet, A. S. (1937). A revision of the Malayan species of *Curetis* Hübner (Lepidoptera - Lycaenidae). *Proceedings of the Royal Entomological Society of London (B), 6*(12), 224-233. https://doi.org/10.1111/j.1365-3113.1937.tb01679.x

Das Das, S. K., Murmu, S., & Maity, K. L. (1992), A census of the family Papilionaceae in West Bengal. *Journal of Economic and Taxonomic Botany, 16*(2), 305-334.

Dwari, S., & Mondal, A. K. (2020). Diversity of butterflies (Lepidoptera: Rhopalocera) of Jhargram, Paschim and Purba Medinipur districts, West Bengal, India. *Global Journal of Science Frontier Research: C Biological Science, 20*(4), 35-61. https://doi.org/10.34257/GJSFRCVOL20IS4PG35

Druce, H. H. (1896). Further contributions to our knowledge of the Bornean Lycaenidae. *Proceedings of the Zoological Society of London, 1896*(3), 650-683, pl. 29-31. https://doi.org/10.1111/j.1096-3642.1896.tb03073.x

Ek-Amnuay, P. (2012). *Butterflies of Thailand* (2nd edition). Baan Lae Suan Amarin Printing.

Eliot, J. N. (1990). Notes on the genus *Curetis* Hübner (Lepidoptera, Lycaenidae). *Tyô to Ga, 41*(4), 201-225. https://doi.org/10.18984/lepid.41.4_201

ESRI (2017). *World Street Map (v2)* [basemap]. India Street Map. https://www.arcgis.com/home/item.html?id=de26a3cf4cc9451298ea173c4b324736.

ESRI (2020). *ArcGIS Dekstop 10.8*. Environmental Systems Research Institute.

Evans, W. F. (1932). *The identification of Indian butterflies* (2nd edition). Bombay Natural History Society.

Fruhstorfer, H. (1908). Neueu *Curetis* und Übersicht der bekannten Arten. *Stettiner Entomologische Zeitung, 69*(1), 49-59.

Gasse, P. van (2018). *Butterflies of the Indian subcontinent - Annotated checklist*. http://biodiversityofindia.org/images/2/2c/Butterflies_of_India.pdf

GBIF.org (2024). *GBIF Occurrence download*. https://doi.org/10.15468/dl.q5yty5.

Godfrey, E. J. (1927). A list of butterflies collected in Northern Siam by Mr. M. B. Tennent. *Journal of the Natural History Society of Siam, 7*(2), 119-127.

Google (2024). *Google Collaboratory*. https://colab.research.google.com.

Huang, H. (2003). A list of butterflies collected from Nujiang (Lou Tse Kiang) and Dulongjiang, China with descriptions of new species, new subspecies, and revisional notes. *Neue Entomologische Nachrichten, 55*, 3-114.

Inoué, S., & Kawazoé, A. (1965). Riodinidae, Curetidae and Lycaenidae (Lepidoptera: Rhopalocera) from South Viet-Nam. *Nature and Life in Southeast Asia, 4*, 317-394, pl. 19.

Kehimkar, I. (2016). *Butterflies of India* (2nd edition). Bombay Natural History Society.

Khew, S. K. (2015). *A field guide to the butterflies of Singapore* (2nd edition), Marshall Cavendish International.

Kunte, K., Sondhi, S., & Roy, P. (Eds.) (2024). *Butterflies of India* (Vol. 4.27). Indian Foundation for Butterflies Trust. https://ifoundbutterflies.org.

Larsen, T. B. (2004). *Butterflies of Bangladesh - An annotated checklist*, IUCN Dhara Bangladesh.

Mandal, B., & Roy, S. (2022). Observations of Papilionoidea (Lepidoptera) fauna from heterogeneous patches of Jhargram district with new distribution reports from West Bengal, India. *Journal of Animal Diversity, 4*(4), 59-73. http://dx.doi.org/10.52547/JAD.2022.4.4.6

Metaye, R. (1957). Contribution a l'étude des Lépidoptères du Vietnam (Rhopalocera). *Annals of the Faculty of Science, University of Saigon, 1957*, 149-170.

Moore, F. (1877). The Lepidopterous fauna of the Andaman and Nicobar islands. *Proceedings of the Zoological Society of London, 1877*(3), 580-632, pl. 58-60.

Moore, F. (1884). Descriptions of new Asiatic diurnal Lepidoptera. *Proceedings of the Zoological Society of London, 1883*(4), 521-535, pl. 48-49. https://doi.org/10.1111/j.1469-7998.1883.tb06662.x

Morrison-Godfrey, P. W. (1948). Butterflies of South Bihar. *Journal of the Bombay Natural History Society, 47*, 644-651.

Motono, A., & Negishi, N. (1989). *Butterflies of Laos.* Kirihara Shoten.

Mukherjee, A., Kumar, A., Mahato, S., & Samanta, S. (2023). An updated checklist of the butterfly fauna of Ajodhya Hills, Purulia, West Bengal, India along with new distribution records. *Journal of Animal Diversity, 5*(1), 65-79. https://doi.org/10.61186/JAD.5.1.65

Mukherjee, K., & Mondal, A. (2020). Butterfly diversity in heterogeneous habitat of Bankura, West Bengal, India. *Journal of Threatened Taxa, 12*(8), 15804-15816. https://doi.org/10.11609/jott.5136.12.8.15804-15816

Paria, S., Ghosh, S., Mardaraj, P. C., Mallick, P. H., & Chakraborty, S. K. (2018). Habitat heterogeneity and butterfly diversity of Kuldiha Wildlife Sanctuary, Odisha, India. *Journal of Biodiversity Conservation and Bioresource Management, 4*(1), 93-104. https://dx.doi.org/10.3329/jbcbm.v4i1.37880

Patra, D., Roy, S., Chowdhury, S., Hossain, A., Shit, P. K., & Biswas, S. J. (2022). A preliminary study of butterfly diversity in hilly terrains of Ghatsila, Jharkhand, India. *Proceedings of the Zoological Society*, *75*, 262-268. https://doi.org/10.1007/s12595-022-00439-0

Payra, A., Das, G. N., Boruah, B., Dash, S. K., Das, U. P., & Sethy, J. (2016). Butterfly diversity in two selected fringe area of Simlipal Biosphere Reserve, Odisha, India, with notes on some important sightings. *Journal of Wildlife Research, 4*(2), 17-25. https://jakraya.com/journal/pdf/11-jwrArticle_1.pdf

Pinratana, A. (1981). *Butterflies in Thailand. Lycaenidae* (Vol. 4). Viratham Press.

Poel, P. van der, & Smetacek, P. (Eds.) (2022). An annotated catalogue of the butterfly species of Nepal, *Bionotes*, *Occasional Paper, 1*, vii+1-241.

Rao, K. T., Raju, M .P., Javed, S. M. M., & Krishna, I. S. R. (2004). A checklist of butterflies of Nagarjunasagar Srisailam Tiger Reserve, Andhra Pradesh, *Zoo's Print Journal, 19*(12), 1713-1715. https://doi.org/10.11609/JoTT.ZPJ.1184.1713-5

Reddy, B. T., Rajgopal, N. N., Shashank, P. R., Baig, M. M., Ashoka, K. S., Srinivas, C., & Sathyanarayana, K. (2023). Butterfly diversity in Sal forests of Kharsawan. *Indian Forester, 149*(6), 629-637. https://doi.org/10.36808/if/2023/v149i6/168730

Reddy, C. S., Jha, C. S., & Dadhwal, V. K. (2014). Spatial dynamics of deforestation and forest fragmentation (1930-2013) in Eastern Ghats, India. *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, 8*, 637-644. https://doi.org/10.5194/isprsarchives-XL-8-637-2014

Robinson, G. S., Ackery, P. R., Kitching, I., Beccaloni, G. W., & Hernández, L. M. (2023). *HOSTS - a Database of the World's Lepidopteran Hostplants*. https://doi.org/10.5519/havt50xw

Rodgers, W. A., & Panwar, H. S. (1988). *Planning a wildlife protected area network in India. Project FO: IND/82/003.* Food and Agriculture Organization.

Roy, S., Singhamahapatra, A., & Nayak, A. K. (2022). Observations of Odonata (Insecta) from heterogeneous habitat patches in Bankura district with the first report of *Microgomphus torquatus* (Selys, 1854) from West Bengal, India. *Journal of Animal Diversity, 4*(2), 121-152. https://doi.org/10.52547/JAD.2022.4.2.8

Savela, M. (2016). *Curetis* Hübner, [1819]. https://ftp.funet.fi/index/Tree_of_life/insecta/lepidoptera/ditrysia/papilionoidea/lycaenidae/curetinae/curetis.

Sharma, N., & Sharma, S. (2018). New Lycaenid butterfly records from Jammu & Kashmir, India. *Journal of Threatened Taxa, 10*(7), 11984-11987. https://doi.org/10.11609/jott.4046.10.7.11984-11987

Sheikh, T., Awan, M. A., & Parey, S. H. (2021). Checklist of butterflies (Lepidoptera: Rhopalocera) of Union Territory Jammu and Kashmir, India. *Records of Zoological Survey of India, 121*(1), 127-171. https://doi.org/10.26515/rzsi/v121/i1/2021/154311

Singh, A. K. (2012). Probable agricultural biodiversity heritage sites in India: XIV. The Chotanagpur Plateau region. *Asian Agri-History, 16*(4), 371-392. https://www.asianagrihistory.org/pdf/research/ak-singhs-paper-16-4.pdf

Singh, A. P. (2010). Butterfly diversity in tropical moist deciduous sal forests of Ankua Reserve Forest, Koina Range, Saranda Division, West Singhbhum district, Jharkhand, India. Journal of Threatened Taxa, *2*(9), 1130-1139. https://doi.org/10.11609/JoTT.o2274.1130-9

Sinha, R. K., Sen Gupta, S., Basu Roy, A., Baidya, S., Roy, S., Das, N., Paul, A., & Pal, A. (Eds.) (2019). *Butterflies of Buxa Tiger Reserve*. India & Buxa Tiger Conservation Foundation Trust.

Sulaiman, M. H., Zaki, A. M. M., Yap, G. C., Aniruddin, N. A., & Chong, J. L. (2022). Butterfly diversity and composition at Chemerong Amenity Forest, Terengganu, Malaysia. *Journal of Threatened Taxa, 14*(2), 20584-20596. https://doi.org/10.11609/jott.7021.14.2.20584-20596

Tan, H. (2010). *Life history of the Sumatran Sunbeam*. https://butterflycircle.blogspot.com/2010/08/life-history-of-sumatran-sunbeam.html

Tomlinson, P. B. (1986). *The botany of mangroves*. Cambridge University Press.

Varshney, R. K., & Smetacek, P. (Eds.) (2015). *A synoptic catalogue of the butterflies of India*. Butterfly Research Centre, Bhimtal India and Indinov Publishing.

Van Rossum, G., & Drake, F. L. (2009). *Python 3 Reference Manual*. CreateSpace.

Verma, S. K. (2009). Species composition and seasonal variation of butterflies in Dalma Wildlife Sanctuary, Jharkhand, India, *Journal of Threatened Taxa, 1*(5), 295-297. https://doi.org/10.11609/JoTT.o2126.295-7

Wangdi, K., & Sherub, S. (2015). *UWICE Nature Guide Series - Butterflies of Bhutan: Pieridae (Whites and Yellows) & Lycaenidae (Blues)*. Ugyen Wangchuk Institute for Conservation and Environment, Bumthang.

Zhang, L. L., Hao, J. S., Huang, D. Y., Sun, X. Y., Hao, J. J., Peng, C. M., & Yang, Q. (2013). Complete mitochondrial genomes of the Bright Sunbeam *Curetis bulis* and the Small Copper *Lycaena phlaeas* (Lepidoptera: Lycaenidae) and their phylogenetic implications. *Genetics and Molecular Research, 12*(4), 4434-4445. http://dx.doi.org/10.4238/2013.October.10.9 PMid:24222223

Zhang, Y., Liao, B., Xin, K. & Sheng, N. (2021). Allometric equations for liana species *Derris trifoliata* and the relationship between inflorescence generation and stem diameter. *Global Ecology and Conservation*, 26, e01511. https://doi.org/10.1016/j.gecco.2021.e01511

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Figure 1. Map of West Bengal state, India showing the observational records of *Curetis* spp. along with the novel distributional records.

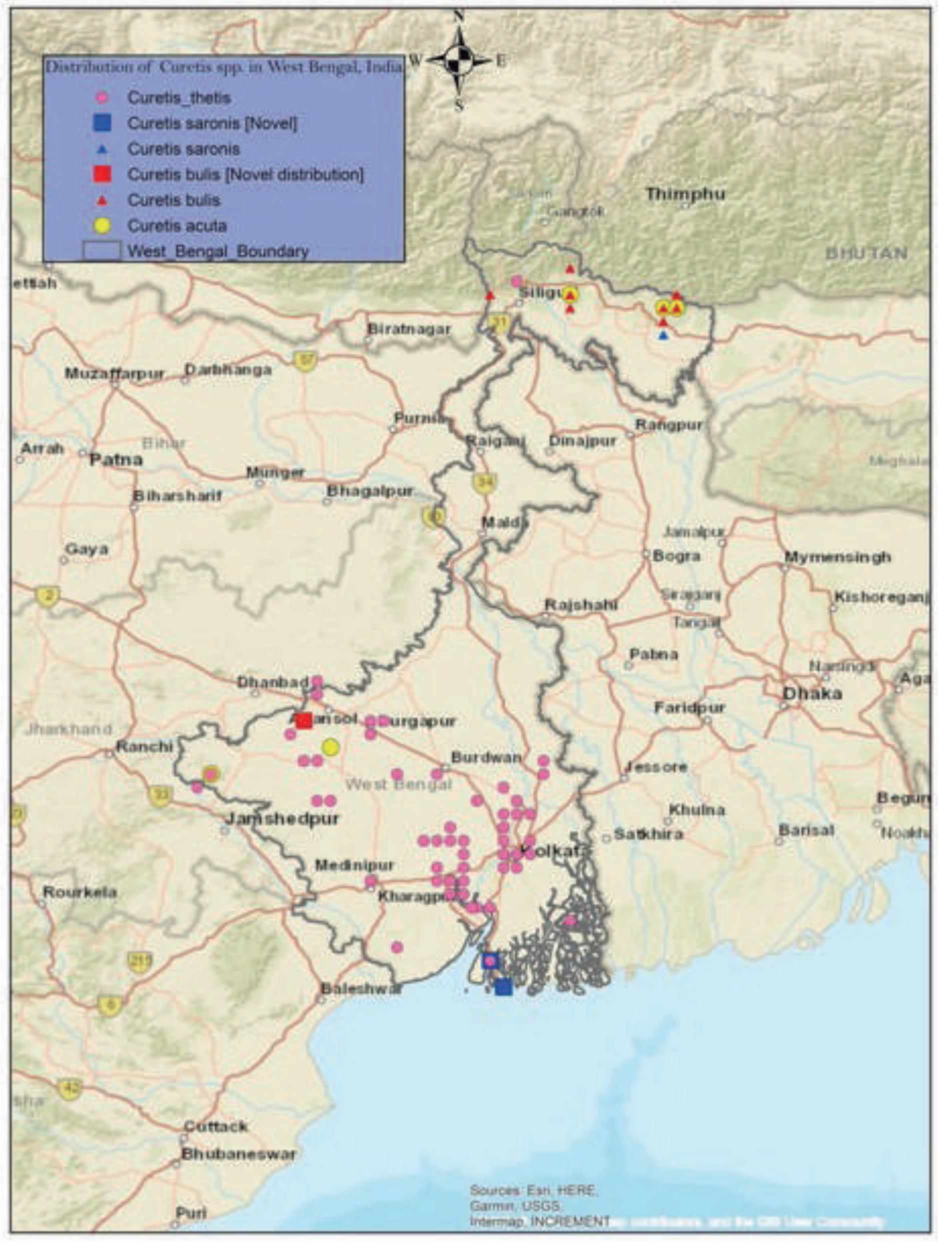


Figure 2. 2a. Open wing of *Curetis saronis* female. **2b.** Closed wing of *Curetis saronis* female, Bakkhali (South 24 Parganas district, West Bengal), 29-XII-2023 (Photographs by Sandip Das and Subhajit Roy respectively).

Figure 3. 3a. Open wing of *Curetis saronis* male **3b.** Open wing of *Curetis thetis* male, Namkhana (South 24 Parganas district), 26-XI-2022 (Photographs by Sandip Das).

Figure 4. 4a. Open wing of *Curetis acuta* male. **4b.** Open wing of *Curetis bulis* male, Susunia Hill (Bankura district) and Garh Panchakot Hill (Purulia district), 05-XII-2017 and 05-IV-2023 (Photographs by Aniruddha Singhamahapatra and Anitava Roy respectively).

Figure 5. 5a. Closed wing of *Curetis bulis* male. **5b.** Open wing of *Curetis acuta* male, Garh Panchakot Hill (Purulia district), 29-VII-2023 (Photographs by Anitava Roy).

