VOLUMEN / *VOLUME* 53 eISSN: 2340-4078 ISSN: 0300-5267
NÚMERO / *NUMBER* 211 LCCN: sn93026779 CODEN: SRLPEF
(Fecha de publicación 30 de septiembre de 2025 / *Issued 30 September 2025*)

SHILAP

REVISTA DE LEPIDOPTEROLOGÍA

SOCIEDAD HISPANO-LUSO-AMERICANA DE LEPIDOPTEROLOGIA -1973-

Madrid
2025

2024 CALIDAD REVISTAS CIENTÍFICAS ESPAÑOLAS
FECYT
FECYT-072/2024
Fecha de certificación: 20 de mayo de 2011 (2ª convocatoria)
Válido hasta: 24 de julio de 2025

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ISSN: 0300-5267 (edición impresa / *print edition*) / eISSN: 2340-4078 (edición electrónica / *online edition*)
CODEN: SRLPEF / LCCN: sn 93026779 / NLM ID: 101611953 / CDU: 595.78(05) / GND: 3004332-3
TIRADA / *EDITION*: 400 ejemplares / *400 copies*
EDITADO por / *EDITED by*: © Sociedad Hispano-Luso-Americana de Lepidopterología
IMPRESO por / *PRINTED by*: Ágata Comunicación Gráfica. Gamonal, 5 - Planta 4ª - Nave 15. E-28031 Madrid, ESPAÑA / *SPAIN*
Depósito Legal: M. 23.796-1973

VOLUMEN / *VOLUME* 53 eISSN: 2340-4078 ISSN: 0300-5267
NÚMERO / *NUMBER* 211 LCCN: sn93026779 CODEN: SRLPEF
(Fecha de publicación 30 de septiembre de 2025 / *Issued 30 September 2025*)

SHILAP REVISTA DE LEPIDOPTEROLOGIA

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SHILAP Revista de lepidopterología 53 (211) septiembre 2025: 429-437 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1094 https://shilap.org
https://zoobank.org/5C3BC408-C8A0-4408-9CC0-9FE532A7CB21

Expecting the unexpected: Random tissue barcoding reveals the presence of Pieridae in the diet of grounddwelling Tenebrionidae (Insecta: Lepidoptera, Coleoptera)

Pilar Jurado-Angulo, Raquel Vasconcelos & Mario García-París

Abstract

The genus of Tenebrionidae (Coleoptera) *Oxycara* Solier, 1835 includes 16 species endemic to the Cabo Verde Archipelago. In this study we analysed part of the diet of *O. richardi* Alluaud, 1936, endemic to the island of Sal, through the non-targeted amplification of a fragment of the mitochondrial gene cytochrome *c* oxidase subunit I (COI) from a specimen of this species. The results revealed that these detritivorous Coleoptera opportunistically feed on *Pontia glauconome* (Klug, 1829), a species of Pieridae also present in the archipelago. This finding provides new data on the trophic interactions and feeding behaviour of *O. richardi*.

Keywords: Insecta, Lepidoptera, Coleoptera, COI, Tenbrionidae, *Oxycara*, Pieridae, *Pontia*, Cabo Verde.

Esperando lo inesperado: *barcoding* aleatorio de los tejidos revela la presencia de Pieridae en la dieta de Tenebrionidae terrestres (Insecta: Lepidoptera, Coleoptera)

Resumen

El género de Tenebrionidae (Coleoptera) *Oxycara* Solier, 1835 incluye 16 especies endémicas del archipiélago de Cabo Verde. En este estudio analizamos parte de la dieta de *O. richardi* Alluaud, 1936, endémica de la isla de Sal, mediante la amplificación no dirigida de un fragmento del gen mitocondrial citocromo *c* oxidasa subunidad I (COI) de un ejemplar de esta especie. Los resultados revelaron que estos Coleoptera detritívoros se alimentan oportunistamente de *Pontia glauconome* (Klug, 1829), una especie de Pieridae también presente en el archipiélago. Este hallazgo aporta nuevos datos sobre las interacciones tróficas y el comportamiento alimentario de *O. richardi*.

Palabras clave: Insecta, Lepidoptera, Coleoptera, COI, Tenebrionidae, *Oxycara*, Pieridae, *Pontia*, Cabo Verde.

Esperando o inesperado: *barcoding* aleatório de tecidos revela a presença de Pieridae na dieta de Tenebrionidae terrestres (Insecta: Lepidoptera, Coleoptera)

Resumo

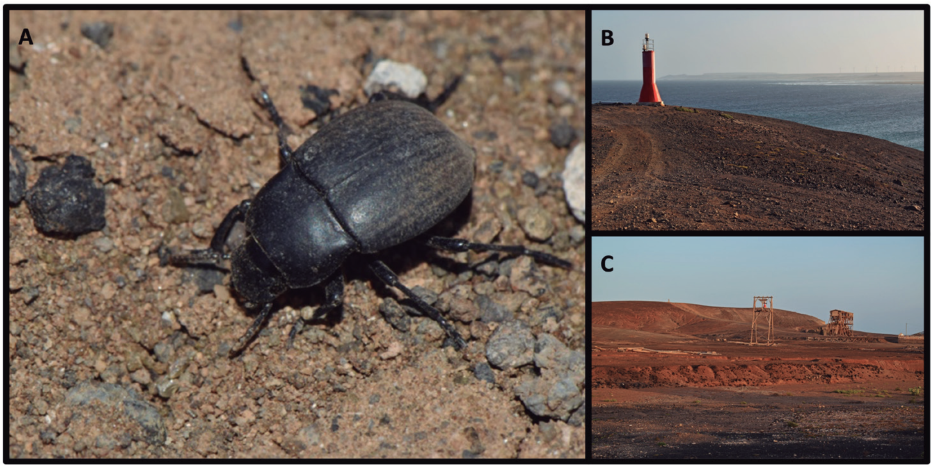
O género de Tenebrionidae (Coleoptera) *Oxycara* Solier, 1835 inclui 16 espécies endémicas do Arquipélago de Cabo Verde. Neste estudo analisámos parte da dieta de *O. richardi* Alluaud, 1936, endémica da ilha do Sal, através da amplificação não dirigida de um fragmento do gene mitocondrial citocromo *c* oxidase subunidade I (COI) de um exemplar desta espécie. Os resultados revelaram que estes Coleoptera detritívoros se alimentam oportunisticamente de *Pontia glauconome* (Klug, 1829), uma espécie de Pieridae também presente no arquipélago. Esta descoberta fornece novos dados sobre as interações tróficas e o comportamento alimentar de *O. richardi*.

Palavras-chave: Insecta, Lepidoptera, Coleoptera, COI, Tenebrionidae, *Oxycara*, Pieridae, *Pontia*, Cabo Verde.

Introduction

DNA barcoding is a versatile, useful, and important technique for monitoring and cataloguing biodiversity (Francis et al. 2010; Miller et al. 2016; Dincă et al. 2021), especially in hotspot areas where many endemic species are usually found, and cryptic species can hence be unveiled (Vasconcelos et al. 2016). This technique is thus crucial in under-studied sites, such as most African countries (Vasconcelos et al. 2016; Pereira et al. 2019; Gil et al. 2020; Pinho et al. 2024), and groups, such as invertebrates, which not only constitute the greatest diversity on earth, but also form the foundation of ecological chains (Shashank et al. 2022). DNA barcoding hinges on the comparison of individual DNA sequences with a reference library of known sequences (or DNA barcodes) linked to identified taxa, enabling precise identification of organisms (Hebert et al. 2003a, b; Ferri et al. 2009). This molecular method is especially useful when traditional species identification techniques are not applicable, such us with unknown or cryptic species (Hebert et al. 2004; Lara et al. 2010; Vasconcelos et al. 2016), developmental stages that are challenging to identify morphologically (Webb et al. 2006; Yeo et al. 2018; Chu et al. 2019) or parts or excretions (such as faeces) of organisms (Speller et al. 2016; Bennett et al. 2017; Dalén et al. 2017). The gene regions for effective barcoding depends on the group of organisms being worked with, as a good reference library is required, but certainly the mitochondrial cytochrome *c* oxidase subunit I (COI) is the most widely used, especially for animals and protists (Hebert et al. 2003a, b).

Figure 1. Study species: *Oxycara richardi* Alluaud, 1936 from Monte Grande (Sal, Cabo Verde) (photographed by PJ-A) **(A)**. Lighthouse **(B)** and Salterns of Pedra de Lume **(C)** (Sal, Cabo Verde), where specimens of *Oxycara richardi* Alluaud, 1936 were captured (photographed by MG-P).



Amplification of non-target organism is one of the biggest obstacles to DNA barcoding (Vargas et al. 2012), a problem that increases when universal COI primers are used (Mioduchowska et al. 2018; Leese et al. 2021). In many cases, barcoding of bacteria, parasites, or other organisms associated with the target species, such as their prey, are obtained (Smith et al. 2012; Mioduchowska et al. 2018; Pilgrim et al. 2021). In other cases, this obstacle can turn into an advantage, unveiling useful information about the species ecology (Pilgrim et al. 2021).