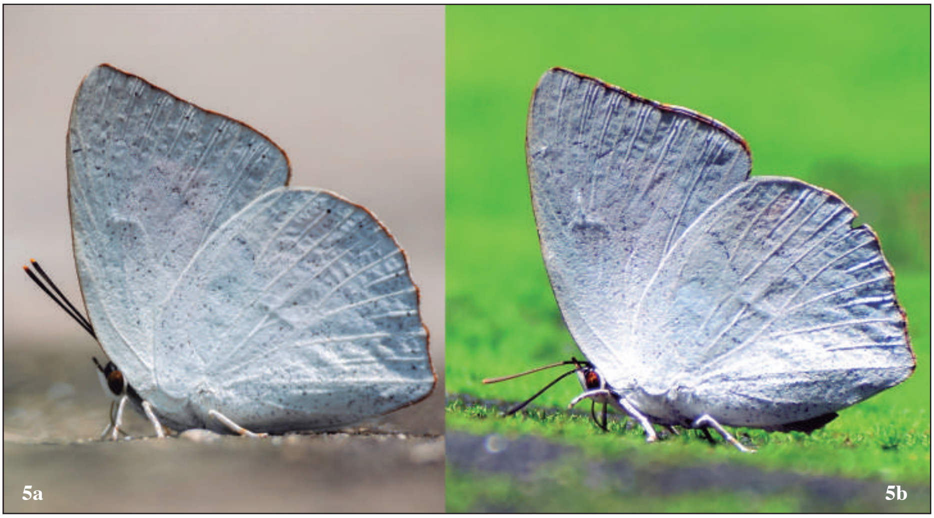
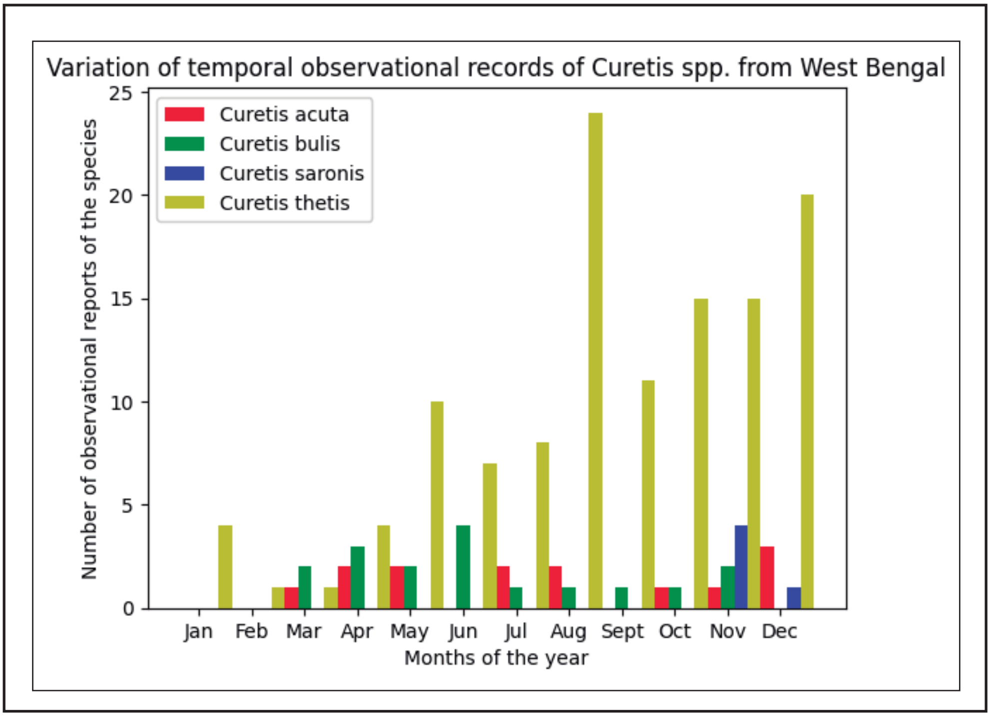


Figure 6. Temporal observational records of the *Curetis* spp. in West Bengal, India from peer-reviewed citizen science portals



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REVISIÓN DE PUBLICACIONES
BOOK REVIEWS

J. Tabell, R. Siloaho & L. Sippola
The Casebearer Moths (Coleophoridae) of Northern Europe
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Formato 29,0 x 21,0 cm
Tibiale, Helsinki, 2024
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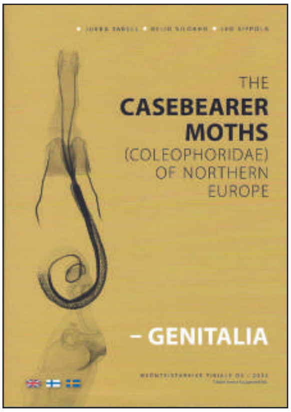

Tenemos en nuestras manos, un interesante libro sobre la fauna de Coleophoridae presente en el norte de Europa, concretamente abarcando las Islas Británicas, Países Bajos, norte de Alemania, norte de Polonia, Kaliningrado, países nórdicos incluyendo Islandia y la parte europea del norte de Rusia. El libro está escrito en tres idiomas, inglés, finlandés y sueco, lo que facilitará su lectura.

Después de una introducción, entramos en un interesante capítulo sobre la historia de los Coleophoridae y como se realiza la identificación de las diferentes especies mediante el estudio de su genitalia.

Ya dentro del estudio de la genitalia del macho, presentan las especies en dos grupos A (con 6) y B (con 5), en función de su phalloteca, representados por dibujos y esquemas, que permiten su diferenciación. Igualmente ocurre con la genitalia de la hembra, pero en este caso, utiliza el ductus bursae.

En el estudio de la genitalia del macho y para facilitar su identificación, nos presentan microfotografías de las diferentes especies, agrupadas en dos géneros *Augasma* Herich-Schäffer, 1853 (1 especies) y *Coleophora* Hübner, 1822 (188 especies).

A continuación, nos presentan la agrupación de las especies por las estructuras abdominales y, sobre todo, con el estudio del ADN genético, para la taxonomía e identificación específica, finalizando con un índice y una pequeña lista de las principales referencias consideradas.

Si ya es importante las aportaciones científicas de este libro, se ven incrementadas con la descripción de tres nuevas especies, a saber: *Coleophora avellanae* Tabell & Huemer, *C. mishai* Tabell & Kullberg y *C. pilosae* Tabell.

No podemos terminar estas líneas, sin felicitar a los autores por este extenso y detallado trabajo y que, sin duda, ayudará a todos los interesados en esta interesante familia y a la Editorial por la excelente presentación del libro, obra que no puede faltar en cualquier biblioteca que se precie.

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Target and non-target Lepidoptera species captured in semiochemical-baited traps for Zygaenidae in two NATURA 2000 protected areas in Bulgaria (Insecta: Lepidoptera)

Teodora B. Toshova, Ana Nahirnić-Beshkova, Vasily V. Anikin, Stoyan Beshkov, Boyan Zlatkov, Konstantin A. Efetov, Elena E. Kucherenko, Joseph Burman & Miklós Tóth

Abstract

Semiochemical lures known to attract Zygaenidae species were screened by means of sticky Delta traps and CSALOMON® VARL funnel traps in two Natura 2000 protected areas in Bulgaria - Nikopolsko plato (near Lozitsa village) (northern central Bulgaria) and Lozenska planina Mts, in 2015-2018 and 2023, respectively. As a result, *Rhagades* (*Rhagades*) *pruni*, *Theresimima ampellophaga*, *Zygaena* (*Agrumenia*) *carniolica* and *Z.* (*Zygaena*) *filipendulae* were recorded in the vineyards near Lozitsa vill. while *Adscita* (*Eurasiterna*) *geryon*, *A.* (*Tarmannita*) *mannii*, *Jordanita* (*Tremewania*) *notata* and *Rh.* (*Rh.*) *pruni* were registered in Lozenska planina Mts. *Rhagades* (*Rh.*) *pruni* was newly recorded in northern central Bulgaria. In addition to Zygaenidae species, a total of 62 non-target species belonging to following Lepidoptera families: Coleophoridae, Crambidae, Erebidae, Gelechiidae, Geometridae, Noctuidae, Nolidae, Nymphalidae, Oecophoridae, Pieridae, Plutelliidae, Pyralidae, Tortricidae and Yponomeutidae, were recorded. Sex attractants for one Coleophoridae, one Cambidae, one Geñechiidae and two Noctuidae species were established for the first time. Two *Augasma* species are new records for the fauna of the Balkan Peninsula.

Keywords: Insecta, Lepidoptera, new attractants, new distributional records, Balkan Peninsula.

Especies de Lepidoptera objetivo y no objetivo, capturadas en trampas con cebo semioquímico para Zygaenidae en dos espacios protegidos NATURA 2000 de Bulgaria (Insecta: Lepidoptera)

Resumen

Se seleccionaron semioquímicos conocidos por atraer a especies de Zygaenidae mediante trampas Delta adhesivas y trampas de embudo CSALOMON® VARL en dos zonas protegidas Natura 2000 en Bulgaria: el plato de Nikopolsko (cerca del pueblo de Lozitsa), en el centro-norte de Bulgaria, y los montes Lozenska planina, en 2015-2018 y 2023, respectivamente. Como resultado, se registraron *Rhagades* (*Rhagades*) *pruni*, *Theresimima ampellophaga*, *Zygaena* (*Agrumenia*) *carniolica* y *Z.* (*Zygaena*) *filipendulae* en los viñedos cercanos a la aldea de Lozitsa, mientras que *Adscita* (*Eurasiterna*) *geryon*, *A.* (*Tarmannita*) *mannii*, *Jordanita* (*Tremewania*) *notata* y *Rh.* (*Rh.*) *pruni* se registraron en Lozenska planina Mts. *Rhagades* (*Rh.*) *pruni* se registró por primera vez en el centro-norte de Bulgaria. Además de las especies de Zygaenidae, se registraron un total de 62 especies no objetivo pertenecientes a las siguientes familias de Lepidoptera: Coleophoridae, Crambidae, Erebidae, Gelechiidae, Geometridae, Noctuidae, Nolidae, Nymphalidae, Oecophoridae, Pieridae, Plutelliidae, Pyralidae, Tortricidae e Yponomeutidae. Se establecieron por primera vez atrayentes sexuales para una especie de Coleophoridae una de Crambidae, una de Gelechiidae y dos de Noctuidae. Dos especies de *Augasma* son nuevos registros para la fauna de la península balcánica.

Palabras clave: Insecta, Lepidoptera, nuevos atrayentes, nuevos registros de distribución, península Balcánica.

Introduction

The earliest publication reporting a synthetic chemical attractant of a zygaenid species was the study of Benz & von Salis (1973), who reported attraction of *Zygaena transalpina* Esper, 1780, males to compounds in a field test organized for the Larch bud moth *Zeiraphera griseana* (Hübner, 1799) (= *Z. diniana* (Guenée, 1845)). Focused studies on zygaenid sex attractants started with the investigations of Decamps et al. (1981), Renou & Decamps (1982), Priesner et al. (1984) and Renou & Zagatti (1984). Over the last fifty years sex attractants for species belonging to the following genera have been published: *Acoloithus*, *Adscita*, *Doratopteryx*, *Epizygaenella*, *Goazrea*, *Harrisina*, *Illiberis*, *Jordanita*, *Neoalbertia*, *Neoilliberis*, *Neoprocris*, *Pyromorpha*, *Reissita*, *Rhagades*, *Staphylinochrous*, *Theresimima*, *Triprocris*, *Zygaena* and *Zygaenoprocris* (Efetov et al. 2011, 2023; Efetov & Kucherenko, 2020; El-Sayed, 2025; Subchev, 2014; Yardım et al. 2025). However, sex pheromones are known for a few species in Zygaenidae. Two pests of *Vitis vinifera* L., viz. *Harrisina brillians* Barnes & McDunnough, 1910, and *Theresimima ampellophaga* (Bayle-Barelle, 1809), use the enantiomers of 2-butyl-(7*Z*)-tetradecenoate in their intraspecific chemical communication systems, (2*S*)-butyl (7*Z*)-tetradecenoate (S-7-14) (Myerson et al. 1982; Soderstrom et al. 1985) and a mixture of (2*R*)-butyl (7*Z*)-tetradecenoate (main pheromone compound) (R-7-14) and S-7-14 (minor pheromone compound) (Subchev et al. 1998, erratum - 1999), respectively. Subchev et al. (2009) identified (2*R*)-butyl (7*Z*)-dodecenoate (R-7-12) and (2*R*)-butyl (9*Z*)-tetradecenoate (R-9-14) as sex pheromone compounds of *Illiberis* (*Primilliberis*) *rotundata* Jordan, 1907 females. Zagrobelny et al. (2015) analysed volatile emissions from males and females of the six-spot burnet moth, *Zygaena* (*Zygaena*) *filipendulae* (Linnaeus, 1758), which resulted in the identification of novel putative pheromones for this species. Thus, sex pheromone components exactly established for only three species of Zygaenidae from the subfamily Procridinae. All of them are esters of butan-2-ol and higher unsaturated carboxylic acids. Similar esters are known as sex attractants for much more Zygaenidae species from two subfamilies, viz. Procridinae and Zygaeninae. In particular, the enantiomers of 2-butyl 2-dodecenoate are sex attractants from the series ‘EFETOV-2’ (patented name), which are active for the males of almost 30 Zygaenidae species from two subfamilies noted above (Can et al. 2019; Can Cengiz et al. 2018; Drouet et al. 2021; Efetov et al. 2016, 2018, 2019, 2020, 2024, 2025; Efetov & Kucherenko 2021; Yardım et al. 2024).

The aim of the current study was to investigate the occurrence and diversity of forester and burnet moths (Zygaenidae) in an agricultural land in northern Bulgaria and in a mountain habitat in western part of the country; both study places fall in Natura 2000 protected areas. The paper presents also data about other lepidopteran species captured during the study including the first records of two *Augasma* species in Bulgaria and new sex attractants for five lepidopteran species.

Materials and methods

Study sites

The experiments were carried out in two regions - Nikopolsko plato situated in northern central Bulgaria and Lozenska Mts situated in southwest Bulgaria in areas included within NATURA 2000 ecological network under Directive 92/43 / EEC for the Conservation of Natural Habitats and Wild Flora and Fauna, NATURA 2000 sites BG0000274 and BG0000165, respectively.

Investigations were performed over a three-year period (2015-2018) in vineyards in Nikopolsko plato near Lozitsa village (Nikopol Municipality, Pleven Province). The wine grape varieties were ‘Muskat Ottonel’ and ‘Mavrud’. The area is characterized by vineyards of different type of management - well managed, neglected or abandoned vineyards (Toshova et al. 2017), arable lands and perennial meadows. The last two types of vineyards are habitats, which also offer suitable host-plants of numerous insect species including pests.

In 2023, the tests with attractant lures were performed in Lozenska planina Mts at the base of Lalina mogila peak, where the habitat is characterized by mixed deciduous forest and meadows. The dendroflora in the studied sites is represented by *Quercus cerris* L., *Quercus frainetto* Ten., *Ulmus minor* Mill., *Fagus sylvatica* L., *Corylus avellana* L., *Carpinus orientalis* Mill., *Pyrus pyraster* (L.) Burgsd., *Prunus spinosa* L., *Cornus mas* L., *Juniperus communis* L. and *Rosa* sp.

Traps

For Procridinae tests home-made transparent Delta traps with replaceable sticky inserts were used while for Zygaeninae tests the traps were CSALOMON® VARL funnel traps (Plant Protection Institute, Centre for Agricultural Research, HUN-REN, Budapest; www.csalomontraps.com). Delta sticky inserts were with a size 10 cm x 16 cm. A piece (1 × 1 cm) of a household anti-moth insecticide strip (Chemotox®, Slouth, UK; active ingredient 15% dichlorvos) was placed into the collection container of the VARL funnel traps to kill captured insects. The traps used in the experiments are shown on Figure 1.

Lures

Lures for Procridinae

For preparing the lures, the synthetic pheromone compounds, R-7-14 and R-7-12 and the enantiomer of the last compound, S-7-12, in a dose of 100 μg were applied singly onto serum vial caps of grey rubber as a hexane solution. The two-component lure of R-7-14 and R-7-12 (tested in Lozitsa vill. in 2017 and Lozenska planina Mts in 2023) was in a ratio 100:100 (R-7-14 + R-7-12). The lures were prepared at the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences (IBER-BAS). The sex attractant EFETOV-2, the rubber caps were impregnated with 100 μl of the racemic mixture of (2*R*)-butyl 2-dodecenoate and (2*S*)-butyl 2-dodecenoate, which was prepared in the Crimean Federal University, Simferopol (Crimea) (Efetov et al. 2014).

Lures for Zygaeninae

The synthetic compounds used were (*Z*)-5-dodecenyl acetate (Z5-12Ac), (*Z*)-7-dodecenyl acetate (Z7-12Ac), (*Z*)-7-tetracenyl acetate (Z7-14Ac), (*Z*)-9-dodecenyl acetate (Z9-12Ac), (*Z*)-9-tetradecenyl acetate (Z9-14Ac), (*Z*)-11-hexadecenyl acetate (Z11-16Ac), and (*Z*)-8-dodecenyl acetate (Z8-12Ac). They were purchased from Sigma-Aldrich® or obtained from Pherobank (Netherlands) and their purity was > 96%.

The following one-compound lures and mixtures were prepared at IBER-BAS by the method described above: Z5-12Ac, Z7-12Ac, Z9-14Ac, Z7-12Ac + Z9-14Ac (100:100) and Z7-12Ac + Z9-14Ac + Z8-12Ac (100:100:100).

The lures for *Zygaena* (*Mesembrinus*) *purpuralis* (Brünnich, 1763) (Z_pur) and *Z.* (*Agrumenia*) *viciae* ([Denis & Schiffermüller], 1775) (Z_vic) were prepared by the Ecology Research Group, Canterbury Christ Church University, England (UK). The lure preparation and composition for *Z.* (*M.*) *purpuralis* and *Z.* (*A.*) *viciae* were described in Can et al. (2019) and Vrenozi et al. (2020) and contained Z7-12Ac + Z7-14Ac + Z9-14Ac (100:10:100) and Z5-12Ac + Z7-12Ac + Z9-12Ac + Z9-14Ac + Z11-16Ac (10:100:1:10:5) for Z_pur and Z_vic, respectively.

Dispensers were wrapped singly in pieces of aluminum foil and were stored at -30ºC until use.

Field Experiments

In seven field experiments we evaluated the attractiveness of lures for Procridinae and Zygaeninae in two sites in Bulgaria in the period of 2015-2018 and 2023. One to five lures were tested within each experiment. Two replications/blocks of the treatments were deployed at each site, and the traps in a replicate were spaced 10-15 m apart along the field. Distance between the vineyards in Lozitsa vill. was about 0.800 km while the distance between localities in Lozenska planina Mts - about 0.500 km. For unbaited controls, traps without any lure were also used in the most of the experiments. Lures last for different lengths of time. Previous experience obtained in many years in different countries showed that the traps baited with the lures for *Th. ampellophaga* and also lures containing R-7-12, S-7-12 and their blend do not attract any other lepidopteran species, and they are active at least six - seven weeks (Subchev et al. 2004; Toshova et al., unpublished data) while EFETOV-2 lures are active not less than six months (Efetov et al. 2022, 2024; Vrenozi et al. 2019). Other lures tested were replaced every four weeks. Details about the experiments are provided in Table 1.

Traps were checked at approximately weekly intervals and only in some single cases for a longer period, however not exceeding four weeks (August, 2016 and 9-VI - 21-VII-2018, Lozitsa vill.). Trap positions within each trap block were rotated at each inspection date. In tests where sticky traps were used at each sample interval, the sticky layers were replaced with new bottoms. The collected moths were taken to the laboratory for species identification. For accurate identification of Microlepidoptera species captured into the sticky traps, insects were kept in glass vials with xylenes purriss., ≥ 96.0% (Sigma-Aldrich®) for 48 hours to remove the sticky material from the insect's body. After any residual sticky materials were dissolved the specimens were placed on filter paper to dry. The procedure of cleaning of insects was done under a fume hood in the laboratory. The identification of specimens caught during the field tests was based on external morphological characters and genitalia examination. The species were identified using the following identification keys: Anikin & Sinichkina (2018), Danilevsky & Kuznetzov (1968), Falkovitsh (1986), Razowski (2003), and without identification guides for the "Macrolepidoptera" species.

Statistical analysis

A minimum of 30 specimens of a non-target species per year was the criterion chosen for performing the statistical analysis. For a robust analysis we included in each analysis only data that had a sufficient number of replicates ($n \geq 10$ replicates). The data were tested for normal distribution using the Kolmogorov-Smirnov test. Since these conditions were not met, a Kruskal-Wallis test was used as nonparametric test to determine the significance of treatments. When the Kruskal-Wallis test indicated significant differences between treatment means, subsequent pairwise Mann-Whitney U test was used to detect the significant differences between the tested variants. All statistical analyses were performed in STATISTICA v.7.0 (StatSoft, Tulsa, OK, USA). The significant difference was set at $P < 0.05$.

Results

Target species

A total of 230 males of the following seven Zygaenidae species were captured during the study. All Zygaenidae were captured in the sticky traps. *Rhagades* (*Rhagades*) *pruni* ([Denis & Schiffermüller], 1775), *Th. ampellophaga*, *Zygaena* (*Agrumenia*) *carniolica* (Scopoli, 1763) and *Z.* (*Z.*) *filipendulae* were recorded in the vineyards near Lozitsa vill. while *Adscita* (*Eurasiterna*) *geryon* (Hübner, 1813), *A.* (*Tarmannita*) *mannii* (Lederer, 1853), *Jordanita* (*Tremewania*) *notata* (Zeller, 1847) and *Rh.* (*Rh.*) *pruni* were registered in Lozenska planina Mts (Tables 2-3). In Lozitsa vill., the most numerous species were *Th. ampellophaga* and *Z.* (*Z.*) *filipendulae* captured in the traps baited with R-7-14 + R-7-12 and mainly Z_vic, respectively. In 2017, one flight peak of the males of the vine bud moth occurred with catches from the middle of June to the middle of July. In the same year, *Z.* (*Z.*) *filipendulae* catches were registered during the whole period of the investigation from the middle of June to the end of August - beginning of September. In Lozenska planina Mts, *A.* (*T.*) *mannii* was the most abundant species followed by *J.* (*T.*) *notata* captured in the traps baited with S-7-12 and R-7-12 (alone or in combination with the opposite enantiomer), respectively. In Lozitsa vill., catches of the males of *Rh.* (*Rh.*) *pruni* were recorded during the period of 12-26-VI-2015 (males attracted to R-7-12 and S-7-12) and 3-12-VI-2016 (single males attracted to R-7-12 and EFETOV-2 lures, respectively) while in Lozenska planina Mts - 15-28-VII-2023 (single male attracted to R-7-12).

Non-target species

In addition to the Zygaenidae species, traps tested captured a wide range of species from different Lepidoptera families - Coleophoridae, Crambidae, Erebidae, Gelechiidae, Geometridae, Noctuidae, Nolidae, Nymphalidae, Oecophoridae, Pieridae, Plutelliidae, Pyralidae, Tortricidae and Yponomeutidae, and some of them were caught in high numbers. Catches of the individual species are shown in Tables 2-3.

In Lozitsa vill., the most numerous non-target species was *Augasma aeratella* (Zeller, 1839) (Coleophoridae) followed by *Autographa gamma* (Linnaeus, 1758) (Noctuidae) and *Evergestis aenealis* ([Denis & Schiffermüller], 1775) (Crambidae) (Table 2). The trap catches in the experiments performed in 2015 and 2016 indicated that the highest mean catches of *A. aeratella* males were found in the traps baited with Z7-12Ac alone or in combination with Z9-14Ac (100:100) and no significant difference between catches was observed despite the trap type was different in the two years (Table 4). The flight of the adults was at least five months from the end of April - beginning of May to the end of September. In 2015, when Delta sticky traps were used similar results were obtained with *A. gamma* males. However, in the next year when lures were tested in combination with VARL funnel traps Z7-12Ac attracted significantly more males compared with the two-component mixture.

Evergestis aenealis ([Denis & Schiffermüller], 1775) males were captured in the traps baited with the two-component mixture of Z7-12Ac and Z9-14Ac in Lozitsa vill. and Lozenska planina Mts, and a single male was recorded also in the traps baited with Z9-14Ac in Lozitsa vill. in 2016. The period of flight activity differed between the study sites and years. In the vineyards in Lozitsa vill. in 2015, catches were registered in the period of 19-VI - 20-IX, and two peaks of flight were observed: 1) the end of June - beginning of July and the second half of August. In 2016 in the same area, the flight activity began earlier - at the end of April - beginning of May while the last catch was recorded at the end of September. In Lozenska planina Mts, *E. aenealis* males were captured during the whole monitoring period - from the beginning of June to the middle of July.

In Lozitsa vill., where EFETOV-2 lures were tested *Udea ferrugalis* (Hübner, 1796) (Crambidae) males were attracted. Catches were recorded in the period of 3-25-VI-2016 and 9-VI - 5-VIII-2018.

Pammene gallicolana (Lienig & Zeller, 1846) was caught in the traps baited with the triple mixture of Z7-12Ac + Z9-14Ac + Z8-12Ac in unusually high number of males in June 2023 in Lozenska planina Mts Bulgaria.

In addition to the lepidopteran species, a single male specimen of *Tilloidea unifasciata* (Fabricius, 1787) (Coleoptera: Cleridae) was registered in Lozitsa vill. in the trap baited with EFETOV-2 lure during the period of 25-VI - 2-VII-2015.

Discussion

Target species

The Zygaenidae species recorded during the study are widely distributed species in Bulgaria in exception of *Rh.* (*Rh.*) *pruni*. *Rhagades* (*Rh.*) *pruni* is newly recorded in the region of northern central Bulgaria. In the whole northern part of Bulgaria, on the north of Stara planina Mts, *Rh.* (*Rh.*) *pruni* has been recorded only in Sveshtari vill. (Razgrad Province) in 1923 (Buresh & Tuleshkov, 1943). There are only two more historical records in the Danube plain, Bucharest and Comana, originating from 1916 (Popescu-Gorj, 1964). In the wider area of Sofia, only one record has been known so far. Subchev et al. (2010) recorded *Rh.* (*Rh.*) *pruni* in Botanical garden of the Bulgarian Academy of Sciences in Sofia in 2005. Our record from Lozenska planina Mts confirms its presence in this region. Both of new records fill in considerable wide gaps in distribution of this species (Figure 2). *Prunus spinosa* L., *Rosa sp.* and *Rubus fruticosus* L., which are host-plants for the caterpillars of *Rh.* (*Rh.*) *pruni* were observed in vineyards in Lozitsa vill. and the studied habitats in Lozenska planina Mts (Toshova, personal observations). *Zygaena* (*A.*) *carniolica* and *Z.* (*Z.*) *filipendulae* are common species in Bulgaria and neighbouring countries, however there are no published records after 1923 for *Z.* (*A.*) *carniolica* and after 1982 for *Z.* (*Z.*) *filipendulae* for the wider area of Danube Plain in Bulgaria and Romania.

Our results confirm the data obtained earlier that S-7-12 (alone or in mixtures) attracts *A.* (*Eur.*) *geryon* and *A.* (*T.*) *mannii* while R-7-12 (alone or in mixtures) is an attractant for *J.* (*T.*) *notata* (Drouet et al. 2021; Efetov et al. 2015; Subchev et al. 2010; Vrenozi et al. 2020). Attraction of *Rh.* (*Rh.*) *pruni* males to R-7-12 alone or in mixtures has been reported from Bulgaria, Crimea, Hungary and France (Drouet et al. 2021; Subchev et al. 2010). It was also reported that the males of this species were attracted to EFETOV-2 in the Crimea (Efetov et al. 2016) and its *S*-enantiomer, EFETOV-S-S-2, in Spain (Efetov et al. 2019; Efetov &

Kucherenko, 2021). The five-component lure Z_vic (Z5-12Ac + Z7-12Ac + Z9-12Ac + Z9-14Ac + Z11-16Ac in a ratio 10:100:1:10:5) attracted for the first time the male specimens of *Z.* (*Z.*) *filipendulae*. Single specimens of *Z.* (*Z.*) *filipendulae* and *Z.* (*A.*) *carniolica* were captured in the traps baited with Z7-12Ac + Z9-14Ac (100:100) in Lozitsa vill. in July, 2015. The last two compounds have been reported in the attractive mixtures for these species with Z7-12Ac as a dominant component in these mixtures (El-Sayed, 2025). It seems the addition of the sex pheromone component of *I.* (*P.*) *rotundata* (R-7-12) to the main sex pheromone compound of *Th. ampellophaga* females (100:100) does not influence the activity of the latter compound. In 2017, male specimens recorded in the traps with the two-component mixture in Lozitsa vill. belongs to the first generation of this species.

All zygaenid species were captured in the baited sticky Delta traps in the two localities - Lozitsa vill. and Lozenska planina Mts. Knodel & Agnello (1990) reported that sticky traps caught higher number of moths than various funnel traps. When comparing different trap designs baited with sex pheromone including VARL funnel traps for effectiveness in capturing of *Th. ampellophaga* males Subchev et al. (2004) reported that there was no statistically significant difference between the catches of males in all types of traps, although numerically somewhat more moths were caught in sticky Delta traps than in VARL funnel traps.

Non-target species

Augasma nitens Amsel, 1935 and *A. uljanovi* Anikin, 2017

Augasma nitens and *A. uljanovi* are new records for the Bulgarian fauna and Balkan Peninsula. *Augasma nitens* was described by Amsel (1935) from Palestine (Jéricho) by a moth caught in the first half of August, 1930, and no other localities have been reported. Male genital apparatus was presented by Toll (1962). Female and developmental stages are unknown. In our study, *A. nitens* was captured in the traps baited with Z7-12Ac + Z9-14Ac at the second half of July, in the period of 17-14-VII-2015 in Lozitsa vill. *Augasma uljanovi* was described by Anikin (2017) from Uljanovsk region in Russia. Recently it was recorded in Volgograd and Saratov regions in Russia (Anikin & Khapugin, 2024) and in the vicinity of Mingechaur in Azerbaijan (Anikin et al. 2025). The moths of the type series of *A. uljanovi* have emerged from galls of *Atraphaxis frutescens* (L.) Eversm. (Polygonaceae) (Anikin, 2017). *Atraphaxis frutescens* is native to European Russia, Siberia, Kazakhstan, Turkmenistan, Uzbekistan, Mongolia and China (Abilkassymova et al. 2024).

Augasma aeratella (Zeller, 1839)

The results of the present study confirmed literature data on Z7-12Ac as being a sex attractant of *A. aeratella* males (Tóth et al. 1992). Although a high number of males was found also in the traps baited with the mixture with Z9-14Ac (100:100) in Nikopolsko plato in 2015-2016 we consider that Z7-12Ac was responsible for the attraction. The larva of *A. aeratella* lives on *Polygonum aviculare* Linnaeus, 1753 and *Persicaria lapathifolia* (L.) Delarbre 1800 (Toll, 1962) from October to April and the species fly from May to August (Fazekas & Schreurs, 2010). However, we recorded catches of males in the period from the end of April - beginning of May to the end of September, 2016. Kulikov & Naumkin (2004) reported *A. aeratella* as a pest of buckwheat, *Fagopyrum esculentum* Moench (Polygonaceae).

It is worth mentioning that some dry *Augasma* specimens captured in the sticky traps were sent for molecular analysis. Unfortunately probably the rapid degradation of DNA in the insects has rendered them unsuitable for genetic analyses. Later Butterwort et al. (2022) presented a DNA extraction method designed for the detection of insects from sticky traps.

Tuberculia albitarsella Zeller, 1849

During screening test in Pancharevo (Sofia) Subchev et al. (1990) reported two-component sex attractant, Z5-10Ac + Z7-12Ac, for *T. albitarsella* males as captures were registered in various ratios of the two compounds (100:100, 100:10 and 10:100). However, the single compounds were inactive in their study. We recorded a single male of this species in a VARL funnel trap baited with Z7-12Ac in Lozitsa vill.

Evergestis aenealis ([Denis & Schiffermüller], 1775)

Tóth et al. (1994) reported that the mixture of Z7-12Ac + Z9-14Ac is an attractant for *E. aenealis* in Hungary. In the current study, the same mixture was proved to be attractive to *E. aenealis* males in Lozitsa vill. (2015-2016) and Lozenska planina Mts (2023). In Bulgaria, this species is widely distributed from the sea level to above 2000 m (Ganev, 1986; Plant, 2016). The species develops two generations per year in Bulgaria but in some years (Plant, 2016). Our results from Lozitsa vill., where monitoring periods were longer showed that *E. aenealis* had two generations. The flight of the first generation was from the end of August - beginning of May to the beginning of July, and catches of the males from the second generation were recorded from the second half of July to the middle of September.

Udea ferrugalis (Hübner, 1796)

Udea lutealis (Hübner, [1809]), is the only species of the genus *Udea* with known sex attractant (Z11-16Ac) (El-Sayed 2025). However, during our study with the exception of *Rh.* (*Rh.*) *pruni* the rusty dot pearl moth, *U. ferrugalis* was the only species attracted to EFETOV-2 lures in Lozitsa vill. in 2016 and 2018. This species is a common and widespread species in Bulgaria. *Udea ferrugalis* is polyphagous attacking numerous plant species (Slamka, 2013). It is considered as a pest of greenhouse plants in Bulgaria (Loginova, 1992).

Bryotropha tachyptilella (Rebel, 1916)

This species was described by Rebel (1916) by two males captured by Petar Chorbadziev from Burgas, Bulgaria in June 1910. Additional data about distribution of this species in Bulgaria has been provided by Karsholt & Rutten (2005): Arkutino (Black sea coast), Sliven, Sandanski, all sites in southern Bulgaria. The attraction of males of *B. tachyptilella* to the two-component blend of Z7-12Ac and Z9-14Ac in Lozitsa vineyards was documented for the first time. According to the literature, Z9-14Ac alone or in mixtures with other compounds attracts *B. similis* (Stainton, 1854) (Roelofs & Comeau, 1969), *B. galbanella* (Zeller, 1839), *B. terrella* ([Denis & Schiffermüller], 1775) (Mozūraitis et al. 1998) and *B. senectella* (Zeller, 1839) (Kovaleva et al. 1975). From the other hand, Arn et al. (1974) reported that *B. terrella* males have been attracted by the opposite isomer, *trans*-9-tetradecenyl acetate. According to Kovács & Kovács (2022), *B. tachyptilella* has two generations, adults from the first generation fly in May and June and the moths from the second generation – from the beginning of August to the middle of September. We recorded catches in August-September, which correspond to the adults of the second generation. There is no information available on the host-plant of *B. tachyptilella* but *Bryotropha* larvae are known to feed on mosses and some species on grasses (Karsholt & Rutten, 2005).

Chloantha hyperici ([Denis & Schiffermüller], 1775)

Captures of *Ch. hyperici* males in the traps baited with Z7-12Ac in 2015 and 2016 in Lozitsa vill. to the traps baited with Z7-12Ac is an indication that this alcohol acts as a sex attractant of the males of this species. No reports about sex attractants have been published for this species. *Ch. hyperici* occurs in two or partially three generations between March and September. Larva feeds on *Hypericum* (Hypericaceae). This species is widely distributed in Bulgaria (Beshkov et al. 1999; Kostova et al. 2019; Zlatkov, 2007).