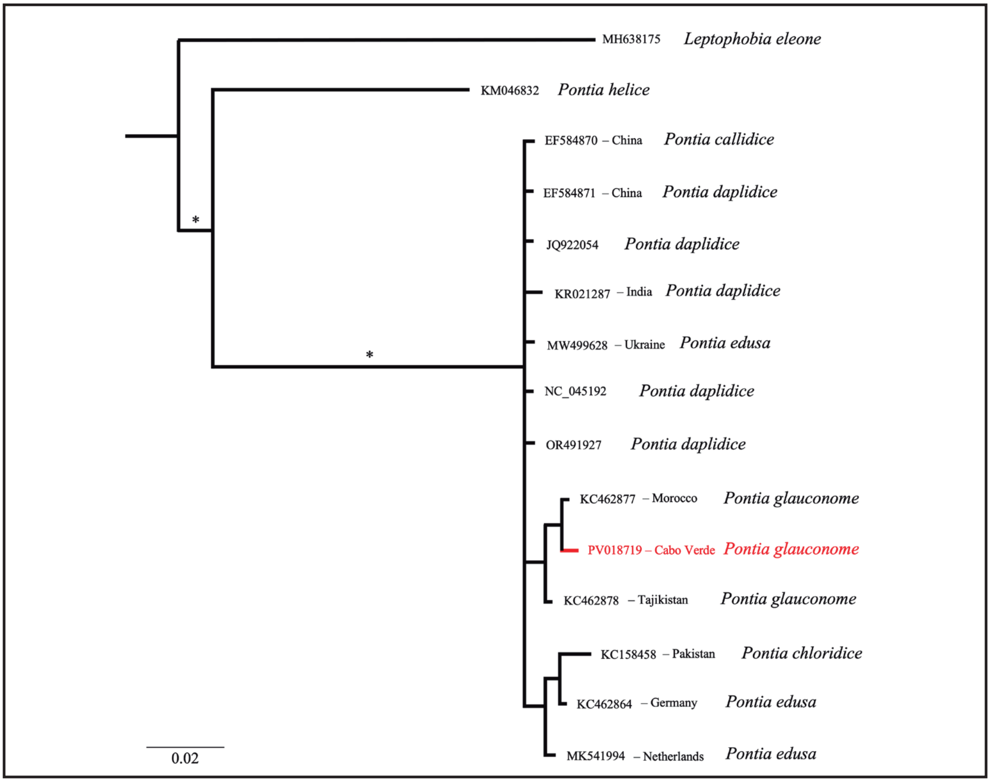
Thus, the goal of this article was to identify part of the diet of a darkling beetle *Oxycara richardi* Alluaud, 1936 (Figure 1A), endemic to the African insular country Cabo Verde that we failed to amplify, by amplifying some of what was probably its digestive content instead.

Materials and Methods

Specimens of *Oxycara richardi* (Figure 1A), an endemic Tenebrionidae species of the island of Sal, Cabo Verde Island, were captured in January 2023 to study the distribution of the genetic diversity of this genus in this African country. The specimens were found in Pedra Lume, in the east part of the island, under stones near a lighthouse (Figure 1B), and next to the salterns (Figure 1C). Specimens were preserved in ethanol 96% and stored at -20ºC at the entomological collection of the Museo Nacional de Ciencias Naturales (MNCN-CSIC), Madrid, Spain.

DNA material was extracted using the Qiagen DNeasy Blood and Tissue kit (Qiagen, Hilden, Germany) and following the protocol described by the manufacturer. For DNA extraction from beetles, the coxa muscle or one or two legs of specimens is usually used (Sánchez-Vialas et al. 2020; Mas-Peinado et al. 2022; Jurado-Angulo et al. 2023). However, in the case of small taxa, usually the whole body is used (Sanz-LaParra et al. 2023). Thus, the whole specimen was used for DNA extraction, with a small perforation on the ventral part of the thorax. After incubation of the sample in Buffer ATL and proteinase K as indicated in the protocol, the specimen was recovered, washed in Milli-Q water and preserved again in ethanol 96% for morphological studies. This drilling technique is commonly used on small invertebrates (Sanz-LaParra et al. 2023).

Figure 2. Bayesian phylogenetic tree based on COI partial sequences. The sequences are identified by their GenBank codes, followed by their geographical origin when available, and their published taxonomic identification. The red colour indicates the sequence obtained in this study. Posterior probability (PP) values higher than 95% for the Bayesian analysis are represented by an asterisk (*) and are shown above nodes.



Polymerase chain reaction (PCR) was used to amplify a fragment of the mitochondrial cytochrome *c* oxidase subunit I (COI), using the universal set of primers LCO1490 and HCO2198 (Folmer et al. 1994). PCR was performed in 25 µL, including 24 µL of the PCR mix (17.8 µL of H2O; 2.5 µL of a reaction buffer with MgCl2 (NZYtech); 1.5 µL of MgCl2; 1 µL of dNTPs; 0.5 µL of each primer and 0.2 µL of Taq polymerase (5U/ µL, NZYtech)) and 1 µL of specimen DNA. Amplification was conducted under the following PCR conditions: initial denaturation step at 95ºC (5 min), followed by 40 cycles of denaturation at 94ºC (45 seg), annealing at 42ºC (45 seg) and extension at 72ºC (1 min), and a final elongation step at 72ºC (10 min). Amplified product was visualized on a 1% agarose gel, and it was purified and sequenced by Sanger at Macrogen Inc. (Macrogen Europe, Madrid, Spain). Chromatograms of forward and reverse sequence were visualized, checked, and concatenated using Geneious Prime 21.1.1 (https://www.geneious.com). Consensus sequence was identified at the specific level using BLAST (Camacho et al. 2023) as belonging to the Pieridae *Pontia glauconome* (Klug, 1829). Since this result does not correspond to the expected one, which would be that the sequence was identified as *Oxycara*, and since the laboratory work was carried out with the pertinent care and no laboratory user works with Lepidoptera, we assume that it is not a contamination, but we amplified part of the diet of the studied specimen.

To identify the possible geographical origin of the butterfly consumed by *Oxycara*, a phylogenetic tree was reconstruct using this sequence, 13 GenBank sequences of *Pontia* Fabricius, 1807, and one additional sequence of *Leptophobia philoma* (Hewitson, 1870) used as closely related outgroup (Figure 2) (Ashfaq et al. 2013; Wahlberg et al. 2014; Dufour et al. 2018; Nie et al. 2018; Dincă et al. 2021).

Bayesian inference (BI) was conducted in MrBayes 3.2.6 (Ronquist et al. 2012). The command lset nst = mixed was used to determine the best substitution model. The BI consisted of two simultaneous runs of 20 million generations, sampling trees every 100 generations, and discarding the first 20% generations as burnin. Visualization and editing of the resulting phylogenetic tree were carried out in FigTree v.1.4.4 (Rambaut et al. 2018).

Results

BLAST identified the amplified sequence as *Pontia glauconome* (GenBank accession number PV018719), with 99.85% and 99.70% ID (GenBank accession numbers KC462877 and KC46878, respectively). Based on the phylogenetic tree (Figure 2), the specimen from Cabo Verde was more closely related to specimens from this species from Morocco than from those available from Tajikistan. The three sequences of the species were more related to each other than to those of other species of *Pontia* Fabricius, 1807. However, not all the sequences included depicted monophyletic taxa. The mitochondrial phylogenetic tree reflects the poor diversification of the COI in this species group (Figure 2).

Discussion

The DNA barcoding of a *O. richardi* specimen from Sal, Cabo Verde, did not provide the expected results. Instead, *Pontia glauconome* was amplified, suggesting that this species of Lepidoptera is part of the diet of the species. DNA amplification of food items was possible because, as the abdomen of the darkling beetle was perforated, DNA from its digestive contents was also extracted. Instead of considering this as a setback in the aimed phylogenetic study, this result was investigated as it highlights how DNA barcoding may have significant applications in ecological studies, particularly in diet analyses when morphological identification is compromised (Pompanon et al. 2012; Pinho et al. 2022, 2023).

Different parts of organisms can be used for diet analyses using DNA (meta) barcoding, such as stomachs (Harms-Tuohy et al. 2016; Pinho et al. 2024), faeces (Santos et al. 2022), saliva (Nichols et al. 2015), or the entire bodies (Macías-Hernández et al. 2018). The latter is used with small animals (Lynggaard et al. 2021). The total medium length of *Oxycara richardi* is approximately 1 cm, including head, thorax, and abdomen (Figure 1A). In addition, for the correct preservation of tenebrionid DNA, the specimens must be injected with alcohol, resulting in a perforation in the area where the needle is introduced, usually the anterior portion of the abdomen (Mas-Peinado et al. 2015, 2021, 2022).