Axylia putris (Linnaeus, 1761)

Our results confirmed the attraction of the males of *A. putris*, to Z9-14Ac already reported for several European and Asian countries (El-Sayed, 2025). The flight period of male moths in Lozitsa vill. (April-July) overlaps that reported by Zlatkov (2007) (April - August). Host-plants for the larvae of this species are variety of plants belonging to Fabaceae, Poaceae, Polygonaceae, Rubiaceae, Urticaceae, etc. (Agius, 2023). Molinari et al. (1996) reported *A. putris* as a pest of peach orchards in Italy.

Hoplodrina respersa ([Denis & Schiffermüller], 1775)

No sex attractant has been previously described for *H. respersa* and our results showed behavioral activity of three lures containing Z9-14Ac. The attraction of males of this species to the three-component lure tested in Lozenska planina Mts, Z7-12Ac + Z9-14Ac + Z8-12Ac, should be confirmed.

Pammene gallicolana (Lienig & Zeller, 1846)

Pammene gallicolana is a species associated with wasp galls of oak (Kemal & Koçak, 2010). Our results confirm the importance of Z8-12Ac in attraction of *P. gallicolana* males (Olenici et al. 2007; Rotundo et al. 1991; Sziráki, 1978). Velcheva (2000) reported relatively low number of males of this species captured in the traps baited with Z8-12Ac in combination with the geometrical isomer, *trans*-8-dodecenyl acetate, and the single Z8-12Ac in Sofia (Pancharevo), Bulgaria. Males of several *Pammene* species including *P. albuginana* (Guenée, 1845) respond to the commercially available sex attractants containing Z8-12Ac (Jakubíková et al. 2016; Mayer & McLaughlin, 1991).

Autographa gamma (Linnaeus, 1785) and *Macdunnoughia confusa* (Stephens, 1850) males were attracted most strongly by the single-component lure of Z7-12Ac. This compound has been previously identified in the sex pheromone mixtures of the conspecific females. From the other hand the importance of Z9-14Ac in the intraspecific communication of *Noctua janthina* ([Denis & Schiffermüller], 1775) and *Panemeria tenebrata* (Scopoli, 1763) has been documented (El-Sayed 2025). Our data confirmed the attraction of the turnip moth *Agrotis segetum* ([Denis & Schiffermüller], 1775) to the binary mixture of Z7–12Ac and Z9-14Ac in Bulgaria (Subchev et al. 1986).

We confirmed the attraction of the checkered beetle *Tilloidea unifasciata* to EFETOV-2, which was reported by Efetov & Kucherenko (2024) in five sites in the Crimea in 2013-2015.

Protected area effectiveness depends on both the quantity (e.g., coverage) and quality (e.g., representativeness, abundance, good condition, high species richness) (Cooke et al. 2023). Our results highlight the role of two protected areas in Bulgaria for lepidopteran diversity studied by sex pheromone/ attractant traps.

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Conflict of Interest

The authors declare that there is no known financial interest or personal relationship that could have influenced the work presented in this article.

References

Abilkassymova, A., Turgumbayeva, A., Sarsenova, L., Tastambek, K., Altynbay, N., Ziyaeva, G., Blatov, R., Altynbayeva, G., Bekesheva, K., Abdieva, G., Ualieva, P., Shynykul, Z., & Kalykova, A. (2024). Exploring Four *Atraphaxis* Species: Traditional Medicinal Uses, Phytochemistry, and Pharmacological Activities. *Molecules*, *29*, 910. https://doi.org/10.3390/molecules29040910 PMid:38398660 PMCid:PMC10891555

Agius, J. (2023). *Axylia putris* (Linnaeus, 1761) new to the Maltese Islands (Lepidoptera: Noctuidae). *SHILAP Revista de lepidopterología*, *51*(203), 427-429. https://doi.org/10.57065/shilap.527

Amsel, H. G. (1935). Neue palästinensische Lepidopteren. Coleophoridae. *Mitteilungen aus dem Zoologischen Museum in Berlin*, *20*(2), 305-307.

Anikin, V. V. (2017). A new species of the genus *Augasma* from the Volgo-Ural Region and re-description of a female of *Casignetella genviki* Anikin, 2002 (Lepidoptera: Coleophoridae). In V. V. Anikin, S. A. Sachkov & V. V. Zolotuhin. Fauna lepidopterologica Volgo-Uralensis: from P. Pallas to present days. *Proceedings of the Museum Witt Munich* (Vol. 7, pp. 526-528). Museum Witt Munich & Nature Research Center Vilnius

Anikin, V. V., & Khapugin, A. A. (2024). Biodiversity of Microlepidoptera (Lepidoptera) of the Saratov and Volgograd regions (Russia, Lower Volga). *Journal of Wildlife and Biodiversity*, *8*(3), 240-269. https://doi.org/10.5281/zenodo.11569419

Anikin, V. V., Snegovaya, N. Yu., Shapoval, N. A., Humbatov, M. F.-O., Mammadov, I. B.-O., & Yakovlev, R. V. (2025). Lepidoptera of Azerbaijan (Southern Transcaucasia). Family Coleophoridae. *Russian Entomological Journal*, *34*(1), 116-120. https://doi.org/10.15298/rusentj.34.1.13

Anikin, V. V. & Sinichkina, O. V. (2018). *Chaetotaxy of casebearer larvae (Lepidoptera: Coleophoridae)*. V. V. Zolotuhin (Ed.). Ulyanovsk: «Korporatsiya Technologyj Prodvizhenia». (in Russian).

Arn, H., Schwarz, C., Limacher, H., & Mani, E. (1974). Sex attractant inhibitors of the codling moth *Laspeyresia pomonella* L. *Experientia*, *30*(10), 1142-1144. https://doi.org/10.1007/bf01923655 PMid:4435116

Benz, G., & von Salis, G. (1973). Use of synthetic sex attractant of larch bud moth *Zeiraphera diniana* (Gn.) in monitoring traps under different conditions, and antagonistic action of cis-isomer. *Experientia*, *29*, 729-730. https://doi.org/10.1007/BF01944802

Beshkov, S., Nowacki, J., & Pałka, K. (1999). Contribution to the knowledge on the distribution of Macrolepidoptera in Bulgaria. *Wiadomości Entomologiczne*, *18*(3), 169-185.

Buresch, Iw., & Tuleschkow, Kr. (1943). Die horizontale Verbreitung der Schmetterlinge (Lepidoptera) in Bulgarien V. Mitteilungen aus den Königl. *Naturwissenschaftlichen Instituten in Sofia*, *16*, 79-188. [In Bulgarian, German summary]

Butterwort, V., Dansby, H., Zink, F. A., Tembrock, L. R., Gilligan, T. M., Godoy, A., Braswell, W. E., & Kawahara, A. Y. (2022). A DNA extraction method for insects from sticky traps: targeting a low abundance pest, *Phthorimaea absoluta* (Lepidoptera: Gelechiidae), in mixed species communities. *Journal of Economic Entomology*, *115*(3), 844-851. https://doi.org/10.1093/jee/toac046 PMid:35391487

Can, F., Efetov, K. A., Burman, J., Kaya, K., Kucherenko, E. E., Ulaşlı, B., & Tarmann, G. M. (2019). A study of the Zygaenidae (Lepidoptera) fauna of Central Anatolia, Turkey. *Turkish Journal of Entomology*, *43*(2), 189-199. https://doi.org/10.16970/entoted.512580

Can Cengiz, F., Efetov, K. A., Kaya, K., Kucherenko, E. E., Okyar, Z., & Tarmann, G. M. (2018). Zygaenidae (Lepidoptera) of Thrace Region of Turkey. *Nota lepidopterologica*, *41*(1), 23-36. https://doi.org/10.3897/nl.41.21065

Cooke, R., Mancini, F., Boyd, R. J., Evans, K. L., Shaw, A., Webb, T. J., & Isaac, N. J. (2023). Protected areas support more species than unprotected areas in Great Britain, but lose them equally rapidly. *Biological Conservation*, *278*, 109884. https://doi.org/10.1016/j.biocon.2022.109884

Danilevsky, A. S., & Kuznetzov, V. I. (1968). Listovertki - Tortricidae triba plodozhorki Laspeyresiini. In V. I. Byhovskiy (ed.). *Fauna SSSR, 5*(1), 635 pp. [In Russian].

Decamps, C., du Merle, P., Gourio, C., & Luquet, G. (1981). Attraction d'especes du genre *Zygaena* F. par des substances pheromonales de tordeuses (Lepidoptera, Zygaenidae et Tortricidae). *Annales de la Société entomologique de France*, *17*, 441-448.

Drouet, E., Toshova, T. B., & Efetov, K. A. (2021). Results of the use of synthetic sex attractant lures for Zygaenidae in south-eastern France (Lepidoptera: Zygaenidae). *SHILAP Revista de lepidopterología*, *49*(193), 183-191. https://doi.org/10.57065/shilap.334

Efetov, K. A., Knyazev, S. A., & Kucherenko, E. E. (2022). The first record of *Jordanita* (*Solaniterna*) *subsolana* (Staudinger, 1862) from Kazakhstan (Lepidoptera: Zygaenidae, Procridinae). *SHILAP Revista de lepidopterología*, *50*(198), 233-239. https://doi.org/10.57065/shilap.127

Efetov, K. A., Knyazev, S.A., & Kucherenko, E. E. (2024). New results of testing the attractant EFETOV-2 in the Far East of Russia, Siberia and South Africa. *Ecologica Montenegrina*, *71*, 323-332. https://doi.org/10.37828/em.2024.71.35

Efetov, K. A., Koshio, C., & Kucherenko, E. E. (2018). A new synthetic sex attractant for males of *Illiberis* (*Primilliberis*) *pruni* Dyar, 1905 (Lepidoptera: Zygaenidae, Procridinae). *SHILAP Revista de lepidopterología*, *46*(182), 263-270. https://doi.org/10.57065/shilap.817

Efetov, K. A., & Kucherenko, E. E. (2020). Structural analysis of sex pheromones and attractants in Zygaenidae

(Insecta, Lepidoptera): biochemical and evolutionary aspects. *Journal of Evolutionary Biochemistry and Physiology*, *56*(5), 381-395. https://doi.org/10.1134/S0022093020050014

Efetov, K. A., & Kucherenko, E. E. (2021). Enantiomers of 2-butyl dodec-2-enoate as sex attractants. *Russian Journal of Bioorganic Chemistry*, *47*(5), 1043-1050. https://doi.org/10.1134/S1068162021050241

Efetov, K. A., & Kucherenko, E. E. (2024). Attraction of *Tilloidea unifasciata* (Fabricius, 1787) (Coleoptera: Cleridae) by synthetic sex attractants from the series 'EFETOV-2' in the Crimea. *Ecologica Montenegrina*, *80*, 142-151. https://doi.org/10.37828/em.2024.80.13

Efetov, K. A., Kucherenko, E. E., Ivanovskaya, A. V., & Baevsky, M. Y. (2023). Synthesis and field testing of esters of (2*R*)-butan-2-ol and (2*S*)-butan-2-ol and monounsaturated fatty acids as sex attractants for the males of Procridinae species (Lepidoptera: Zygaenidae). *SHILAP Revista de lepidopterología*, *51*(202), 375-384. https://doi.org/10.57065/shilap.474

Efetov, K. A., Kucherenko, E. E., Parshkova, E. V., & Tarmann, G. M. (2016). 2-Butyl 2-dodecenoate, a new sex attractant for *Jordanita* (*Tremewania*) *notata* (Zeller, 1847) and some other Procridinae species (Lepidoptera: Zygaenidae). *SHILAP Revista de lepidopterología*, *44*, 519-527.

Efetov, K. A., Kucherenko, E. E., & Tarmann, G. M. (2019). New synthetic sex attractants for the males of two endemic Iberian Procridinae species (Lepidoptera: Zygaenidae). *SHILAP Revista de lepidopterología*, *47*, 307-315. https://doi.org/10.57065/shilap.771

Efetov, K. A., Kucherenko, E. E., & Tarmann, G. M. (2020). An application of the synthetic sex attractants from the series "EFETOV-2" for studying Procridinae in Italy (Lepidoptera: Zygaenidae). *SHILAP Revista de lepidopterología*, *48*(192), 733-749. https://doi.org/10.57065/shilap.351

Efetov, K. A., Parshkova, E. V., Baevsky, M. Y., & Poddubov, A. I. (2014). Sec-butyl ester of dodecenoate: synthesis and attractive properties. *The Ukrainian Biochemical Journal*, *86*(6), 175-182. https://doi.org/10.15407/ubj86.06.175 PMid:25816618

Efetov, K. A., Prosvirov, A. S., & Kucherenko, E. E. (2025). The substance 'EFETOV-2' confirmed as a sex attractant for the males of *Jordanita* (*Tremewania*) *splendens* (Staudinger, 1887) (Lepidoptera: Zygaenidae) in Uzbekistan. *Ecologica Montenegrina*, *82*, 80-88. https://doi.org/10.37828/em.2025.82.5

Efetov, K. A., Subchev, M. A., Toshova, T. B., & Kiselev, V. M. (2011). Attraction of *Zygaenoprocris taftana* (Alberti, 1939) and *Jordanita horni* (Alberti, 1937) (Lepidoptera: Zygaenidae, Procridinae) by synthetic sex pheromones in Armenia. *Entomologist's Gazette*, *62*(2), 113-121.

Efetov, K. A., Tarmann, G. M., Toshova, T. B., & Subchev, M. A. (2015). Enantiomers of 2-butyl 7Z-dodecenoate are sex attractants for males of *Adscita mannii* (Lederer, 1853), *A. geryon* (Hübner, 1813) and *Jordanita notata* (Zeller, 1847) (Lepidoptera: Zygaenidae, Procridinae) in Italy. *Nota lepidopterologica*, *38*(2), 161-169. https://doi.org/10.3897/nl.38.6312

El-Sayed, A. M. (2025). *The Pherobase: Database of Pheromones and Semiochemicals*. http://www.pherobase.com.

Falkovitsh, M. I. (1986). Fam. Crambidae. In G. S. Medevedev (ed.). *Keys to the Insects of the European part of the USSR. Lepidoptera* (Vol. 4(3), pp. 430-481). Nauka. (in Russian).

Fazekas, I., & Schreurs, A. (2010). Microlepidoptera Pannoniae meridionalis, VIII. Data to knowledge of micro-moths from Dombóvár (SW Hungary) (Lepidoptera). *Natura Somogyiensis*, *17*, 273-292. https://doi.org/10.24394/NatSom.2010.17.273

Ganev, J. (1986). Katalog der unterfamilien Cybalomiinae, Evergestinae, Pyralinae und Peoriinae in Bulgarien (Lepidoptera, Pyraloidea). *Neue Entomologische Nachrichten*, *19*(1-2), 99-111.

Jakubíková, K., Komínková, J., Šefrová, H., & Laštůvka, Z. (2016). Target and Non-Target Moth Species Captured by Pheromone Traps for Some Fruit Tortricid Moths (Lepidoptera). *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, *64*(5), 1561-1568. https://doi.org/10.11118/actaun201664051561

Karsholt, O., & Rutten, T. (2005). The genus *Bryotropha* Heinemann in the western Palaearctic (Lepidoptera: Gelechiidae). *Tijdschrift voor Entomologie*, *148*, 77-207, figs. 1-422.

Kemal, M., & Koçak, A. Ö. (2010). Winter trips to south Van Lake and the cynipid galls on oaks (Hymenoptera, Cynipidae). *Cesa News*, *56*, 1-66.

Knodel, J. J., & Agnello, A. M. (1990). Field Comparison of Nonsticky and Sticky Pheromone Traps for Monitoring Fruit Pests in Western New York. *Journal of Economic Entomology*, *83*, 197-204. https://doi.org/10.1093/jee/83.1.197

Kostova, R., Bekchiev, R., & Beshkov, S. (2019). Coleoptera and Lepidoptera (Insecta) diversity in the central part of Sredna Gora Mountains (Bulgaria). *Bulletin of the Entomological Society of Malta*, *10*, 75-95. https://doi.org/10.17387/BULLENTSOCMALTA.2019.09

Kovaleva, S., Ivanov, L., Piatnovai, B., Kovalev, B. G., Minyailov, A., & Minyailoa, K. (1975). Results of testing synthetic compounds as on attractiveness to insects in nature. *Chemorecepcya Nasekomych*, *2*, 159-164. (in Russian)

Kovács, Z., & Kovács, S. (2022). An overview of the Romanian Gelechiidae (Lepidoptera) summarizing the current knowledge in an updated and annotated checklist. *Entomologica romanica*, *26*, 1-76. https://doi.org/10.24193/entomolrom.26.1

Kulikov, N. I., & Naumkin, V. P. (2004). Plant - Insect Relation in Buckwheat Agrocoenosis. In Iva Faberová, Václav Dvořáček, Petra Čepková, Ivan Hon, Vojtěch Holubec & Zdeněk Stehno (Editors). Advances in Buckwheat Research. *Proceedings of the 9th International Symposium on Buckwheat, Prague 2004*, 505-508.

Loginova, E. (1992). Some new pests of glasshouse crops in Bulgaria and their control by an IPM programme. *EPPO Bulletin*, *22*(3), 357-361. https://doi.org/10.1111/j.1365-2338.1992

Mayer, M. S., & McLaughlin, J. R. (1991) *Handbook of Insect Pheromones and Sex Attractants*, CRC Press.