Pontia glauconome is a Pieridae inhabiting xerophytic areas in North Africa, Arabian and Middle Eastern deserts, also recorded in Cabo Verde, specifically on Fogo, Maio, Boavista and Sal islands (Tennent &

Russell 2015, 2019). There are other Cabo Verdean records from the islands of Santiago (Báez & García 2005) and Santo Antão (Nyströn 1958; Vieira 2008), however, Tennent & Russell (2015, 2019) consider that these could be misidentifications requiring confirmation based on the more humid habitats that exist on those areas. The tenebrionid was collected in Pedra Lume, Sal (Figure 1B), where this Pieridae is common (Tennent & Russell 2015, 2019) and was previously reported in December. We captured the specimen of *Oxycara* in January. The climatic conditions in Cabo Verde have remained largely unchanged on this very arid island from 2017 (year in which previous surveys were conducted) to 2023 (year of this surveys), so it is likely that this Lepidoptera is still common in the region during this season. Species of *Pontia* have a short adult life span, less than a week for some species (Kingsolver 1999; Sidhu et al. 2014). Based on that, at least part of the *P. glauconome* population would be dying by January.

Tenebrionidae are mainly detritivores, that means that they feed mainly on decaying organic matter, such as leaves, dead wood and other plant debris (Watt 1974; Matthews et al. 2010). However, diet of Pimeliinae is quite diverse and often includes animal matter, such as dead bodies of other invertebrates (Fattorini 2023). In desert environments, where food availability can be highly variable, tenebrionids consume those whenever available, showing that these species of Coleoptera can exploit a wide range of resources available if needed (Duncan et al. 2002). Since there is no available information on the diet of *Oxycara*, this result suggests that *O. richardi*, a flighless ground dweller tenebrionid that cannot predate on living Pieridae, is feeding opportunistically on dead *P. glauconome* as part of its winter diet.

Finally, regarding to the phylogenetic tree, it seems that the taxonomy of *Pontia* is not clear and specific studies would be needed to clarify the relationships between species and the diversification within the genus (Chew & Watt 2006).

Acknowledgements

This work was funded by Portuguese funds through ‘Fundação para a Ciência e a Tecnologia, I.P’ (FCT) that funded the BIGFIT project (EXPL/BIA-EVL/0470/2021) to RV, and by the Spanish Government project-grant PID2019-110243GB-100/ AEI/10.13039/501100011033 (Ministerio de Ciencia e Innovación) to MGP. FCT also supported RV contract under the ‘Norma Transitória’ (DL57/2016/CP1440/CP1646/CT0003), and PJA PhD grant (2022.14742.BD; financed by the European Social Fund and the national programme ‘Portugal 2030’). We also thank to Direcção Geral do Ambiente, MAA, Cabo Verde Government for the sampling and exporting permits (Nº 017/DNA/2023) and Cabeólica S.A. for supporting fieldwork.

Conflict of interest

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

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(Recibido para publicación / *Received for publication* 14-X-2024)
(Revisado y aceptado / *Revised and accepted* 20-XI-2024)
(Publicado */ Published* 30-IX-2025)

eISSN: 2340-4078 ISSN: 0300-5267
https://shilap.org

COMITÉ PARA LA PROTECCIÓN DE LA NATURALEZA, PROYECTO DE INVESTIGACIÓN CIENTÍFICA DE SHILAP / *COMMITTEEFORTHEPROTECTION 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 nom-bre, 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.

SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 439-460 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1073 https://shilap.org
https://zoobank.org/842D0A6-AC51-43DF-8733-43E55E351FF2

What flies in the far south of Croatia? The diversity of Rhopalocera in the Konavle region, southern Dalmatia (Lepidoptera: Papilionoidea)

Toni Koren, Matea Martinović & Dubravko Dender

Abstract

This research explores the diversity of Rhopalocera in the Konavle region, the southernmost part of Dalmatia. A total of 106 species were recorded, the majority of which were documented for the first time in this area due to the scarcity of previous surveys. Zoogeographical analysis indicated a high proportion of Euro-Siberian and Euro-Oriental species, with significant contributions from Holarctic and Mediterranean species. Compared to the surrounding areas in Bosnia and Herzegovina and Montenegro, between Trebinje and Mt. Orjen, a greater diversity of Rhopalocera was observed, with a Sorensen similarity index of 0.39, indicating a relatively distinct fauna. Most of the studied area falls within the Natura 2000 ecological network, where all species were recorded, including nearly all sites of conservation value based on the abundance of endangered species and species listed in the Habitats Directive. The northern part of the study area belongs to the Snježnica mountain, which has been separately analysed, with 103 species recorded so far, more than on smaller mountains such as Mosor and Kozjak but fewer than larger and significantly higher mountains like Biokovo, Svilaja, and Dinara. Many interesting species were recorded during this survey and the presence of several of them was discussed in greater detail. Notes about the conservation of Rhopalocera in the surveyed areas are provided.

Keywords: Lepidoptera, Papilionoidea, Rhopalocera, faunistic, diversity, Konavosko polje, Snježnica, Croatia.

¿Qué vuela en el extremo sur de Croacia? La diversidad de Rhopalocera en la región de Konavle, al sur de Dalmacia (Lepidoptera: Papilionoidea)

Resumen

Esta investigación explora la diversidad de Rhopalocera en la región de Konavle, la parte más meridional de Dalmacia. Se registraron un total de 106 especies, la mayoría documentadas por primera vez en esta zona debido a la escasez de estudios previos. El análisis zoogeográfico indicó una elevada proporción de especies eurosiberianas y euro orientales, con contribuciones significativas de especies holárticas y mediterráneas. En comparación con las zonas circundantes de Bosnia-Herzegovina y Montenegro, entre Trebinje y el monte Orjen, se observó una mayor diversidad de Rhopalocera, con un índice de similitud de Sorensen de 0,39, lo que indica una fauna relativamente distinta. La mayor parte de la zona estudiada pertenece a la red ecológica Natura 2000, donde se registraron todas las especies, incluidos casi todos los lugares con valor de conservación en función de la abundancia de especies amenazadas y de especies incluidas en la Directiva sobre hábitats. La parte norte de la zona de estudio pertenece a la montaña Snježnica, que se ha analizado por separado, con

103 especies registradas hasta ahora, más que en montañas más pequeñas como Mosor y Kozjak, pero menos que en montañas más grandes y significativamente más altas como Biokovo, Svilaja y Dinara. Durante esta prospección se registraron muchas especies interesantes y se analizó con más detalle la presencia de varias de ellas. Se ofrecen notas sobre la conservación de los Rhopalocera en las zonas estudiadas.

Palabras clave: Lepidoptera, Papilionoidea, Rhopalocera, faunística, diversidad, Konavosko polje, Snježnica, Croacia.

Introduction

The Konavle region is the southernmost part of Croatia, and borders two neighbouring countries, Bosnia and Herzegovina, and Montenegro. The country's border areas often pique the additional interest of entomologists, who see them as an opportunity to record rare or previously undocumented insect species that occur in the neighbouring countries. This was the case for the first author of this study, who first visited the area of southern Dalmatia in 2009 and has continued visiting ever since. Later, two additional authors, originally from neighbouring Dubrovnik, joined the field expeditions, and eventually began documenting the Rhopalocera of the area.

The Rhopalocera fauna of Konavle has never been systematically researched, and all existing knowledge mostly pertains to smaller areas or findings of individual species or a limited number of additional observations from the same locality (Mihoci et al. 2005). Still, the area is known to be very diverse with species like *Papilio alexanor* being observed there recently (Russell & Pateman, 2018). It is also the only area in Croatia where *Lycaena ottomanus* occurs (Koren et al. 2012; Mihoci et al. 2005). In addition, the species *Kirinia roxelana* was recently recorded here, 120 years after the last record in Croatia (Koren, 2015), and further research has documented the species in additional locations (Koren et al. 2019b). Most of the works deal with one or a small number of observed species while a systematic overview of the species occurring in this area is lacking.

The goal of this work is to provide the results of a long-term semi-systematic survey of Rhopalocera of the Konavle region, to give some insights about some rare and potentially endangered species and provide a basis for future monitoring and conservation measures in the area.

Materials and methods

Study area

The region of Konavle today administratively represents the southernmost municipality in the Republic of Croatia, and it is part of the Dubrovnik-Neretva County. The boundaries of the present region/municipality were defined back in the 15th century when the area was acquired by the then Dubrovnik Republic or Republic of Ragusa (Živković, 1998).

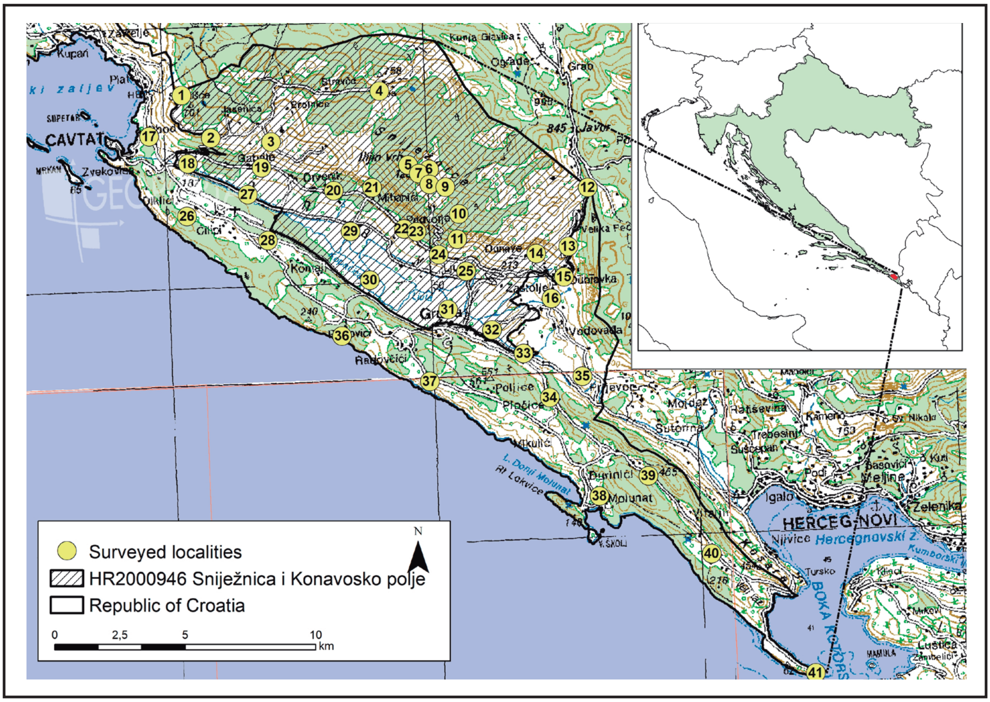
The landscape of Konavle is dominated by the centrally positioned Konavosko polje, a closed, karst depression surrounded by higher elevations on all sides. Consequently, there is no surface drainage of water into the sea, which regularly flooded the area in the past. Today, the excess water is drained directly into the sea through tunnels. Karst fields such as Konavle field represent alluvial deposits and are the most fertile areas in the Dinaric karst (Jelavić, 1974). Grassland habitats dominate it today, with a smaller portion under different crops. The surrounding area is predominantly limestone terrain. On the north-eastern side, the higher part is represented by Mt. Snježnica (1234 m a.s.l.), which merges into the massif of Mt. Orjen (1895 m a.s.l.) after Mrcine - Grab ravine (Roglić & Baučić, 1958). A smaller part of Orjen, which is located in Croatia, is locally known as Bjelotina. Its highest peak in Croatia is 1089 m above sea level. The Konavle field is separated from the sea by a dolomite-limestone ridge stretching from Cavtat (ancient Epidaur) to Cape Oštro (the southernmost point of Croatia), with its highest elevation being 561 m above sea level and an average of 150-200 m above sea level. The main watercourses in the Konavosko polje are Ljuta River as the only permanent watercourse, and Kopačica and Konavočica, which have a more torrential character (Roglić & Baučić, 1958). The surrounding limestone area represents a combination of forest and grassland habitats interspersed with rural landscapes, consisting of small settlements and cultivated areas in the surroundings around them. Grassland habitats on rocky areas are the result of fires of natural or anthropogenic origin, but also of formerly prevalent open grazing. Those on deeper soil are usually the result of existing or somewhat neglected agricultural production. Such areas are also found in the higher parts of Snježnica and are called “do(l) - do(l)ci” by the locals.

According to the Köppen classification, the Konavle area has two climate types. The narrower coastal part is categorised as the Mediterranean climate with hot summers (Csa), while the larger part of the area falls into the category of Mediterranean climate with warm summers (Csb) (Filipčić, 1998). The main characteristics of the Mediterranean climate are mild winters and dry summers, with three times less precipitation in the driest summer month compared to the wettest (Seletković et al. 2011). Only in the highest parts of Konavle snow is not an uncommon phenomenon.

The area of Croatia with a Mediterranean climate belongs to the Mediterranean phytogeographical region. In a narrower sense, this region includes the *Oleo-Cerationion* and *Quercion ilicis alliances,* in which evergreen woody elements predominate. In a broader sense, the region also encompasses the deciduous broadleaved belt that continues from the mentioned coastal belt and extends deeper inland. This refers to the *Ostryo-Carpineon orientalis alliance*, who’s main edificator in the southern part of the Croatian coast is *Quercus virgiliana*. In the higher parts of the coastal Dinarides, the belt is followed by the *Ostryo-Carpineon orientalis* alliance, indicating the so-called Mediterranean montane belt, with its main edificator being *Ostrya carpinifolia* (Trinajstić, 1998). Such stands in the higher parts of Konavle are most found at altitudes of over 1000 meters above sea level.

In all these belts, along with forest areas, various degraded forms (maquis, garigue, grasslands, etc.) are regularly present. The wetter parts of the karst fields, such as the Konavle field, are generally characterized by vegetation of floodplain thickets and forests of the *Populetalia albae* alliance and typical grassland habitats (Horvatić, 1963). Except in higher areas and more distinctly alluvial habitats, alongside native stands, there are also pine (*Pinus* spp.) and cypres (*Cupressus sempervirens*) plantations, often mixed with native vegetation.

Figure 1. Map of surveyed localities in the Konavle area. Localities are numbered from northeast to southwest direction and correspond to locality numbers in the Materials and Methods section.



A large part of the Konavle area, 11.250,06 ha is protected within the Ecological Network Natura 2000 as HR2000946 Snježnica i Konavosko polje. All but 14 of the sites surveyed in this study are in this area. No target Lepidoptera species are listed in this area.

Data collecting

The field surveys were mainly conducted in the period from 2015 to 2023, but we also included unpublished records from earlier years. The fieldwork was not planned from the beginning, but rather most interesting areas were visited during the first years and additional localities later, to cover most parts of the study region. A total of 41 localities were visited during the survey (Figures 1, 2), the most interesting of those on several occasions to cover the entire Rhopalocera season. A part of the research was done during the most unfavourable period of the year for Rhopalocera from December to February, and data was collected on the activity of some species. Since standard Rhopalocera surveys generally do not include the coldest period of the year, data on the flight of individual species from that part of the year are usually missing. One of the few references to flight periods and the number of generations of individual species in Croatia can be found in Lorković's manuscript from 1954 (Lorković, 2009).

Figure 2. Selected habitats in the survey area. **a)** Typical view of Konavosko polje and southern slopes of Mt. Snježnica. **b)** Karstic hills and Prapratni do field. **c)** Karstic grasslands on the northern parts of Mt. Snježnica. **d)** Open grassland near Vitaljina settlement.

The spatial processing and visualization of the data was done within the program ARC GIS desktop. Rhopalocera were identified using standard field guides (Lafranchis, 2004; Tolman & Lewington, 2008). Identification of the *Hipparchia fagi/syriaca* complex was based on the examination of the male Julien organ in the field as well as in the laboratory from the collected specimens (Lorković, 1976). The specimens of the genera *Gegenes, Pyrgus* (*alveus-armoricanus*)*, Plebejus,* and *Leptidea* were identified by examining the male or female genital structures (Higgins, 1975). The nomenclature follows Lepiforum (Lepiforum e.V., 2024), while the nomenclature of the plant species follows Euro+Med PlantBase (2006+) The conservation value of each locality was calculated by weighting the species included in the red lists of Croatia (Šašić et al. 2015) or Europe (van Swaay et al. 2010): 2x for Near Threatened species (NT) and 3x for Vulnerable species (VU). In addition, species listed in Annexes II and/or IV of the European Habitats Directive were weighted 5x. Each species was counted only once with the highest available weight (Verovnik et al. 2023).

Comparisons of species composition between Konavle and the surrounding area in Bosnia and Herzegovina and Montenegro (Sijarić, 1983) were made based on biogeographical affiliations of the Rhopalocera, generally following Kudrna et al. (2015).

To assess the diversity within the Natura 2000 area HR2000946 Snježnica i Konavosko polje for future management, species were additionally delimited using these borders to assess the diversity within the protected area in comparison with the wider Konavle region.

The same analysis was performed only from the northern part of Konavle, Mt. Sniježnica, and its fauna was compared to the fauna of other better-surveyed Dalmatian mountains Dinara (Koren & Lauš, 2013; Tvrtković et al. 2012), Kozjak (Koren, et al. 2019), Svilaja (Verovnik et al. 2023), Mosor (Koren et al. 2020), and Biokovo (Kačírek, 2017; Mihoci et al. 2011).

List of localities

The list contains localities arranged geographically from northwest to southeast, relevant toponyms, short description of habitats, altitude, and coordinates.