Molinari, F., Reguzzi, M., Quaglia, M., Galliano, A., & Cravedi, P. (1996). Infestation of noctuid larvae in peach orchards in northern Italy. *Acta Horticulturae, 422*, 372-373. https://doi.org/10.17660/ActaHortic.1996.422.86

Mozūraitis, R., Būda, V., Borg-Karlson, A.-K., Ivinskis, P., Karalius, V., Laanmaa, M., & Pleys, D. (1998). New sex attractants and inhibitors for 17 moth species from the families Gracillariidae, Tortricidae, Yponomeutidae, Oecophoridae, Pyralidae and Gelechiidae. *Journal of Applied Entomology*, *122*, 441-452. https://doi.org/10.1111/j.1439-0418.1998.tb01524.x

Myerson, J., Haddon, W. F., & Soderstrom, E. L. (1982). *sec*-Butyl (*Z*)-7-tetradecenoate. A novel sex pheromone component from the western grapeleaf skeletonizer, *Harrisina brillians*. *Tetrahedron Letters*, *23*, 2757-2760. ttps://doi.org/10.1016/S0040-4039(00)87450-X

Olenici, N., Capuşe, I., Olenici, I., Oprean, I., & Mihalciuc, E. (2007). Non-target Lepidoptera species in pheromone traps baited with attractants for several tortricid moths. *Analele ICAS*, *50*, 185-201.

Plant, C. W. (2016). An Annotated Systematic, Synonymic and Distributional Checklist of the Pyraloidea of Bulgaria. *Neue Entomologische Nachrichten*, *72*, 1-231.

Popescu-Gorj, A. (1964). *Catalogue de la collection de lépidoptères "Prof. A. Ostrogovich" du Musée d'Histoire Naturelle "Gr. Antipa", Bucarest*. Edition Mus. "Gr. Antipa".

Priesner, E., Naumann, C. M., & Stertenbrink, J. (1984). Specificity of synthetic sex-attractants in *Zygaena* moths. *Zeitschrift für Naturforschung C*, *39*, 841-844. https://doi.org/10.1515/znc-1984-7-826

Razowski, J. (2003). *Tortricidae (Lepidoptera) of Europe. Olethreutinae* (Vol. 2). František Slamka.

Rebel, H., (1916). Beitrag zur Lepidopterenfauna Bulgariens. *Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien*, *66*, 36-46.

Renou, M., & Decamps, C. (1982). Les phéromones sexuelles de Zygènes (Lepidoptera, Zygaenidae): données d'électroantennographie. *Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences, Paris, Série III, Sciences de la Vie*, *295*(10), 623-626.

Renou, M., & Zagatti, P. (1984). Les phéromones sexuelles de Zygènes (Lepidoptera, Zygaenidae) (2): nouvelles données d'électroantennographie concernant *Zygaena carniolica* Scopoli et *Zygaena purpuralis* Pontoppidan. *Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences, Paris, Série III, Sciences de la Vie*, *299*(6), 157-160.

Roelofs, W. L., & Comeau, A. (1969). Sex Pheromone Specificity: Taxonomic and Evolutionary Aspects in Lepidoptera. *Science*, *165*(3891), 398-400. https://doi.org/10.1126/science.165.3891.398 PMid:17809523

Rotundo, G., Giacometti, R., & de Cristofaro, A. (1991). Individual mixtures attractive to males of *Pammene fasciana* L. (Lep., Tortricidae) using electroantennograms and field studies. *Bollettino del Laboratorio di Entomologia Agraria Filippo Silvestri*, *48*, 89-104.

Slamka, F. (2013). *Pyraloidea of Europe, Pyraustinae and Spilomelinae* (Vol. 3). František Slamka.

Soderstrom, E. L., Brandl, D. G., Myerson, J., Buttery, R. G., & Mackey, B. E. (1985). Sex pheromone for attracting western grapeleaf skeletonizer (Lepidoptera: Zygaenidae). *Journal of Economic Entomology*, *78*, 799-801. https://doi.org/10.1093/jee/78.4.799

Subchev, M. (2014). Sex pheromone communication in the family Zygaenidae (Insecta: Lepidoptera): a review. *Acta Zoologica Bulgarica*, *66*(2), 147-157.

Subchev, M., Efetov, K. A., Toshova T., Parshkova, E. V., Tóth, M., & Francke, W. (2010). New sex attractants for species of the zygaenid subfamily Procridinae (Lepidoptera: Zygaenidae). *Entomologia Generalis*, *32*, 243-250. https://doi.org/10.1127/entom.gen/32/2010/243

Subchev, M. A., Krusteva, I. A., & Arn, H. (1986). Bulgarian pheromone “dialect” of *Agrotis segetum* Schiff. (Lepidoptera: Noctuidae). *Ecology (Sofia)*, *19*, 71-75.

Subchev, M. A., Krusteva, I. A., Ganev, J. A., & Milkova, T. S. (1990). Some new lepidopteran sex attractants and attractant inhibitors in Bulgaria. *Journal of Applied Entomology*, *109*, 189-193. https://doi.org/10.1111/j.1439-0418.1990.tb00036.x

Subchev, M., Toshova, T., Tóth, M., Voigt, E., Mikulás, J., & Francke, W. (2004). Catches of vine bud moth *Theresimima ampellophaga* (Lep., Zygaenidae: Procridinae) males. *Journal of Applied Entomology*, *128*(1), 44-50. https://doi.org/10.1046/j.1439-0418.2003.00805.x

Sziráki, G. (1978). Specificity of sexual attraction traps for signalization of oriental fruit moth. A*cta Phytopathologica et Entomologica Hungarica*, *13*, 205.

Toll, S. (1962). Materialien zur Kenntnis der paläarktischen Arten der Familie Coleophoridae (Lepidoptera). *Acta Zoologica Cracoviensia*, *7*, 577-720. http://www.isez.pan.krakow.pl/journals/azc/pdf/07/7_16.pdf

Tóth, M., Szöcs G., & Sziráki, G. (1994). Male sex attractants for some Lepidopterous pests of the genera *Evergestis* and *Pyrausta* (Lepidoptera: Pyralidae). *Acta Phytopathologica et Entomologica Hungarica*, *29*, 155-159.

Tóth, M., Szöcs, G., Sziráki, G., & Sauter, W. (1992). Sex attractants for male microlepidoptera found in field trapping tests in Hungary. *Journal of Applied Entomology*, *113*, 342-355. https://doi.org/10.1111/j.1439-0418.1992.tb00674.x

Velcheva, N. (2000). Faunal investigations on the species of leaf rollers attracted by synthetic pheromones for the plum (*Grapholitha funebrana* Tr.) and oriental *(Gr. molesta* Busck*)* fruit moths. *Plant Science (Sofia)*, *37*, 181-187. (in Bulgarian, English summary)

Vrenozi, B., Burman, J., Toshova, T. B., & Tarmann, G. M. (2020). The application of sex attractant traps for studying the Zygaenidae (Lepidoptera) fauna of Albania. *Entomologist's Gazette*, *71*(2), 135-148. https://doi.org/10.31184/G00138894.712.1751

Vrenozi, B., Toshova, T. B., Efetov, K. A., Kucherenko, E. E., Rredhi, A., & Tarmann, G. M. (2019). The first well-documented record of the vine bud moth *Theresimima ampellophaga* (Bayle-Barelle, 1808) in Albania established by field screening of sex pheromone and sex attractant traps (Lepidoptera: Zygaenidae, Procridinae). *SHILAP Revista de lepidopterología*, *47*(187), 567-576. https://doi.org/10.57065/shilap.551

Zagrobelny, M., Simonsen, H. T., Olsen, C. E., Bak, S., & Møller, B. L. (2015). Volatiles from the burnet moth *Zygaena filipendulae* (Lepidoptera) and associated flowers, and their involvement in mating communication. *Physiological Entomology*, *40*, 284-295. https://doi.org/10.1111/phen.12113

Zlatkov, B. (2007). Butterflies and moths (Lepidoptera: Macrolepidoptera) of Mesta Valley in SW Bulgaria. *Historia naturalis bulgarica*, *18*, 95-126.

Yardım, C., Efetov, K. A., Ölmez Bayhan, S., Can, F., & Kucherenko, E. E. (2024). Results of an application of sex attractant EFETOV-2 in Southeastern Anatolia of Türkiye (Turkey). *Ecologica Montenegrina*, *78*, 260-270. https://doi.org/10.37828/em.2024.78.25

Yardım, C., Efetov, K. A., Ölmez Bayhan, S., Toshova, T. B., & Can, F. (2025). Population dynamics of the vine bud moth *Theresimima ampellophaga* (Bayle-Barelle, 1809) (Lepidoptera: Zygaenidae, Procridinae) in vineyard areas of Diyarbakır, Mardin and Batman Provinces in Türkiye (Turkey). *Ecologica Montenegrina*, *83*, 112-119. https://dx.doi.org/10.37828/em.2025.83.12

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Figure 1. Traps in the study sites: **A.** Delta sticky traps and **B.** VARL funnel traps in Lozitsa vill. **C.** Delta sticky traps and **D.** VARL funnel traps in Lozenska planina Mts.

Figure 2. Distribution of *Rhagades* (*Rhagades*) *pruni* in Bulgaria and surrounding countries. Grey dots - published records before 1974, black dots - published records after 2000, red dots - new records, 1 -Lozenska planina Mts, 2 - Nikopolsko plato.

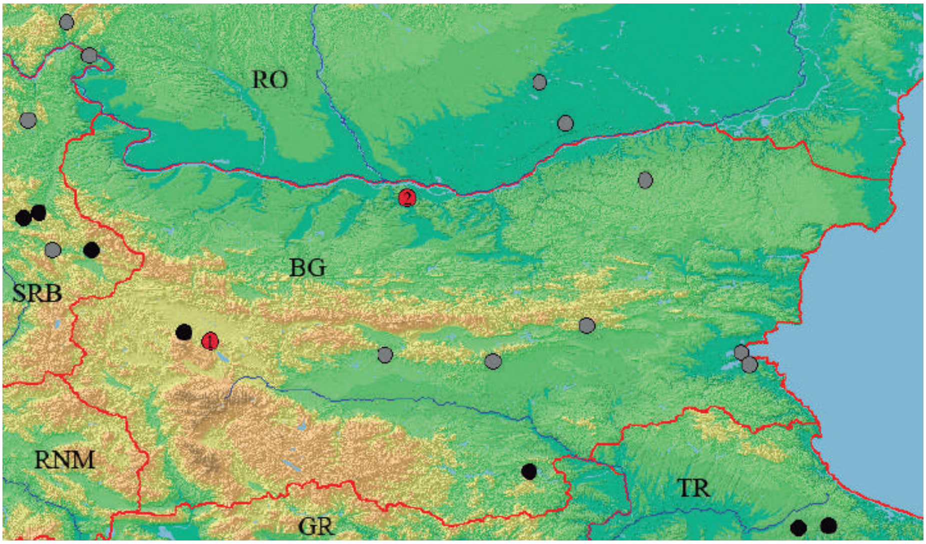

Table 1. Details about the experiments near Lozitsa vill. (2015-2018) and Lozenska planina Mts (2023): site, habitat type, geographic coordinates of the localities, duration of the experiment (period), date of lure replacement, lure tested and trap type.

Experiment Nº	Site, habitat	Coordinates, altitude, m a.s.l.	Period start - end	Date of lure replacement	Lure/ treatments	Trap type
Exp. 1	Lozitsa vill., vineyard, arable land	**locality 1** 43.60656°N, 24.97407°E, 239 m **locality 2** 43.60942°N, 24.98929°E, 228 m	12-VI-2015-07-X-2015	03-VII-2015 30-VII-2015 12-IX-2015	R-7-12 S-7-12 Z5-12Ac Z7-12Ac Z7-12Ac + Z9-14Ac Unbaited	Delta sticky trap
Exp. 2	Lozitsa vill., vineyard, arable land	**locality 1** 43.60656°N, 24.97407°E, 239 m **locality 2** 43.60942°N, 24.98929°E, 228 m	28-V-2016-29-VII-2016	02-VII-2016 (except EFETOV-2 lures, which work all season)	R-7-12 S-7-12 EFETOV-2 Unbaited	Delta sticky trap
Exp. 3	Lozitsa vill., vineyard, arable land	**locality 1** 43.60656°N, 24.97407°E, 239 m **locality 2** 43.60942°N, 24.98929°E, 228 m	17-IV-2016-25-IX-2016	24-V-2016 25-VI-2016 30-VII-2016 03-IX-2016	Z7-12Ac Z9-14Ac Z7-12Ac + Z9-14Ac Unbaited	VARL funnel traps
Exp. 4	Lozitsa vill., vineyard, arable land	**locality 1** 43.60942°N, 24.98929°E, 218 m **locality 2** 43.59872°N, 24.97404°E, 239 m	16-VI-2017-16-IX-2017	06-VIII-2017 (R-7-14+R-7-12) 20-VII-2017 20-VIII-2017 (*Zygaena* lures)	R-7-14 + R-7-12 Z_pur Z_vic	Delta traps
Exp. 5	Lozitsa vill., vineyard, arable land	**locality 1** 43.60942°N, 24.98929°E, 218 m **locality 2** 43.59872°N, 24.97404°E, 239 m	06-VI-2018-05-VIII-2018	no replacement	EFETOV-2 Unbaited	Delta traps
Exp. 6	Lozenska planina Mts, S Lalina mogila, mixed forest, meadow	**locality 1** 42.57772°N, 23.49367°E, 1034 m **locality 2** 42.57564°N, 23.49673°E, 1012 m	02-VI-2023-28-VII-2023	15-VII-2023	R-7-12 S-7-12 R-7-12 + S-7-12	Delta traps
Exp. 7	Lozenska planina Mts, S Lalina mogila, mixed forest, meadow	**locality 1** 42.58006°N, 23.49298°E, 1079 m **locality 2** 42.57564°N, 23.49673°E, 1012 m	02-VI-2023-15-VII-2023	no replacement	Z7-12Ac Z9-14Ac Z7-12Ac+Z9-14Ac Z7-12Ac+Z9-14Ac+ Z8-12Ac Unbaited	VARL funnel traps

Table 2. Catches of lepidopteran species in baited and control (unbaited) traps, Lozitsa village.

Family/Species	Number of moths caught (period of collection: months and year); Lure	Sum
Coleophoridae		
Augasma aeratella (Zeller, 1839)	539 ♂ (VI-IX-2015); Z7-12Ac (402) and Z7-12Ac+Z9-14Ac (137) 154 ♂ (IV-IX-2016); Z7-12Ac (83), Z7-12Ac+Z9-14Ac (70) and Z9-14Ac (1)	693
Augasma nitens Amsel, 1935	1 ♂ (VII-2015); Z7-12Ac+Z9-14Ac	1
**Augasma uljanovi* Anikin, 2017	5 ♂ (VI-VII-2016); Z7-12Ac	5
Tuberculia albitarsella Zeller, 1849	1 ♂ (IV-V-2016); Z7-12Ac	1
Crambidae		
Evergestis aenalis ([Denis & Schiffermüller], 1775)	74 ♂ (VI-IX-2015); Z7-12Ac+Z9-14Ac 34 ♂ (V-IX-2016); Z7-12Ac+Z9-14Ac (33) and Z7-12Ac (1)	108
Platytes cerusella ([Denis & Schiffermüller], 1775)	1 ♂ (VI-2016); Z7-12Ac+Z9-14Ac	1
**Udea ferrugalis* (Hübner, 1796)	14 ♂ (VI-2016); EFETOV-2 5 ♂ (VII-VIII-2018), EFETOV-2	19
Erebidae		
Dysgonia sp.	1 ♂ (VII-VIII-2018); EFETOV-2	1
Lygephila craccae ([Denis & Schiffermüller], 1775)	2 ♂ (IX-2015); Z5-12Ac (1) and Z7-12Ac (1)	2
Gelechiidae		
Anarsia lineatella Zeller, 1839	1 ♂, 1 ♀ (VII-2015); control	2
Bryotropha senectella (Zeller, 1839)	2 ♂ (VII-2016); control	2
**Bryotropha tachyptilella* (Rebel, 1916)	30 ♂, 2 ♀ (VIII-IX-2015); Z7-12Ac+Z9-14Ac 1 ♂ (IX-2016); Z7-12Ac+Z9-14Ac	33
Dichomeris alacella (Zeller, 1839)	3 ♂ (3♀) (VII-2015); R-7-12	3
Helcystogramma triannulella (Herrich-Schäffer, 1854)	1 ♂ (VIII-IX-2016); R-7-14	1
Geometridae		
Ematurga atomaria (Linnaeus, 1758)	1 ♂ (VI-2015); R-7-14 1 ♂ (VI-2016); Z7-12Ac+Z9-14Ac	2
Scopula sp.	1 ♂ (VII-2015); Z7-12Ac	1
Noctuidae		
Agrotis exclamationis (Linnaeus, 1758)	1 ♂ (V-2016); Z7-12Ac+Z9-14Ac	1