1. Mt. Sniježnica, towards and around Velji do village, rocky grasslands and arable lands surrounded by lower deciduous vegetation; 548 m a.s.l; 42º36’02.9”N, 18º14’50.7”E.
2. Mt. Sniježnica, N of Uskoplje, rocky grasslands and arable lands surrounded by lower deciduous vegetation; 473 m a.s.l; 42º35’08.7”N, 18º15’36.8”E.
3. Mt. Sniježnica, Vojski do, a wooded area interspersed with grasslands on deeper soil, surrounded by karst grasslands.; 421 m a.s.l; 42º35’01.3”N, 18º17’17.5”E.
4. Mt. Sniježnica, Duba Konavoska, around the village, karst grasslands and other forms of degraded forests with arable lands and grasslands on deeper soil (dolci); 468 m a.s.l; 42º35’58.9”N, 18º20’22.5”E.
5. Mt. Sniježnica, Sv. Ilija peak and the surroundings, rocky grasslands and rocky areas surrounded by lower deciduous stands; 1208 m a.s.l; 42º34’26.2”N, 18º21’06.2”E.
6. Mt. Sniježnica, SE of the Sv. Ilija peak, Rocky grasslands and rocky areas, as well as grasslands on deeper soil (dolci), surrounded by lower deciduous stands; 1004 m a.s.l; 42º34’19.6”N, 18º21’40.8”E.
7. Mt. Sniježnica, below the Sv. Ilija peak; 1130 m a.s.l,, rocky grasslands and rocky areas surrounded by lower deciduous stands; 42º34’15.0”N, 18º21’23.7”E.
8. Mt. Sniježnica, N of Kuna Konavoska, around the ponds and Velje br. Dolac, rocky grasslands and rocky areas, as well as grasslands on deeper soil (dolci), surrounded by forest fragments; 1007 m a.s.l; 42º34’01.0”N, 18º21’40.3”E.
9. Mt. Sniježnica, N of Kuna Konavoska, V. Jaje, rocky grasslands and rocky areas, along with grasslands on deeper soil (dolci), surrounded by fragments of forest; 920 m a.s.l; 42º33’57.0”N, 18º22’07.2”E.
10. Mt. Sniježnica, Kuna Konavoska, around and E of the village, rocky grasslands and rocky areas, along with grasslands on deeper soil (dolci), surrounded by fragments of forest; 800 m a.s.l; 42º33’23.0”N, 18º22’28.0”E.
11. Mt. Sniježnica, road towards Kuna Konavoska, karst plateau, karst grasslands and rocky areas with forest fragments; 589 m a.s.l; 42º32’51.8”N, 18º22’23.5”E.
12. Dubravka, Prapratni do, N part, Straža, grasslands and arable lands on deeper karst soil, surrounded by rocky grasslands and forest; 700 m a.s.l; 42º33’49.4”N, 18º26’06.2”E.
13. Dubravka, N of village, Prapratni Do, S part, grasslands and arable lands on deeper karst soil (dolci), surrounded by rocky grasslands and forest; 522 m a.s.l; 42º32’37.5”N, 18º25’29.5”E.
14. Dunave, around the cemetery, ruderal areas, grasslands, and arable lands on deeper karst soil, surrounded by rocky grasslands and forest; 432 m a.s.l; 42º32’30.2”N, 18º24’35.6”E.
15. Dubravka, around and S of the village, ruderal areas, grasslands, and arable lands on deeper karst soil, surrounded by rocky grasslands and forest; 460 m a.s.l; 42º32’00.1”N 18º25’20.3”E.
16. Vodovađa, north of the village, ruderal areas, grasslands, and arable lands on deeper karst soil, surrounded by rocky grasslands and forest; 310 m a.s.l; 42º31’34.1”N 18º24’57.7”E.
17. Zvekovica - Obod, between the villages, ruderal areas near settlements, arable lands surrounded by forest and degraded stands; 62 m a.s.l; 42º35’13.5”N 18º13’53.6”E.

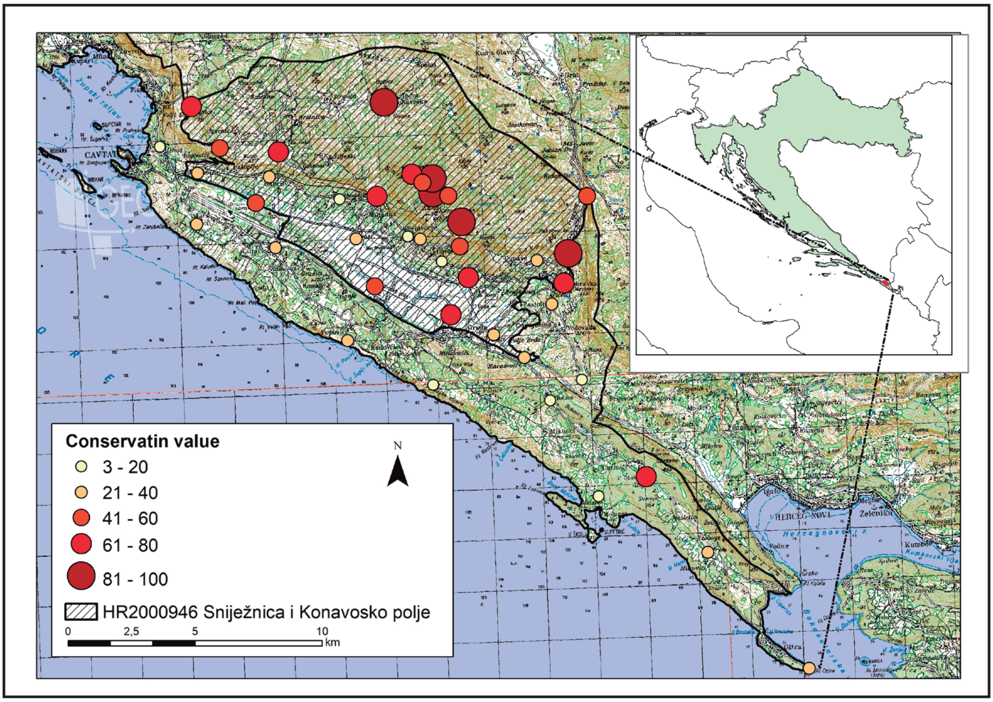
18. Uskoplje, around the village, a karst field with grasslands and arable lands, featuring ruderal areas and forest fragments; 122 m a.s.l; 42º34'38.2"N, 18º14'56.7"E.
19. Gabrili - Klečaci, between the villages, arable and ruderal areas surrounded by forest; 188 m a.s.l; 42º34'29.9"N, 18º17'00.3"E.
20. Drvenik, around the village, arable and ruderal areas surrounded by forest; 192 m a.s.l; 42º33'58.0"N, 18º18'59.6"E.
21. Mihanići, old railroad NW of the settlement, a karst field with arable lands and grasslands, surrounded by ruderal areas and forest.; 324 m a.s.l; 42º33'59.6"N, 18º20'04.1"E.
22. Pridvorje-Mihanići, fields between the villages, arable and ruderal areas surrounded by forest; 219 m a.s.l; 42º33'07.1"N, 18º20'54.8"E.
23. Lovorno, road N of the village, arable and ruderal areas surrounded by forest; 291 m a.s.l; 42º33'03.0"N, 18º21'16.1"E.
24. Lovorno, around the village and slopes, arable and ruderal areas surrounded by forest; 193 m a.s.l; 42º32'33.5"N, 18º21'51.5"E.
25. Gornja Ljuta - Konavoski Dvori, banks of river Ljuta, a karst field with arable lands and grasslands, surrounded by ruderal areas and forest.; 73 m a.s.l; 42º32'11.8"N, 18º22'36.3"E.
26. Močići, around the village, arable and ruderal areas surrounded by forest; 129 m a.s.l; 42º33'33.0"N, 18º14'52.0"E.
27. Uskoplje, Vlahutini, around the village, a karst field with arable lands and grasslands, surrounded by ruderal areas and forest.; 91 m a.s.l; 42º33'57.2"N, 18º16'35.5"E.
28. Čilipi, around and N of the village, arable and ruderal areas surrounded by forest; 159 m a.s.l; 42º32'59.6"N, 18º17'06.0"E.
29. Miljasi, around the village, a karst field with arable lands and grasslands, surrounded by ruderal areas and forest.; 58 m a.s.l; 42º33'06.6"N, 18º19'25.2"E.
30. Popovići, Konavosko polje NE of the settlement, a karst field with arable lands and grasslands, surrounded by ruderal areas and forest.; 44 m a.s.l; 42º32'05.6"N, 18º19'54.6"E.
31. Gruda, Konavosko polje around the settlement, ruderal areas and a karst field with grasslands, arable lands, and a river surrounded by forest; 52 m a.s.l; 42º31'25.5"N, 18º22'03.5"E.
32. Gruda, NW of Crnjegovina, banks and fields of Konavočica river, a karst field with grasslands, arable and ruderal areas, and forest fragments; 73 m a.s.l; 42º30'57.7"N, 18º23'15.8"E.
33. Gruda, banks of river Konavočica N of Karasovići, A karst field with arable lands and grasslands, surrounded by ruderal areas and forest.; 85 m a.s.l; 42º30'27.3"N, 18º24'06.9"E.
34. Pločice, S of the village, arable and ruderal areas surrounded by forest; 210 m a.s.l; 42º29'31.5"N, 18º24'48.6"E.
35. Palje Brdo, road verges S of the village, a karst field with arable lands and grasslands, surrounded by ruderal areas and forest; 242 m a.s.l; 42º29'56.0"N, 18º25'44.4"E.
36. Popovići, around the village, mediterranean evergreen forests, maquis, and garigue, as well as rocky grasslands with arable lands; 80 m a.s.l; 42º30'57.7"N, 18º19'04.2"E.
37. Radovčići - Poljice, field road S of the main road, mediterranean evergreen maquis and garigue, along with rocky grasslands and arable lands on deeper soil; 316 m a.s.l; 42º29'57.4"N, 18º21'28.2"E.
38. Molunat, W and N of the settlement, mediterranean evergreen forests, maquis, and garigue with ruderal areas; 57 m a.s.l; 42º27'27.0"N, 18º26'04.9"E.
39. Vitaljina, around Višnjići village, ruderal areas and arable lands surrounded by forest and degraded stands; 205 m a.s.l; 42º27'49.4"N, 18º27'28.3"E.
40. Vitaljina, Tripkovići, road N of the village, arable lands surrounded by forest and degraded stands; 140 m a.s.l; 42º26'10.0"N, 18º29'08.7"E.
41. Prevlaka, central part to Rt Oštro, mediterranean evergreen forests, maquis, and garigue with ruderal areas; 23 m a.s.l; 42º23'37.1"N, 18º31'54.9"E.