Agrotis segetum ([Denis & Schiffermüller], 1775)	63 ♂ (VII-X-2015); Z7-12Ac+Z9-14Ac (33); Z7-12Ac (23) and Z5-12Ac (7) 15 ♂ (IV-IX-2016); Z7-12Ac+Z9-14Ac (14) and Z7-12Ac (1)	78
Autographa gamma (Linnaeus, 1758)	33 ♂ (VII-IX-2015); Z7-12Ac (16) and Z7-12Ac+Z9-14Ac (17) 178 ♂ (V-IX-2016); Z7-12Ac (177) and Z7-12Ac+Z9-14Ac (1)	211
Axylia putris (Linnaeus, 1761)	43 ♂ (IV-VII-2016); Z9-14Ac	43
Caradrina flavirena Guenée, 1852	1 ♂ (IV-2016); Z7-12Ac	1
Charanyca trigrammica (Hufnagel, 1766)	1 ♂, 1 ♀ (V-2016); control	2
**Chloantha hyperici* ([Denis & Schiffermüller], 1775)	4 ♂ (VII-IX-2015); Z7-12Ac 4 ♂ (VI-2016); Z7-12Ac	8
Helicoverpa armigera (Hübner, [1808])	1 ♂ (VII-2016); Z7-12Ac	1
Macdunnoughia confusa (Stephens, 1850)	2 ♂ (VII-2015); Z7-12Ac (1) and Z7-12Ac+Z9-14Ac (1) 42 ♂ (IV-VI-2016); Z7-12Ac (33) and Z7-12Ac+Z9-14Ac (9)	44
Mesapamea secalis (Linnaeus, 1758)	2 ♂ (VIII-2015); control (1) and Z5-12Ac (1)	2
Mythimna albipuncta ([Denis & Schiffermüller], 1775)	2 ♂ (VIII-2015); Z5-12Ac (1) 1 ♂ (IX-2016); control	3
Mythimna congrua (Hübner, [1817])	1 ♂ (IX-2015); Z7-12Ac+Z9-14Ac	1
Mythimna ferrago (Fabricius, 1787)	3 ♂ (VIII-2015); Z5-12Ac (2) and Z7-12Ac (1) 1 ♂ (VIII-2016); Z7-12Ac	4
Mythimna vitellina (Hübner, [1808])	2 ♂ (IX-2016); control	2
Noctua janthina ([Denis & Schiffermüller], 1775)	1 ♂ (IX-2016); Z9-14Ac	1
Noctua pronuba (Linnaeus, 1758)	1 ♂ (IX-X-2015); control	
Oligia latruncula ([Denis & Schiffermüller], 1775)	1 ♂ (V-2016); control	1
Panemeria tenebrata (Scopoli, 1763)	1 ♂ (IV-2016); Z9-14Ac	1
Tyta luctuosa ([Denis & Schiffermüller], 1775)	1 ♂ (VIII-2016); Z7-12Ac+Z9-14Ac	2
Xestia xanthographa ([Denis & Schiffermüller], 1775)	4 ♂ (IX-2015); Z5-12Ac (2), Z7-12Ac (1) and R-7-12 (1)	4
Nolidae		
Nola cicatricalis (Treitschke, 1835)	1 ♂ (IX-2015); R-7-14	1
Pieridae		
Gonepteryx rhamni (Linnaeus, 1758)	6 ♂ (IV-2016); Z7-12Ac (5) and Z9-14Ac (1)	6
Plutelliidae		
Plutella xylostella (Linnaeus, 1758)	1 ♀ (VII-2015); R-7-12 2 ♀ (VII-2016); control	3
Pyralidae		
Oncocera semirubella (Scopoli, 1763)	1 ♂ (VIII-2015); Z5-12Ac	1

Tortricidae		
Cochylis hybridella (Hübner, [1813])	1 ♂ (IX-2016); Z7-12Ac	1
Epinotia abbreviana (Fabricius, 1794)	3 ♂ (V-2016); Z7-12Ac	3
Hedya pruniana (Hübner, [1799])	2 ♀ (VI-2016); control	2
Neosphaleroptera nubilana (Hübner, [1799])	2 ♂, 2 ♀ (V-2016); Z7-12Ac+Z9-14Ac	4
Yponomeutidae		
Paraswammerdamia albicapitella (Scharfenberg, 1805)	1 ♀ (IX-2015); Z7-12Ac+Z9-14Ac	1
Zygaenidae		
Rhagades pruni ([Denis & Schiffermüller], 1775)	10 ♂ (VI-2015); R-7-12 (9) and S-7-12 (1) 2 ♂ (VI-2016); R-7-12 (1); EFETOV-2 (1)	12
Theresimima ampellophaga (Bayle-Barelle, 1809)	68 ♂ (VI-VII-2017); R-7-14+R-7-12	68
Zygaena carniolica (Scopoli, 1763)	1 ♂ (VII-2015); Z7-12Ac+Z9-14Ac	1
Zygaena filipendulae (Linnaeus, 1758)	2 ♂ (VII-2015); Z7-12Ac+Z9-14Ac 47 ♂ (VI-IX-2017); Z_vic**	49

*species for which new attractants were found for the first time
**new attractant for the species with known attractants

Table 3. Catches of lepidopteran species in baited and control (unbaited) traps, Lozenska planina Mts.

Species	Number of moths caught (period of collection: months and year); Lure	Sum
Crambidae		
Evergestis aenealis ([Denis & Schiffermüller], 1775)	37 ♂ (VI-VII-2023); Z7-12Ac + Z9-14Ac	37
Erebidae		
Euclidia glyphica (Linnaeus, 1758)	1 ♀, 1 ♂ (VI-VII-2023); Z7-12Ac (1 ♀) and R-7-12 (1 ♂)	2
Geometridae		
Chiasmia clathrata (Linnaeus, 1758)	2 ♂ (VI-2023); S-7-12	2
Gandaritis pyraliata ([Denis & Schiffermüller], 1775)	1 ♂ (VII-2023); R-7-12	1
Heliomata glarearia ([Denis & Schiffermüller], 1775)	1 ♂ (VII-2023); S-7-12	1
Horisme corticata (Treitschke, 1835)	2 ♂ (VI-VII-2023); control (1) and Z7-12Ac + Z9-14Ac + Z8-12Ac (1)	2
Noctuidae		
Autographa gamma (Linnaeus, 1758)	4 ♂ (VI-2023); Z7-12Ac	4

Cucullia umbratica (Linnaeus, 1758)	1 ♂ (VI-2023); Z7-12Ac + Z9-14Ac	1
**Hoplodrina respersa* ([Denis & Schiffermüller], 1775)	13 ♂ (VII-2023); Z7-12Ac + Z9-14Ac + Z8-12Ac (9); Z9-14Ac (2) and Z7-12Ac + Z9-14Ac (2)	13
Sideridis reticulata (Goeze, 1781)	1 ♂ (VII-2023); Z7-12Ac + Z9-14Ac + Z8-12Ac	1
Nymphalidae		
Coenonympha glycerion (Borkhausen, 1788)	1 ♀ (VI-2023); Z7-12Ac	1
Coenonympha leander (Esper, [1784])	1 ♂ (VI-2023); S-7-12	1
Brintesia circe (Fabricius, 1775)	1 ♂ (VII-2023); R-7-12 + S-7-12	1
Oecophoridae		
Borkhausenia unitella (Hübner, [1801])	1 ♀ (VII-2023); Z7-12Ac + Z9-14A + Z8-12Ac	1
Tortricidae		1
Pammene gallicolana (Lienig & Zeller, 1846)	745 ♂ (VI-2023); Z7-12Ac + Z9-14A + Z8-12Ac** (743) and Z9-14Ac (2)	745
Endothenia gentianaeana (Hübner, [1799])	1 ♂ (VI-2023); Z9-14Ac	1
Grapholita tenebrosana (Duponchel, 1842)	2 ♂ (VI-2023); Z7-12Ac + Z9-14A + Z8-12Ac	2
Pammene albuginana (Guenée, 1845)	4 ♂ (VI-2023); Z7-12Ac + Z9-14A + Z8-12Ac	4
Zygaenidae		
Adscita geryon (Hübner, [1813])	2 ♂ (VII-2023); S-7-12	2
Adscita mannii (Lederer, 1853)	71 ♂ (VI-VII-2023); S-7-12 (48) and R-7-12 + S-7-12 (23)	71
Jordanita notata (Zeller, 1847)	26 ♂ (VI-VII-2023); R-7-12 (20) and R-7-12 + S-7-12 (6)	26
Rhagades pruni ([Denis & Schiffermüller], 1775)	1 ♂ (VII-2023); R-7-12	1

*species for which new attractants were found for the first time
**new attractant for the species with known attractants

Table 4. Results of screening of Z5-12Ac, Z7-12Ac, Z9-14Ac and a mixture of Z7-12Ac and Z9-14Ac (100:100), Lozitsa vill., 12- VI – 7-X-2015, Delta sticky traps, two replications; 25-IV – 25-IX-2016, VARL funnel traps, two replications and Lozenska Planina Mts, 2-VI – 15-VII-2023, VARL funnel traps, two replications. Means captures marked with different letter within a column are significantly different (Kruskal-Wallis test followed by Mann-Whitney U test, $P < 0.05$).

Compound Dose, μg per lure			**Mean number of male moths captured (± SE) in the respective year**												
Z5-12Ac	Z7-12Ac	Z9-14Ac	*A. aeratella*		*E. aenealis*			*B. bachyptilella*	*A. segetum*		*A. gamma*		*A. putris*	*M. confusa*
			2015	2016	2015	2016	2023	2015	2015	2016	2015	2016	2016	2016
0	0	0	0.00b	0.00b	0.00b	0.00b	0.00b	0.25 ± 0.24	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b
100	0	0	0.00b	-	0.00b	-	-	0.00	0.58 ± 0.31b	-	0.08 ± 0.08b	-	-	-
0	100	0	40.20 ± 13.37a	3.86 ± 0.98a	0.00b	0.08 ± 0.08b	0.00b	0.00	1.92 ± 1.16ab	0.06 ± 0.06b	1.33 ± 0.51a	8.05 ± 1.91a	0.00b	4.13 ± 2.59a
0	0	100	-	0.05 ± 0.05b	-	0.00b	0.00b	-	-	0.00b	-	0.00b	3.58 ± 2.08a	0.00b
0	100	100	13.70 ± 4.91a	3.18 ± 1.16a	5.29 ± 1.46a	2.75 ± 0.91a	3.70 ± 1.36a	7.25 ± 3.77	2.75 ± 1.35a	0.78 ± 0.24a	1.42 ± 1.42a	0.05 ± 0.05b	0.00b	1.13 ± 0.88ab

- Lure not tested

REVISIÓN DE PUBLICACIONES
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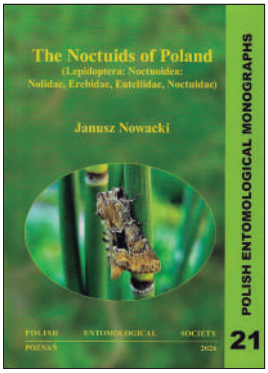

J. Nowacki
The Noctuids of Poland (Lepidoptera: Noctuoidea: Nolidae, Erebidae, Euteliidae, Noctuidae)
579 páginas
Formato 24,0 x 17,0 cm
Moś & Łuczak Printing House, Poznań, 2026
ISBN: 978-83-66185-60-9

Tenemos en nuestras manos un interesante libro sobre la fauna de los Noctuoidea de Polonia y, por ende, del Centro de Europa, de la mano de nuestro estimado colega el Dr. Nowacki, que ya nos tiene acostumbrados a trabajos similares realizados a lo largo de tantos años.

Este trabajo está incluido en la Monografía 21, de la "*Polish Entomological Society*" y es un resumen del conocimiento reunido de los trabajos científicos y de la labor de campo, de esta interesante superfamilia presente en Polonia, tratándose un total de 505 especies, incorporando, en los últimos 40 años, hasta 45 nuevas especies para esta fauna.

Después de un resumen e introducción, nos presenta un interesante capítulo de la historia sobre la investigación realizada sobre la fauna de los Noctuoidea, presentes en Polonia. Continúa hablándonos sobre las características de éstos, sobre su morfología, genitalia, estados inmaturos, crisálida y su biología, ecología, protección e importancia económica.

A continuación, nos presenta una lista de todas las especies consideradas, los agradecimientos y ya dentro de la parte principal del libro las familias, subfamilias y todas y cada una de las especies.

De cada especie, nos da un diagnóstico, nos habla sobre su hábitat, distribución conocida y distribución en Polonia e incluso, en algunas ocasiones, mapas informativos y un capítulo sobre la fauna polaca de estas familias.

Para facilitar la identificación, nos presenta 58 láminas a todo color, con excelentes fotografías de los adultos y 60 microfotografías, en blanco y negro, de la genitalia del macho y de la hembra, que facilita la identificación de especies problemáticas, finalizando la obra con una detallada bibliografía y un índice.

No podemos terminar estas líneas, sin felicitar al autor por este extenso y detallado trabajo sobre esta interesante superfamilia Noctuoidea, que, sin duda, ayudará a todos los interesados en estas familias presentes en Polonia y Europa central y a la Editorial por la excelente presentación del libro, obra que no puede faltar en cualquier biblioteca que se precie.

El precio de este libro no ha sido comunicado, pero los interesados lo pueden pedir a:

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Discovery of *Graellsia isabelae* (Graells, 1849) in a high-mountain biotope of the Catalan Pyrenees (Spain) (Lepidoptera: Saturniidae)

Josep Ylla

Abstract

This work was conducted in two stages separated by approximately 33 years, which is why it is presented in two parts. The first stage took place between 1993 and 1995, within the framework of the author's Doctoral Thesis research (Ylla, 1997). The author transferred 28 cocoons of *Graellsia isabelae* (Graells, 1849) to a forest of *Pinus uncinata* Miller located above the village of Queralbs, at 1600 m a.s.l., (El Ripollès, Gerona, Catalonia, Spain). The objective was to test the hypothesis that "the pupa of *G. isabelae* cannot withstand the cold winter temperatures typical of this ecosystem". If verified, this would explain why the species has failed to establish stable populations in high-altitude *P. uncinata* forests. However, the results did not support the hypothesis. Thirty years later, the situation remains unchanged: *G. isabelae* has still not been detected in *P. uncinata* forests. It will likely be necessary to repeat the study over several additional seasons in order to obtain a more robust dataset. This new research has been carried out in 2026, and the last results are presented in the second part of this paper.
Keywords: Lepidoptera, Saturniidae**,** *Graellsia isabelae, Pinus uncinata*, supercooling point, larval development, altitudinal distribution, host plant suitability, pheromone, Spain.

Descubrimiento de *Graellsia isabelae* **(Graells, 1849) en un biotopo de alta montaña en el Pirineo catalán (España) (Lepidoptera: Saturniidae)**

Este trabajo se ha realizado en dos etapas separadas entre si unos 33 años, siendo este el motivo de que se presente dividido en dos partes. La primera parte tuvo lugar entre 1993 y 1995, en el marco de las investigaciones de su Tesis Doctoral (Ylla, 1997). El autor transportó 28 capullos de *Graellsia isabelae* (Graells, 1849) a un bosque de *Pinus uncinata* Miller situado en las cercanías del pueblo de Queralbs, a 1.600 m de altitud, (El Ripollès, Gerona, Cataluña, España). El objetivo era contrastar la hipótesis siguiente: "las crisálidas de *G. isabelae* no pueden soportar las frías temperaturas hibernales propias de este ecosistema". En caso de confirmarse, ello hubiera explicado porqué dicha especie no ha conseguido establecer poblaciones en estos bosques de *P. uncinata* propios de altitudes elevadas. Los resultados no confirmaron la hipótesis, por lo que 30 años después, la situación sigue sin cambios: *G. isabelae* no ha sido detectada aún en los pinares de *P. uncinata*, llegándose a la conclusión de que probablemente será necesario repetir el trabajo de campo unas cuantas temporadas más, llevando a cabo más y mejores muestreos. Esta nueva investigación ha sido llevada a cabo en 2026, presentando los últimos resultados en la segunda parte del presente artículo.
Palabras clave: Lepidoptera, Saturniidae, *Graellsia isabelae*; *Pinus uncinata*; "supercooling point"; desarrollo larval; distribución altitudinal, plantas huésped propicias, feromona, España.

Introduction

It is well established among entomologists that *Pinus sylvestris* L. and *Pinus nigra salzmannii* Dunal, are the only known host plants utilized by *Graellsia isabelae* (Graells, 1849) under natural conditions. Aside from these two conifer species, no larvae have ever been observed feeding in the wild on any of the other conifer species that occur throughout the Iberian Peninsula.

Pinus uncinata Miller*,* or black pine, is a species of conifer in the Pinaceae family native to the high European mountains, where it lives in the subalpine stage. It is found mainly in the Pyrenees, Alps, Carpathians and Balkans. It forms extensive forest stands within the subalpine belt of the Pyrenees, typically between 1,700 and 2,400 metres a.s.l., where it defines the characteristic plant community *Rhododendron uncinatae typicum* (Folch, 1981).

Besides the Pyrenees, *Pinus uncinata* is restricted to a few isolated populations within the Iberian System, notably in Sierra Cebollera (Soria and La Rioja) and Sierra de Gúdar (Teruel), the latter representing the southernmost limit of its distribution. Notably, *G. isabelae* has not been recorded in any of these locations.

A similar situation is those which occur in the extensive forests of *P. sylvestris* located in the Northern Iberian System (Soria, Segovia, Burgos, La Rioja) in which there is also no evidence of its presence. Chefaoui & Lobo (2007) also indicate other areas, potentially suitable for *G. isabelae*, but where it has not yet been found (mountains of Cantabria, Zamora and Galicia).

It is worth highlighting that, in the Pyrenees, *P. uncinata* extends well into the alpine zone and, conversely, also penetrates the montane belt, where it coexists with *P. sylvestris*, occasionally descending in isolated individuals into shaded ravines as low as 1,000 metres or even lower (Vigo, 1976).

So, ¿why has this species not colonized habitats where this pine is the characteristic arboreal species? The altitudinal and climatic range in which this hardy pine grows may lie beyond the cold tolerance of the moth's immature stages, which could explain why there is no recent evidence of naturally occurring colonies feeding on that pine species (Monasterio et al. 2017; González-Castellano et al. 2023).

Many other researchers have reached the conclusion that, under natural conditions, only two trophic substrates are currently documented for *Graellsia isabelae*: *Pinus sylvestris* and *Pinus laricio salzmannii* (Ylla, 1997), De Arce-Crespo et al. 2010; Baixeras, 2001; Romo et al. 2012; Sánchez-Fernández & De Arce-Crespo, 2017; Marí-Mena et al. 2018; González-Castellano et al. 2023). There is even one study that proves a direct relation among *G. isabelae* and *P. sylvestris* and *P. laricio* (Chefaoui & Lobo, 2007). Nässig, 1991, demonstrated the acceptance of *P. mugo* Turra, but it was a captive breeding experience.