Results

During this survey, a total of 106 species were recorded in the Konavle region (Table 1). The most common species, recorded in 30 or more localities were *Iphiclides podalirius* (Linnaeus, 1758), *Colias croceus*

(Geoffroy, 1785 in Fourcroy), *Gonepteryx rhamni* (Linnaeus, 1758), *Polyommatus icarus* (Rottemburg, 1775), *Lasiommata megera* (Linnaeus, 1767), *Vanessa atalanta* (Linnaeus, 1758), *Vanessa cardui* (Linnaeus, 1758) and *Maniola jurtina* (Linnaeus, 1758).

Figure 3. Conservation value of individual localities in Konavle in relation to the designated Natura 2000 area HR2000946 Snježnica i Konavosko polje.



The rarest species recorded in one or two localities were *Parnassius mnemosyne* (Linnaeus, 1758), *Gegenes nostrodamus* (Fabricius, 1793), *Lycaena tityrus* (Poda, 1761), *Brenthis daphne* (Bergsträsser, 1780), *Coenonympha rhodopensis* Elwes, 1900, *Danaus chrysippus* (Linnaeus, 1758) and *Aglais urticae* (Linnaeus, 1758). The species *Colias alfacariensis* Ribbe, 1905, which was recorded with only five solitary individuals during the years of research, should be also mentioned as a rarity. Since it is an easily noticeable species, it is quite possible that only individuals from nearby populations in the hinterland appear in the studied area, mostly in the fall.

Table 2. Comparison of the Rhopalocera diversity and the biogeographic composition (modified from Kudrna et al. 2015) between Konavle (this study) and the surrounding area Trebinje - Orjen (Sijarić, 1983). ES - Euro-Siberian, EO - Euro-Oriental, Mon - Montane or Boreo-Montane, Hol - Holarctic, EM - Euro-Meridional, MED - Mediterranean, Tro - Tropical, Cos - Cosmopolitan.

Researched area	**No. of species**	**EO**	**ES**	**Hol**	**EM**	**Tro**	**MED**	**Mon**	**Cos**
Konavle	**106**	41	40	7	6	5	5	1	1
Trebinje - Orjen	**85**	31	37	4	6	2	1	3	1

The comparison of Rhopalocera diversity and biogeographical composition between the areas of Konavle and Trebinje-Orjen revealed the prevalence of Euro-Siberian and Euro-Oriental species in both loculations (Table 2). Konavle had a higher number of Holarctic, Tropical, and Mediterranean species while Trebinje-Orjen had a higher number of montane species (Table 2). More species (106) were recorded at Konavle but additional 14 species not recorded in Konavle were recorded in the Trebinje-Orjen area. In total, from the Konavle-Trebinje-Orjen area 120 Rhopalocera species are known so far. The Sorensen's index between Konavle and Trebinje-Orjen is 0.391, which indicates a relatively low similarity between the two areas based on their species composition.

With one exception, all sites with a conservation value of more than 40 were located within the Natura 2000 site HR2000946 Sniježnica i Konavosko polje (figure 3). Also, all 106 recorded species within the Konavle area, were also found in the Natura 2000 site Snježnica i Konavosko polje.

A total of 103 species were found on Mt. Snježnica during this survey. The missing species are *Apatura metis* Freyer, 1829, *Cupido argiades* (Pallas, 1771) and *Gegenes nostrodamus* (Fabricius, 1793) which were recorded only in the Konavosko polje. Mt. Sniježica has fewer species than Mt. Dinara, Mt. Svilaja, and Mt. Biokovo but more than Mt. Mosor and Mt. Kozjak (Table 3). On Snježnica, Euro-Siberian and Euro-Oriental species predominate with a considerable number of Holarctic and Mediterranean species (Table 3).

Table 3. Comparison of the Rhopalocera diversity and the biogeographic composition, modified from Kudrna et al. (2015), between selected mountain ranges of Dalmatia arranged in the northwest-southwest direction. The altitudinal span of the sampled localities in each mountain is added. ES - Euro-Siberian, EO - Euro-Oriental, Mon - Montane or Boreo-Montane, Hol - Holarctic, EM - Euro-Meridional, MED - Mediterranean.

Mountain	Altitudinal span (m)	No. of species	ES	EO	Mon	Hol	EM	MED	other
Dinara	250 - 1910	128	61	42	8	6	8	0	3
Svilaja	270 - 1508	112	52	40	2	7	8	1	2
Kozjak	110 - 740	87	35	34	0	7	6	1	4
Mosor	50 - 1100	96	38	41	1	7	5	1	3
Biokovo	90 - 1760	116	47	45	3	6	7	4	4
Snježnica	150 - 1234	103	39	40	1	6	6	5	6

Discussion

During this research, a total of 106 species of Rhopalocera were recorded in a relatively small part of Croatia, with almost all species being recorded for the first time in the researched area.

Given that the Konavle region is bordered to the north by Bosnia and Herzegovina and to the east by Montenegro, it is meaningful to compare the fauna of these areas. The most comprehensive study on this region, which almost semi-circularly surrounds Konavle, focuses on researching Rhopalocera from Trebinje in Bosnia and Herzegovina to Mount Orjen in Montenegro. A total of 85 species of Rhopalocera are known from this area (Sijarić, 1984), but the author himself emphasises that not all areas were covered, as the research was predominantly ecological. Comparing the biogeographic affiliations between two areas, Konavle and Trebinje-Orjen, reveals a notable lack of systematic research in the spatially and altitudinally more diverse area between Trebinje and Orjen. This is also indicated by the relatively low result of the Sorensen's index of diversity, suggesting a moderate similarity between the surveyed areas. However, further research in these areas in Bosnia and Montenegro will significantly reduce these differences, although disparities in high-mountain species missing on Snježnica and typical Mediterranean species likely absent in those areas will persist.

The analysis of the conservation value of Rhopalocera fauna of Konavle indicates that all localities with the conservation value of more than 40, except one, are located within the Natura 2000 area HR2000946

Snježnica i Konavosko polje (Figure 2). In addition, all species recorded during this survey were recorded within the Natura 2000 area. Currently no Habitats Directive species are listed for the area HR2000946 Snježnica i Konavosko polje, but during our survey we recorded several populations of Annex II species *Euphydryas aurinia.* The occurrence of this species in Dalmatia is mostly limited to its northern parts and that it occurs in southern Dalmatia was not known before this survey (Šašić et al. 2015). Accordingly, we propose including this species in the list of targeted species for the HR2000946 Snježnica i Konavosko polje area. This could help the protection of the species and its habitat in the long term. Aside from it, four Annex IV of the Habitats Directive species were also recorded in the area *Apatura metis, Papilio alexanor, Parnassius mnemosynae,* and *Zerynthia polyxena*. While Natura 2000 areas are not ideal to protect all their biodiversity, they may have a positive impact on targeted (Kajzer-Bonk & Nowicki, 2022) as well as on non-targeted Rhopalocera species but with the improvement the habitat quality of the sites (Pellissier et al. 2020). Also, the effectiveness of Natura 2000 sites may depend on public perception of the network (Blicharska et al. 2016), human population size, and taxonomic group considered (Trochet & Schmeller, 2013). The recent study on three *Phengaris* species demonstrated that Natura 2000 sites fulfil their protective function in halting population loss of species of high conservation interest even in urban areas (Kajzer-Bonk & Nowicki, 2022).

In comparison with other well-researched mountains of Dalmatia (Table 2), Snježnica follows the general trend dominated by Euro-Siberian and Euro-Oriental species (Verovnik et al. 2023), while mountainous species are sparse, like the case of Mt. Mosor (Koren et al. 2020). The area of Snježnica predominantly experiences a Mediterranean climate, yet with relatively cold winters where the summit areas are often covered in snow, likely facilitating the survival of the only high mountain species present in the area, *Coenonympha rhodopensis*. However, it is not sufficiently high for the presence of the genus *Erebia*, which is one of the main high mountain elements of the Dinaric Mountains (Mladinov & Lorković, 1985). In comparison with other mountains, Snježnica has the highest number of Mediterranean species, six in total, surpassing even Mount Biokovo, which rises practically from the sea level. This indicates the uniqueness of Snježnica in the context of Croatian mountains and the need for further research and evaluation. In a recent study on orthoptera, significant diversity was highlighted on this mountain, with two new additions to the fauna of Croatia being recorded (Rebrina & Tvrtković, 2019).