In laboratory rearing experiments where *G. isabelae* larvae were offered different host plants, the tested species could be grouped into the following three categories based on larval development success:

1. Clearly toxic species. Larvae fail to complete the first instar (L1) and die prematurely. Examples: *Pinus halepensis* Mill*., P. pinea* L*., Larix spp., Abies spp.* and *Picea spp.*
2. Partially suitable species. Some larvae successfully pupate, and a few adults may emerge. Examples: *P. pinaster* Ait and *Cedrus spp.*
3. Highly suitable species. These species are well accepted under captive conditions, yielding developmental results comparable to those obtained with *Pinus sylvestris*. Example*: P. uncinata.*

To date, no natural populations of *G. isabelae* have been found feeding on any of the eight former species mentioned in categories 1, 2 and 3.

Regarding the use of *P. uncinata* as a good trophic substrate, Ylla (1997) experiments clearly demonstrated that this pine is a perfectly suitable trophic substrate for the proper development of *Graellsia isabelae*. The results obtained were comparable to, and in some cases exceeded, those recorded for *Pinus sylvestris*, with pupation rates reaching up to 50%.

Several factors may help explain the absence of *Graellsia isabelae* in *Pinus uncinata* forests of the Pyrenees. First, the ecological requirements of the species may not be fully met in these habitats, despite their apparent suitability in terms of altitude and temperature. For example, although *P. uncinata* is a valid trophic substrate, it may not provide the same chemical, nutritional or structural properties as *P. sylvestris*, which is known to be the preferred host plant. In addition, the fragmented distribution and limited dispersal ability of *G. isabelae* could hinder its colonization of these isolated high-altitude forests. Historical biogeographical factors and postglacial recolonization patterns may also have played a role, preventing the species from reaching certain mountain areas. Lastly, biotic interactions, such as the presence of predators, parasitoids, or the absence of mutualistic relationships, could further contribute to its absence from these ecosystems.

Some more questions to take in consideration are:

1. Insufficient field surveys at the appropriate time of year. This is something that has to be considered. The author has conducted repeated and targeted sampling in subalpine pine forests in the Ripollès region, employing light traps and even virgin females during the species' flight period, but without obtaining any positive detections.
2. Winter temperatures: are low winter temperatures the cause of *Graellsia*'s failure to colonize *Pinus uncinata* forests? The extremely low winter temperature could potentially affect the pupal stage, as this is the overwintering phase during which *G. isabelae* would be exposed to low temperatures possibly below the supercooling point.

In temperate regions, insects survive the winter in a frozen state (freezing-tolerant species) or prevent freezing through the synthesis of antifreeze or cryoprotectant compounds which lower the Supercooling point (freezing-intolerant species). As we will see, *Graellsia* belongs to the second group, with a Supercooling Point in principle sufficient to cope with the expected winter thermal drops at ground level, often covered by a more or less thick layer of snow.

Interestingly, the upper altitudinal limit of *G, isabelae* (approximately 1,700-1,750 m), coincides with the elevation at which *P. uncinata* typically begins to appear. The highest recorded occurrence of the species is at 1,866 m, at the summit of "La Mogorrita" in the Serranía de Cuenca, where the larval host plant is *P. sylvestris* (De Arce-Crespo et al. 2010).

Ibáñez et al. (2008) reported the presence of a population in Sierra María (Almería), where the dominant tree species are *Pinus halepensis* and *Pinus pinaster*. Given that *P. halepensis* is not a viable larval host (larvae die in the first instar), and that captive rearing experiments with *P. pinaster* have shown extremely low success rates (not a single imago was obtained from a total of 79 eggs) (Ylla, 1997), the trophic substrate utilised by the Sierra María population remains uncertain. The possibility of isolated individuals of *P. nigra* in the area cannot be ruled out.

Part One: Considerations on winter temperature as a cause for the absence of *G. isabelae* in the Pyrenees (Spain).

Materials and Methods (first part)

Field data collection took place over two seasons: 1993-1994 and 1994-1995. The same site was chosen for both seasons: a typical *P. uncinata* forest in the "Serra de l'Estremera", Ripollès, near the village of Queralbs (Gerona, Spain). A point near the path to the "Font de l'Home Mort" at an altitude of 1,800 m was selected (Figure 1).

Figure 1. Exact point (see arrow) where the chrysalides spent winter.

The Supercooling Point (SCP) of *G. isabelae* was determine by Ylla (1997) following the method described by Leather et al. (1993). The chilling experiments are described also in Ylla (1997).

The Supercooling Point (SCP) is the lowest temperature an insect can reach before ice inevitably forms. When this threshold is exceeded, freezing occurs suddenly and is almost always lethal if the species is not freezing-tolerant.

Season 1993-1994

On November 23, 1993, a group of 8 chrysalids obtained from captive breeding in the same year were transported to the previously chosen location. After confirming their healthy condition, they were placed inside a sealed plastic container with small holes to allow gas exchange and water drainage. This container was designed to protect the chrysalids from predators such as shrews. All eight chrysalids were male.

The container, filled with pine litter, was closed and camouflaged among the forest litter near the base of a pine tree. A Hamster TWIN temperature logger was placed next to it, programmed to take automatic readings every 30 minutes for 333 days. The entire setup was camouflaged with forest litter and marked with a wooden stake (Figure 2).

Figure 2. Images of the data logger and the plastic box with the chrysalides.

On March 31, 1994, after 128 days, the chrysalids were transferred to the urban area of Serrabonica (Gurb, Barcelona) at 650 m altitude, where they remained under natural conditions until adult emergence.

Control group: Comprised of 8 identical chrysalids that remained in Serrabonica for the same 128-day period.

Season 1994-1995

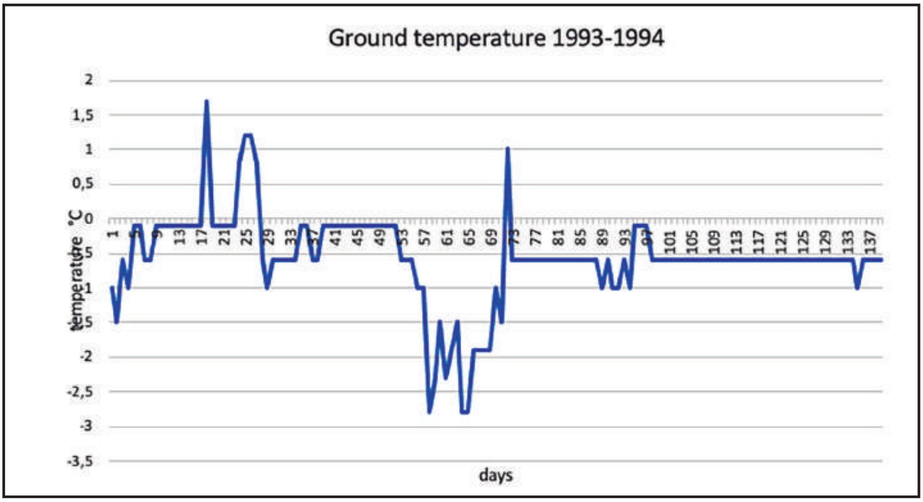
The same procedure was repeated with a few changes. Three groups of 10 cocoons (male and female) were used: one group was left on the ground, camouflaged with forest litter; another was hung from a branch 1.0 m above ground; and the third was the control group kept in Serrabonica. The mountain site was the same as the previous season. The cocoons were transported on October 27, 1994, and retrieved on April 4, 1995, thus remaining for 159 days.

The author wishes to emphasize the antiquity of the dataset which, despite being in many cases more than 30 years old, remains fully valid at the present time. This statement applies unequivocally to all the data and information reported in Ylla (1997). Admittedly, over the past three decades, global knowledge of *G. isabelae* has expanded in several areas. For instance: pheromone identification, improving its geographical distribution, development of predictive distribution models, conservation strategies and population monitoring. Nevertheless, about the specific issue under consideration here, the state of knowledge has essentially remained unchanged.

Results

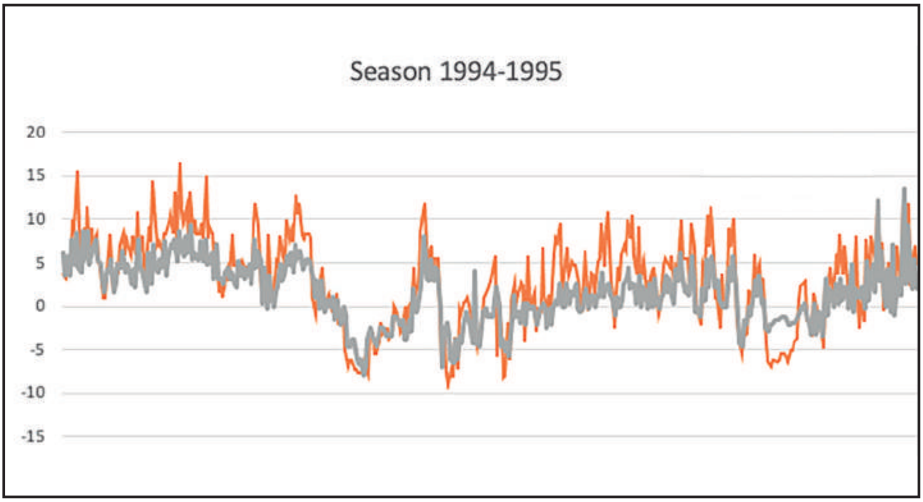
Figure 3 shows the temperature graph for the 1993-1994 season at the Pyrenean site. Temperatures were slightly below 0ºC for much of late January and almost all of February. The lowest temperature recorded was -2.8ºC in January 1994.

Figure 3. Temperature graph for the 1993-1994 season.



Thermometric values from the first season were unexpectedly high for an altitude of 1,800 m in the Pyrenees. This becomes clear when compared with the second season's values (Figure 4).

Figure 4. Temperature trend from the 1994–1995 season, with measurements taken at 1.0 meters above ground (in red) and at ground level (in grey).



As expected, air temperatures were more extreme than those recorded at ground level. This implies that the maximum and minimum values correspond to the higher measurement point, whereas the chrysalids, which invariably remain within their cocoons beneath the forest litter, were not directly exposed to such extremes. Table 1 presents the three lowest temperatures recorded at 1.0 m above ground (all from the same season), together with the corresponding ground-level values. These data clearly illustrate the considerable thermal insulation provided by the snow layer.

Table 1. Lowest temperatures recorded at 1.0 m compared to ground temperatures at the same time. These are the three lowest values observed.

Data	Temp. at 1,0 m	Temp. at grown level	Differences
22-XII	-8,3 °C	-5,8 °C	2.5 °C
3-I	-9,0 °C	-3,2 °C	5,8 °C
11-I	-8,3 °C	-3,8 °C	4,5 °C

Table 2. The minimal and maximal monthly two season temperatures and the number of available chrysalids, are registered in Table 3. In the same table are indicated the quantity of pupae available, their location and the quantity of emerged one.

Location of the probes				
Months	0 m		1,0 m	
	Minimum °C	Maximum °C	Minimum °C	Maximum °C
December 93	- 1,9	+ 5,2	------	------
January 94	- 2,8	+ 1,2	------	------
February 94	- 1,5	- 0,1	------	------
March 94	- 0,6	+ 9,2	------	------
November 94	+ 1,3	+ 9,6	+ 0,3	+ 16,6
December 94	- 7,0	+ 8,3	- 8,3	+ 14,4
January 95	- 7,7	+ 4,2	- 9,0	+ 9,9
February 95	- 5,1	+ 8,0	- 5,8	+ 13,1
March 95	- 5,4	+ 12,2	- 7,0	+ 13,8

Year	Location	Number of chrysalides	Number of chrysalides emerged	%
1994	0 m	8	6	75
1995	0 m	10	9	90
1995	1,0 m	10	7	70
		Total 28	Total 22	78,6

The minimal and maximal monthly two season temperatures and the number of available chrysalids, are registered in Table 2. The same table shows the number of available pupae, their location, and the number of individuals that emerged.

Combining data from different seasons, overwintering in the Pyrenees did not harm the chrysalids. The emergence rate was even higher in the mountain group (78.6%) compared to the control group (66.7%) (Table 3).

Discussion

Supercooling is a physiological and physical phenomenon that many insects use to survive subzero temperatures without freezing. Under normal conditions, water freezes at 0°C, but within insect tissues this only happens if there are ice-nucleating agents (particles or structures that promote the formation of ice crystals). If insects manage to eliminate or control these nucleators, their body fluids can be cooled below 0ºC without immediately freezing.

Table 3. Comparison, of percentage of emerged pupa between the Pyrenees and Serrabonica.

	Pupae at Pyrenees	**Pupae at Serrabonica**
Total	8 + 10 + 10 = 28	10 + 8 = 18
Emerged	6 + 7 + 9 = 22	9 + 3 =12
% emerged	78,6 %	66,7 %

This means that their body temperature can drop to -20ºC, -30ºC, or even lower, while the fluids remain in a liquid state.

As it has been said before, the lowest temperature an insect can reach before ice inevitably forms are called the supercooling point (SCP). Once this threshold is exceeded, freezing occurs suddenly and is almost always lethal if the species is not freezing-tolerant.

Discussion of insect cold tolerance typically revolves around the paradigm that insects use two main strategies to survive low temperatures: (1) freezing avoidance, in which insects endure sub-zero conditions by preventing the formation of ice crystals within their bodies, and (2) freezing tolerance, in which insects withstand sub-zero conditions by tolerating the presence of ice within their tissues. The degree of freezing tolerance may be classified as partial, moderate, or strong, depending on the amount of ice formed (Sinclair, 1999).

Bale (1996), proposed a new categorisation of the insect cold tolerant group, suggesting five distinct situations, ranging from least to most cold hardy, based upon when mortality occurs.

(1) Opportunistic, species cannot enter a dormant state and die when temperatures are too low to maintain normal metabolism.

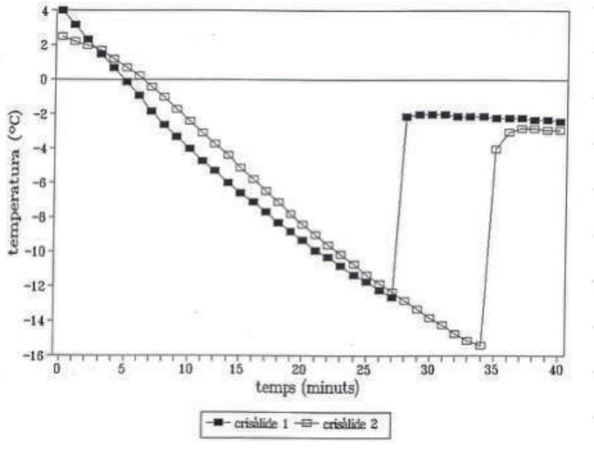
(2) Chill-susceptible, those species that die after brief chilling at moderate to high sub-zero temperatures.

(3) Chill-tolerant, those species that die after prolonged chilling at moderate to low sub-zero temperature above the freezing temperature of SCP.

(4) Freezing avoiding, those that can survive extensive periods in the supercooled state (supercooling), but die when the organism freezes (i.e., at the SCP)

(5) Freezing tolerant, those that can survived the formation of ice in their body tissues.

Figure 5. SCP curve of two *G. isabelae* pupae. Note the sudden temperature rise at the SCP, as a result of the release of the latent heat of crystallization of water. See Ylla (1997) to know how it is performed.



Ylla (1997) showed that 100% of *Graellsia* pupae emerged normally after spending 240 hours (10 days) at -8ºC. However, when the temperature dropped to -10ºC, 80% of the pupae died after 216 hours. Considering these results, *G. isabelae* can be categorized as a chill-tolerant species, corresponding to point 3 of the five previously established physiological categories.

In natural biotope of Pyrenees, at 1,600 m, temperatures of -8ºC to -10ºC are easy to occur, suggesting that the chilling generates by itself a cumulative harmful effect that produced pupal mortality even without freezing.

Supercooling point (SCP), as previously mentioned, represents a thermal threshold which, once reached, in the case of freezing avoiding, results in 100% mortality. Ylla (1997) determined the supercooling point (SCP) using 40 pupae, obtaining an average value of -15.46ºC ± 1,83 (Table 4) with minimum and maximum values of -18.3ºC and -8.2ºC, respectively. Figure 5 presents the supercooling curves of two *G. isabelae* pupae, highlighting the considerable inter-individual variation (approximately 4ºC between the two specimens).

Table 4. Supercooling point determined with 40 pupae.

Average of the Supercooling Point	-15,46°C
Standard deviation	-1,83°C
Minimum value	-18,3°C
Maximum value	-8,2°C

This study confirms that it is possible in the ground litter in the Pyrenees to reach and sustain temperatures below -10ºC, as nearly occurred in the second studied season. In any case, neither of the two possibilities (dying because of SCP or dying because of the chilling) took placed in winters of 1993-1994 and 1994-1995, as was demonstrated next Spring by the emergence of normal imago’s.

In the Pyrenees, in neither of the two trials did the temperature fall low enough to reach the supercooling point (SCP). During the first season, it remained close to -2/-3ºC, while in the second season it decreased considerably further. Therefore, the six death chrysalids were not due to freezing, but most likely to chilling injury.

Table 5 presents the SCP values of different moth species for comparison.

Table 5. Examples of SCP of some European and American species.