During this research, several rare or significant species have been recorded, whose presence in the surveyed area requires further detailed discussion. Some species like *Kirinia roxelana* (Koren et al. 2019b)*, Danaus chrysippus* (Koren et al. 2019a)*, Aricia anteros* (Koren, 2012) and *Lycaena ottomanus* (Koren et al. 2012; Mihoci et al. 2005) have already been dealt with in other publications and will not be mentioned here.

PAPILIONIDAE

Papilio alexanor Esper, 1800 (Figure 4a)

The narrative surrounding this iconic species in Croatia has been recently comprehensively elucidated (Verovnik & Švara, 2016). However, it is remarkable how swiftly, following the initial recent discoveries, the species has been reencountered in both historical (Koren et al. 2019, 2020) and novel locations (Kačírek, 2017; Russell & Pateman, 2018). Within the surveyed region, this species exhibits a relatively broad distribution, albeit localised, intricately tied to the presence of its host plant, *Opopanax chironium* (L.) W. D. J. Koch. Even if a single plant is present there is a probability that eggs and/or caterpillars will be observed on it. On some locations, the species is not recorded each year which indicates that the species probably does not form permanent populations on each small habitat patch, but rather utilizes larger areas. While adults are always a sight to see, the presence of this species in an area is most easily established by the search for caterpillars. In Konavle, many localities where this species was recorded are not easily accessible, but others are located very near roads or hiking paths. This can potentially make them vulnerable for any habitat destruction or degradation. In addition, this may present an opportunity for illegal poaching that can be prevented either by the awareness raising of local communities or regular patrols by the rangers of the Public Institution for the Management of Protected Natural Areas of Dubrovnik-Neretva County.

Parnassius mnemosyne (Linnaeus, 1758)

This species is relatively common in the mountainous regions of central and northern Croatia, while in the southern Dalmatia region, it has only been recorded in the Biokovo area so far (Mihoci et al. 2011). During this study, it was observed only once on the rocky part of Mount Snježnica, and the collected specimen was deposited in the Lepidoptera collection of Dubrovnik Natural History Museum. Despite numerous subsequent visits to the area, the species has never been recorded again. This raises the possibility that the observed individual may have flown in from surrounding border areas of Bosnia and Herzegovina or indicates its rarity in the surveyed area. Since this species is listed in Appendix IV of the Habitats Directive, Croatia is obligated to monitor the status of its populations, and targeted efforts may be needed in the future to determine whether *Parnassius mnemosyne* has a permanent population in the Konavle area or not.

PIERIDAE

Leptidea sinapis / juvernica complex

The genus *Leptidea* Billberg, 1820 is widely distributed across Croatia, with *L. sinapis* (Linnaeus, 1758) being present across the whole country while the presence of *L. juvernica* Williams, 1946 is mostly confined to central northern Croatia (Lorković, 1993) with some records also from the Mediterranean parts of the country (Kučinić et al. 2017). Accordingly, the distribution in some parts of the country remains rather unexplored. This is mostly due to the need to collect specimens and the examination of their genitalia to provide a correct species ID. Within this study, several dozen specimens were collected across the study area. Special attention was given to the borderland areas like northern montane parts or the more moist meadows in the Konavle field which would better suit the known ecological needs of this species (Lorković, 1993). All the examined specimens belonged to *L. sinapis*, which follows the general species' distribution in the Balkan peninsula (Shtinkov et al. 2016).

HESPERIIDAE

Gegenes pumilio and *Gegenes nostrodamus* (Figure 4b)

The story of these two extremely similar species of the genus *Gegenes* Hübner, [1819] in Croatia is still not fully clarified. Until the 1970s, it was believed that only the species *Gegenes nostrodamus* (Fabricius, 1793) lives across the Adriatic coast of Croatia (de la Nicholl, 1899; Mladinov, 1962; Steiner, 1938; Werner, 1895; Zerny, 1920). It was only through Lorković's analysis of available specimens that it was determined that the majority belong to the species *Gegenes pumilio* (Hoffmannsegg, 1804), with only an individual from Marjan, Split originating from Croatia, belonging to the species *G. nostrodamus* (Lorković, 1971). Accordingly, all previous findings of this genus before this publication should be taken with caution because it is not certain to which species they belong. In addition, Lorković also presented a good distinguishing feature for the males of both species, the fringes, or hairs on the front edge of the basal part of the hindwings that are sparse fine, and short in *G. pumilio* while dense long, and broad in *G. nostrodamus* (Lorković, 1971). While this is visible in the fresh specimen, we believe that the examination of male (Filipčić, 1998) or female genitalia (Cotutsis, 2012) is needed to confirm the species' identity without any doubt. All the collected specimens in the study area were analysed which revealed the current distribution. *Gegenes pumilio* is a widespread, but rarely very common species in the study area. The species flies from April until November in two to three consecutive generations with the second one being significantly more numerous. It can most easily be observed at the end of summer and at the beginning of autumn feeding on *Dittrichia viscosa* (L.) Greuter, a common Mediterranean ruderal plant that has its flowering peak during that period. It also seems that the population size to some extent varies between years. In early January, larvae were present on *Hyparrhenia hirta* (L.) Stapf growing along the roadside in close vicinity of Molunat. This record represents the first evidence of a host plant used by the species in Croatia. *H. hirta* is also reported from Greece as a hostplant of *G. pumilio*, together with two other Poaceae species, *Phragmites australis* (Cav.) Steud. and *Imperata cylindrica* (L.) Raeusch (Lafranchis, 2019). As both additional grass species occur in Croatia, it is likely that future research will reveal the presence of early developmental stages of *G. pumilio* on them as well.

On the other hand, *G. nostrodamus* is a very rare species and is for now limited to a single locality within the Konavosko polje. At the single locality, only *G. nostrodamus*, both males and females were observed and collected indicating the present population. This is indeed the first confirmed record of this species in Croatia in more than 50 years. While the aim of this work is only southern Croatia, a note must be given to the rarity and potential endangerment of this species. From all other collected specimens across coastal Croatia, only another locality with *G. nostrodamus* was discovered, at Vransko Lake near Zadar. This shows that indeed this species is very scarce in Croatia, and it may even be endangered due to the small size of its area. While neither species is included in the current Red List of Rhopalocera of Croatia (Šašić et al. 2015), the status of both species should be assessed in the future and according to results *G. nostrodamus* should be placed under legal protection to protect the species, and its habitats. In the Climate risk atlas of European Rhopalocera *G. pumilio* is listed in the category HR (high climate change risk) meaning that climate change poses a high risk to the species because more than 70% of the grids with currently suitable climate may no longer be suitable in 2080 while *G. nostrodamus* is listed in HHHR (extremely high climate change risk) meaning that the climate change poses a very high risk to the species because more than 95% of the grids with currently suitable climate may no longer be suitable in 2080 (Settele et al. 2008).

LYCAENIDAE

Lycaena tityrus (Poda, 1761)

Alongside *Lycaena phlaeas* (Linnaeus, 1761), this is the most common species of this genus in Croatia (Lorković, 2009). However, it was thought that it is completely absent from the entire region of Dalmatia (Jakšić, 1988). For several decades, populations of this species have been known to exist in neighbouring Bosnia and Herzegovina, particularly in the southern Herzegovina area (Jakšić, 1988). Yet, previous research has never documented its presence in southern Dalmatia. This study has discovered a small population of this species in the Dubravka, Prapratni dol. During the field trip to locality 12, three females and two males of this species were found. Aside from this record, one male specimen of this species was also observed in the Imotsko polje on 1-V-2021 (obs. D. Dender) indicating that it may be present at some other habitually and climatically similar places in parts of Dalmatia bordering Bosnia and Herzegovina.

Plebejus idas (Linnaeus, 1761)

The distribution of two rather similar species *Plebejus idas* (Linnaeus, 1761) and *Plebejus argyrognomon* (Bergsträsser, 1779) across Croatia is still not very well known and almost no large-scale distribution analysis exists (Lorković, 2009). In Dalmatia, both species occur, for example in areas of more montane climate like Mt. Svilaja (Verovnik et al. 2023), while toward the south, e.g. on Mt. Biokovo, only *P. idas* is known (Kačírek, 2017). Within this study, we managed to collect only *P. idas* across the study areas, including the montane parts of Mt. Sniježnica where the species is not rare. In general, a large-scale integrative taxonomy analysis is needed for this genus in the region to assess the status of the present taxa in the region.

Polyommatus admetus (Esper, [1783]) (Figure 4c)

This is a rather local, but sometimes common species in Croatia, mostly distributed from the border parts of Mt. Velebit (Tvrtković et al. 2015), across southern parts of Lika and some parts of Dalmatia (Koren, 2010; Verovnik et al. 2023). So far, the southernmost record of this species in Croatia was from Mt. Mosor (Koren et al. 2020). During this survey we recorded this species mostly at the higher parts of Mt. Snježnica, expanding its distribution in Croatia significantly toward the south. On the south-facing slopes, this species was recorded from the elevations above 680 m asl and above 450 m a.s.l. on the north-facing slopes.