Species	Supercooling point (SCP)	Observations
Graellsia isabelae (Graells, 1849) (Saturniidae)	from -8ºC to -18ºC; x̄ =-15ºC	Ylla (1997)
Mythimna unipuncta (Haworth, 1809) (Noctuidae)	-24,29ºC	Roberts et al. (1972)
Agrotis ypsilon (Hufnagel, 1766) (Noctuidae)	-24,42ºC2	Roberts et al. (1972)
Plodia interpunctella Hübner, [1813] (Pyralidae)	-14 / -16ºC	Carrillo et al. (2005)
Plodia interpunctella Hübner, [1813] (Pyralidae)	-21ºC	
Antheraea pernyi (Guérin-Méneville, 1855) (Saturniidae)	-15,6ºC prediapause -20,1ºC diapause -17,5ºC postdiapause	Liu et al (2016)
Malacosoma disstria Hübner, [1820]) (Lasiocampidae)	From -26,8ºC to -40,3ºC	Uelmen et al. (2016)

Erebia medusa (Fabricius, 1787) (Nymphalidae)	From -10,8ºC to -16,5ºC	Vrba et al. (2022)
Erebia pronoe (Nymphalidae)	From -16,1ºC to -18,7ºC	Vrba et al. (2022)
Gynaephora groenlandica Wocke ex Homeyer, 1874 (Lymantriidae)	-8ºC	Danks et al. (1994)
Chilo supresalis (Walker, 1863) (Pyralidae)	-11ºC	Atapour M (2009)
Pieris brassicae (Linnaeus, 1758) (Pieridae)	-23ºC / -28ºC	Pullin et al. (1991)
Epirrita autumnata (Borkhausen, 1794) (Geometridae)	-35/-36ºC	Tenow & Nilssen (1990); Nilssen & Tenow (1990)

One of the most surprising results is the value of -8ºC recorded for *Gynaeohora. groenlandica* (Wocke ex Homeyer, 1874). This relatively high SCP indicates that it is a freezing tolerant species whose survival depends on its ability to withstand body freezing at comparatively high temperatures, rather than on extreme supercooling capacity. A possible explanation is that achieving and maintaining very low SCP values over long periods may be energetically too costly. Indeed, many Arctic species are freezing-tolerant, surviving despite internal ice formation.

It is therefore clear that having an SCP located at high or very high temperatures is an advantage if you are a freezing-tolerant organism living in cold or very cold environments, since it is energetically less costly to survive frozen than unfrozen.

Among the other species listed in the table, *Graellsia isabelae* shares its habitat with the Noctuidae *Agrotis ypsilon* (Hufnagel, 1766) and *Mythimna unipuncta* (Haworth, 1809), both of which have considerably lower SCPs than *G. isabelae*.

G. *isabelae* seems to be perfectly designed to overcome the low winter temperatures that occur in the high mountains, at ground level, among the fir. For example, the SCP decreases as the seasons progress, and the probability of colder conditions increases. That is, the SCP of just formed pupae, at the end of July, is -12,65ºC, whereas this same parameter at the end of January, when pupae really need to withstand low temperatures, the supercooling point have dropped to -16,43ºC (Ylla, 1997).

Undoubtedly, the behaviour of sheltering from the cold by hiding beneath forest litter and/or under a variable layer of snow also constitutes an advantage for the species.

The frequency with which winter temperatures reach the SCP remains unknown and can only be determined through repeated experimentation. Since winters vary in severity, the two examined here are illustrative only. Long before reaching the SCP, most pupae are likely to die from cumulative cold stress. Should the SCP be reached, all individuals in advanced or developing colonization stages would inevitably perish, forcing the population to restart.

The author emphasizes that this study focuses solely on the potential establishment of new colonies in higher, cooler areas, using *Graellsia* as an example. Nevertheless, the possible effects of summer overheating should not be overlooked, as elevated temperatures may affect the eggs or larvae of *Graellsia* or other species which are generally more sensitive to desiccation. For instance, the eggs of *Graellsia* fail to develop when temperatures reach 30ºC (Ylla, 1997).

Conclusions of the first part

1. Of the 28 pupae of *G. isabelae* that overwintered in the Pyrenees over the two-year period, a 78.6% successfully completed its biological cycle, showing that it is possible for *G. isabelae* pupae to spent winter satisfactorily in the *P. uncinata* forests of the region.
2. During the winters of 1993-94 and 1994-95, neither of the two seasonal minimum temperatures approached the SCP (-15.46ºC), with a minimum of -9.0ºC at 1 m in January 1995 and -7.7ºC at

ground level, also in January 1995.

3. *G. isabelae* is a chill-tolerant species who combines a degree of resistance to freezing (with the SCP as a threshold) with the advantage provided by its behaviour of sheltering from the cold, by hiding beneath the forest litter and/or under a variable layer of snow.
4. It has not been possible to demonstrate mortality of *G. isabelae* due to low winter temperatures, as in neither of the two seasons did temperatures reach the SCP. The 6 chrysalids (27,2%) that died likely did so because of chilling injury.
5. It has been showed that the SCP threshold is not reached every year. Only in exceptionally cold years, which may occur infrequently, the temperature can drop so low as to reach the SCP value.
6. The low SCP value undoubtedly provides strong protection to the pupae of *G. isabelae*, which rarely die from freezing. Moreover, given the standard deviation of the SCP and the distance between the minimum and maximum values, it is likely that some individuals survive.
7. Since winter temperatures have remained well above the SCP threshold (-15.46ºC), any hypothetical populations present would likely have successfully endured the characteristic cold of high-elevation zones.
8. Therefore, it cannot be ruled out that *Graellsia isabelae* could successfully inhabit the same habitat as *P. uncinata* pine forests in the Pyrenees.
9. Considering all the evidence presented (the presence of a suitable host plant, the low SCP of the pupae, winter temperatures remaining above the SCP, and the undeniable effects of climate change) together with intensified surveys, the author thinks that *G. isabelae* could eventually be detected in *Pinus uncinata* forests in the Pyrenees.

Part Two: Confirmation of the presence of *G. isabelae* in the Pyrenees (Spain)

Materials and Methods (part two)

To maximize the likelihood of finding a potential *Graellsia isabelae* population, male-targeted detection methods were essential from the start. Individuals of this sex are much more active than females, especially during the first two hours of darkness. At this time, stimulated by the varying concentration of pheromones released by females, they fly erratically and intensely in search of them.

These flying males can be detected using the following four methods:

1. With a butterfly net and a flashlight. Success is highly unlikely.
2. With synthetic pheromone. Good results.
3. With actinic light traps or other types of light. These usually yield good results.
4. With virgin females in calling position. Good results, but females must be available. Unmated females that are three or four days old have the highest attraction capacity.

In this study, the first three methods were used simultaneously. The light traps were the classic Heath traps, equipped with 8W actinic light and the synthetic pheromone was provided by INRA (Institut National de la Recherche Agronomique). Two vials were borrowed, each containing 4 nanograms of the pheromone synthesized by Jocelyn Millar in 2010 and kept frozen at -20ºC.

The vials containing the pheromone were suspended inside a 15 cm diameter transparent methacrylate cylinder, which was wrapped with a rope whose texture mimicked the female's furry abdomen. Figure 6. The purpose was to confuse the males, which would attach themselves to it, believing they were copulating, as indeed occurred.

In principle, doubts could have arisen regarding the functionality of a pheromone synthesized 16 years ago and custom-made for the French subspecies *G. isabelae galliaegloria* Oberthür, 1922. However, initial trials in *Pinus sylvestris* forests quickly dispelled any uncertainty, hence, it was confirmed that the synthetic French pheromone, after all these years, was still able to attract the Catalan subspecies *G. isabelae paradisea* Marten, 1955.

On May 11, 2026, traps were installed at 1,800 m in a dense *P. uncinata* forest at "Font de l'Home Mort", in Queralbs (UTM 312TDG28), the same place where, more than 30 years ago, the cocoons were brought to overwinter.

Figure 6. Methacrylate cylinder wrapped with rope, with a pheromone septum suspended inside.

Two pheromone traps and one actinic light trap were placed in a line along approximately 500 m of a forest track that runs parallel to the upper part of the valley carved out by the "Tosa River" Figures 7-8. Sampling lasted for the first two hours of darkness, which is when the males are active.

Figure 7-8. 7. Male "copulating" with the rope. It is one of the three specimens detected at 1800 m. In the background, the needles of *P. uncinata* can be observed. **8**. Site where the three specimens were detected.

In total, three specimens were detected, all males attracted by the pheromone and none by the actinic light.

The fact that three males arrived makes it highly improbable, if not impossible, that they were lost individuals coming from lower down the mountain where *P. sylvestris* is present. Everything indicates that they were individuals belonging to an autochthonous population established in the same habitat as *P. uncinata*.

Conclusions of part two

1. The presence of *G. isabelae* in high-mountain habitats colonized by *P. uncinata* is unequivocally confirmed.
2. As shown in the first part of this study, no factor against the presence of *G. isabelae* at high altitudes was identified, for the simple reason that none exists.
3. *P. uncinata* is definitively confirmed as a new host plant for *Graellsia* under natural conditions.
4. This discovery considerably expands the potential distribution area of *Graellsia*, at least in the Pyrenees.
5. These findings demonstrate that *Graellsia*, as a species, exhibits greater resilience to climate change than previously anticipated. *Pinus uncinata* woodlands occupy an extensive area (110.000 Ha) characterized by a cold climate regime which, functioning as a climate refugium, should enable *G. isabelae* to tolerate the thermal increase that empirical evidence suggests is already underway.

Observation concerning genus

As is evident, the author has consistently included the taxon *isabelae* within the genus *Graellsia* Grote, 1896, a view contrary to that of most current works, in which this taxon is placed within the genus *Actias* Leach, 1815. The use of the binomen *Graellsia isabelae* is advocated based on the validity of the cladistic analysis in which 93 characters (morphological, molecular, and ethological) from 16 species of Saturniidae were compared, leading to the conclusion that the genus *Graellsia* is valid (Ylla et al. 2005).

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Conflict of Interest

The author declares that there are no known financial interest or personal relationships that could have influenced the work presented in this article.

References

Atapour, M. (2008). Changes of cold hardiness, supercooling capacity and major cryoprotectants in overwintering larvae of *Chilo supresalis* (Lepidoptera; Pyralidae). *Environmental Entomology, 38*(1), 260-265. https://doi.org/10.1603/022.038.0132 PMid:19791622

Baixeras, J. (2001). *Seguimiento de poblaciones de Graellsia isabelae en zonas de actuación del proyecto Life-habitats. Graellsia isabelae en LICS-CV*. Memoria de actividades, julio-noviembre de 2001.

Bale, S. (1996). Insect cold hardiness: A matter of life and death. *European Journal Entomology, 93*, 369-382.

Carrillo, M. A., Cannon, C. A., Wilcke, W. F., Morey, R. V., Kaliyan, N., & Hutchison, W. D. (2005). Relationship between supercooling point and mortality at low temperatures in Indian meal moth (Lepidoptera: Pyralidae). *Journal of Economic Entomology, 98*(2), 618-625. https://doi.org/10.1093/jee/98.2.618 PMid:15889756

Chefaoui, R. M., & Lobo, J. M. (2007). Assessing the conservation status of an Iberian moth using pseudoabsences. *Journal of Wildlife Management, 71*(8), 2507-2516. https://doi.org/10.2193/2006-312

Danks, H. V., Ukal, O., & Ring, R. A. (1994). Insect cold-hardiness: insights from the Artic. *Artic, 47*(4), 391-404. https://doi.org/10.14430/arctic1312

De Arce-Crespo, J. J., Jiménez Mendoza, S., & Sánchez Fernández, P. (2010). Recopilación de la información biogeográfica, análisis de patrones ecológicos, conservación y mapa potencial *de Graellsia isabelae* (Graells, 1849) (Lepidoptera: Saturniidae) en la provincia de Cuenca, España. *Graellsia, 66*(1), 9-20. https://doi.org/10.3989/graellsia.2010.v66.003

González-Castellano, L., Mari-Mena, N., Segelbacher, G., López-Vaamonde, C., González-López, J., Fagúndez, J., & Vila, M. (2023). Landscape genetic of the protected Spanish Moon Moth in core, buffer, and peripheral areas of the Ordesa y Monte Perdido National Park (Central Pyrenees, Spain). *Conservations Genetics, 24*, 767-782. https://doi.org/10.1007/s10592-023-01536-z

Folch, R. (1981). *La vegetació dels Països Catalans*. Institució Catalana d'Història Natural. Memòria núm 10. Ketres Editora.

Ibáñez Vázquez, S., Nevado Ariza, J. C., & Ylla, J. (2008). *Graellsia isabelae* (Graells, 1849) una nueva especie para la fauna lepidopterológica de Almería (España) (Lepidoptera: Saturniidae). *SHILAP Revista de lepidopterología, 36*(144), 427-430.

Leather, S. R., Walters, K. F. A., & Bale, J. S. (1993). *The ecology of insect overwintering*. Cambridge University Press. https://doi.org/10.1017/CBO9780511525834

Liu, Y. Q., Zheng, X. X., Ma, H. F., Run, X. X., Li., Y. P., & Zhang, Q. R. (2016). Supercooling capacity and cold tolerance of the wild silkworm, *Antherea pernyi* (Lepidoptera: Saturniidae). *Journal of Economic Entomology, 109*(4), 1619-1627. https://doi.org/10.1093/j22/tow121 PMid:27371710

Mari-Mena, N., Naveira, H., López-Vaamonde, C., & Vila, M. (2018). Census and contemporary effective population size of two populations of protected Spanish Moon Moth (*Graellsia isabelae*). *Insect Conservation and Diversity, 12*(2), 147-160. https://doi.org/10.1111/icad.12322

Millar, J. G., McElfresch, J. S., Romero, C., Vila, M., Marí-Mena, N., & López-Vaamonde, C. (2010). Identification of the sex pheromone of a protected species, the Spanish Moon Moth *Graellsia isabelae. Journal Chemical Ecology, 36,* 923-932. https://doi.org/10.1007/s10886-010-9831-1 PMid:20658260 PMCid:PMC2941043

Monasterio León, Y., García Carrillo, A., Vicente Arranz, J. C., Marí Mena, N., Murria Beltrán., E., Arce, Crespo, J. J., & Escobés Jiménez, R. (2017). *La "graellsia", Actias isabelae (Graells, 1849). Historia, genética, ecología, distribución y conservación de un emblema de nuestra fauna*. Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente.

Nässig, W. A. (1991). Biological observations and taxonomic notes on *Actias isabellae* (Graells) (Lepidoptera, Saturniidae). *Nota lepidopterologica, 14*(2), 131-143.

Pullin, A. S., Bale, J. S., & Fontaine, L. R. (1991). Physiological aspects of diapause and cold tolerance during overwintering in *Pieris brassicae*. *Physiological Entomology, 16*, 447-456. https://doi.org/10.1111/j.1365-3032.1991.tb00584.x

Roberts, S. J., Armbrust, E. J., & Sell, D. K. (1972). "Supercoolling points of several species of lepidopteran found on soybeans". *Environmental Entomology, 1*(5), 671-172. https://doi.org/10.1093/ee/1.5.671

Romo, H., García-Barros, E., Martín Cano, J., Ylla, J., & López Munguira. J. (2012). *Graellsia isabelae*. In WAA., *Bases ecológicas preliminares para la conservación de las especies de interés comunitario en España: Invertebrados*. Ministerio de Agricultura, Alimentación y Medio Ambiente.

Sánchez-Fernández, P., & De Arce-Crespo, J. I. (2017). Revisión de la distribución biogeográfica, alimentación, patrones ecológicos y estatus de conservación de *Graellsia isabelae* (Graells, 1849) en la provincia de Cuenca, España (Lepidoptera: Saturniidae). *SHILAP Revista de lepidopterología, 45*(180), 609-623. https://doi.org/10.57065/shilap.884

Sinclair, B. J. (1999). Insect cold tolerance: How many kinds of frozen? *European Journal of Entomology, 96*, 157-164.

Tenow, O., & Nilssen. A. (1990). Egg cold hardiness and topoclimatic limitations to the outbreaks of *Epirrita autumnata* in northern Fennoscandia. *Journal of Applied Ecology, 27*, 723-734. https://doi.org/10.2307/2404314 PMid:16838026

Uelmen, J. A., Lindroth, R. L, Tobin, P. C., Reich, P. B., Schwartzberg, E. G., & Raffa, K. F. (2016). Effects of Winter temperatures, spring degree-day accumulation, and insect population source on phenological synchrony between forest tent caterpillar and host trees. *Forest Ecology and Management, 362*, 241-250. https://doi.org/10.1016/j.foreco.2015.11.045

Vigo, J. (1976). *L'alta muntanya catalana. Flora i vegetació*. Centre Excursionista de Catalunya, Editorial Montblanc-Martin.

Vrba, P., Nedvěd, O., Zahradnicková H., & Konvickai. M. (2017). Cold hardiness and the concentration of cryoprotectants in overwintering larvae of five *Erebia* butterflies (Lepidoptera, Nymphalidae. *European Journal of Entomology, 114*, 470-480. https://doi.org/10.14411/eje.2017.060

Ylla, J. (1997). *Història Natural del Lepidòpter Graellsia isabelae, (Graells, 1849)*. Institut d'Estudis Catalans.

Ylla, J., Peigler, R. S., & Kawahara, A. Y. (2005). Cladistic analysis of moon moths using morphology, molecules and behaviour: *Actias* Leach, 1815; *Argema* Wallengren, 1858; *Graellsia* Grote 1896 (Lepidoptera, Saturniidae). *SHILAP Revista de lepidopterología*, *33*(131), 299-317.

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