NYMPHALIDAE

Apatura metis Freyer, 1829 (Figure 4d)

The initial discovery of this species in the researched area was very surprising and unexpected. Generally, neither *A. metis* Freyer, 1829 nor its similar and related species *A. ilia* ([Denis & Schiffermïller], 1775) are found in the southern Dalmatia region. *Apatura metis* is predominantly associated with eastern Slavonia and Baranja in Croatia (Lorković & Siladjev, 1982), while *A. ilia* has a broader distribution and is present also in the Mediterranean parts of Istria and very locally in Dalmatia, Sinjsko polje (Sijarić, 1971). However, if we look at the distribution of *A. metis* in Europe, we observe that this predominantly Pannonian species also has isolated populations in the Balkans, including Montenegro and Albania (Micevski et al. 2015). Therefore, the nearest population to the one in Konavle is located at Lake Skadar in Montenegro (Švara et al. 2015) and Albania, which is only 70 km away from Konavle. There is also an record of this species in the border areas of Bosnia and Herzegovina, from Hutovo blato (https://www.inaturalist.org/observations/28994619) but the validity of the identification should be further investigated as the identification based only on photography can be very misleading with this species. During our research it was regularly observed along the river Ljuta in Konavosko polje. Since this is the only record of this species in the Mediterranean region of Croatia, and the species itself is listed in Annex IV of the Habitats Directive, its location should be included in the species monitoring program in Croatia. The main threat to the survival of this species in the area would be the potential destruction of the willow belt in the vicinity of Ljuta river that could occur with the intensification of agricultural production in the Konavosko polje.

Melitaea ornata Christoph, 1893

This is a sister species to the more common and widespread *Melitaea phoebe* ([Denis & Schiffermüller], 1775) whose distribution in Croatia was established relatively recently (Koren & Štih, 2013). Its known distribution stretches from Istria in the north, inland Medvednica Mountain near the capital city Zagreb, and several locations along the Adriatic coast including northern Dalmatia (Verovnik et al. 2015), Mt. Mosor (Koren et al. 2020) and Mt. Svilaja (Verovnik et al. 2023). In the southernmost part of Dalmatia, both species are present with *M. ornata* being more common than *M. phoebe*. Seemingly in the area they also differ in the used habitat; *M. ornata* is mostly present in higher rocky areas while *M. phoebe* inhabits more humid habitats where deeper soil is present, mostly in the Konavosko polje.

Coenonympha rhodopensis Elwes, 1900

In the ecological sense, of particular significance are the findings of the high mountain species *Coenonympha rhodopensis*, which is locally represented by the subspecies *occupata* Rebel, 1903. This is the only high-mountain species that we recorded in the study area and only at the upper parts of Mt. Snježnica. The discovery of this species was surprising, as the habitat is rather different from the one in other areas of Lika and Dalmatia where this species usually occurs (Kačírek, 2017; Mihoci et al. 2007; Verovnik et al. 2023). In Croatia the closest populations are in the upper zone of Mt. Biokovo where the species inhabits montane grasslands in the littoral beech forests zone (*Fagetum croaticum seslerietosum* Ht.). However, in the neighbouring area Trebinje-Orjen the species also occurs, and in similar habitats to the ones on Mt. Snježnica. Both on Mt. Snježnica and Trebinje-Orjen it occurs at approximately 1000 metres above sea level in the *Querco-Ostryetum carpinifoliae* association, in a very thermophilic habitat of thinned stands with the characteristics of a rocky area (Sijarić, 1983).

Aside from the observed species, some of the species that were expected to be recorded are missing from the region.

The distribution of *Tarucus balkanica* (Freyer, 1843) in Croatia has recently undergone revision (Koren et al. 2022), and notably, the species is absent from southern Dalmatia, including the Konavle area. This absence is quite surprising, given that the habitats, primarily open areas with its host plant *Paliurus spina-christi* Mill., are common in the region. Despite targeted searches and thorough surveys of numerous habitats, the species has never been observed here. Currently, we cannot speculate on the possible reasons for this.

Pyronia cecilia (Vallantin, 1894) is known in Croatia from Istria in the west (Koren et al. 2018) extending along the Adriatic coast of Dalmatia (Jakšić, 1988). However, its presence is notably lacking in southern Dalmatia. The single southernmost recorded instance in the area of Dubrovnik (Habeler, 1976; Seyer, 1938), situated north of Konavle. However, even there, it has never been confirmed with recent studies (authors, unpublished obs.).

The karstic areas of Mt. Snježnica at first glance look like a good habitat for many rocks loving species like *Arethusana arethusa* ([Denis & Schiffermüller], 1775), *Chazara briseis* (Linnaeus, 1764) or the genus *Hyponephele*, but alas, even after many targeted visits and surveys, those species were never recorded in the area. The reason for it is again unknown, especially due to the openness of the area suitable for many species that occur in the same habitats as the mentioned species, but just in middle Dalmatia like on Mt. Mosor (Koren et al. 2020). While the habitat at the first glance seems suitable for them, the lack of those species could be attributed to some still unexplained microclimatic factors so further studies are required. At least some of the mentioned species, *Chazara briseis* and *Hyponephele lupinus,* are also present in the neighbouring areas of Trebević-Orjen (Sijarić, 1983) indicating that at least some of wider area of this region are suitable for them.

Notes on the observed extended flight periods of selected species

In this chapter we give some interesting winter observations on the flight period of several species. Due to the influence of the Mediterranean climate and mild winters, Rhopalocera become a common sight in the lower parts of this area as early as February, and this situation continues until November, at the end of which most species cease to be recorded. However, it is possible to see some species even during the most unfavourable period of the year (December-January), which, in addition to low temperatures, also means the shortest period of daylight and frequent rainfall. In the case of most species, such observations are local and few, and refer to south-oriented - thermophilic, lower positions where, because of anthropogenic influences (road edges, agricultural production, late mowing, etc.), flowering plant species are present. Few and irregular observations of species that overwinter in the imago stage are not surprising: *Gonepteryx rhamni* (Linnaeus, 1775), *Libythea celtis* (Laicharting, 1782), *Polygonia egea* (Cramer, 1775) and *Issoria lathonia* (Linnaeus, 1758). However, the observations of species that are unable to rest longer in the imago stage are interesting (Tolman & Lewington, 2008). The species *Colias croceus* (Geoffroy, 1785 in Fourcroy) was regularly observed in the mentioned habitats during December and January. On the 24th site, 16-I and 30-I-2022. recorded caterpillars in different stages of development, on *Colutea arborescens* L. bushes. Along with it, the following species were irregularly recorded in smaller numbers: *Pieris brassicae* (Linnaeus, 1758) (18-XII-2022 - locality 24; 25-XII-2022 - locality 19; 24-XII-2023 - locality 24), *Pieris rapae* (Linnaeus, 1758) (2-XII-2018 - locality 24; 10-XII-2018 - locality 24 - 3 individuals; 30-I-2022 - locality 24 - 3 individuals), *Pieris manni* (Mayer, 1851) (23-XII-2018, 18-XII-2023 and 25-XII-2023 - locality 24; 14-I-2022 - locality 17), *Pieris ergane* (Geyer, [1828] in Hübner) (30-I-2022 - locality 24), *Lassiomata megera* (Linnaeus, 1767) (30-I-2022 - locality 24; 23-XII-2023 - locality 19, 24-XII-2023 - locality 24) and *Lycaena phlaeas* (16-I-2022 - locality 24). All these observations indicate that in part of the area, at least during normal winters, the summer period of the mentioned species could be uninterrupted, or almost uninterrupted. Such observations partly differ from the data available so far on the flight time of some species (Lorković, 2009). In the mentioned localities, it is still possible to see the last specimens, the last annual generations of *Polyommatus icarus* (Rottemburg, 1775) (2-XII-2018 - locality 24), *Leptotes pirithous* (Linnaeus, 1767) (2-XII-2018 and 10-XII-2018 - locality 24), *Lampides boeticus* (Linnaeus, 1767) 18-XII-2022 and 25-XII-2022 - locality 24), *Colias alfacariensis* Ribbe, 1905 (23-XII-2018 - locality 24) and *Vanessa cardui* (Linnaeus, 1758). In the case of *Vanessa cardui*, the last sightings also come from the second half of December, but it is not clear whether they are maintained in the area throughout the whole year or whether migratory individuals from the south appear already in February. The situation is special with the species *Vanessa atalanta* (Linnaeus, 1758), which is primarily a relatively common sight in the settlements and their surroundings in the Konavle area during autumn and winter.

Threats to the Rhopalocera in the study area

Given that threats and pressures are most often not tied to individual species but rather to the impact on their habitat, which includes host plants, in this chapter, we will provide a collective overview of potential reasons for the endangerment of Rhopalocera in the Konavle area. Regarding the threats and pressures the entire area can be divided into two main parts: the area of Konavosko polje and the surrounding, mostly karstic area. The abandonment of agriculture generally leads to the advancement of woody vegetation, thereby causing habitat closure due to the disappearance of grassland habitats. This process is present throughout the entire limestone area, from the seacoast to the higher parts of Mt. Sniježnica and is particularly relevant to rocky areas where there is no longer grazing, and fires, when they occur, are most often quickly extinguished due to increasingly efficient fire protection. In the area of Snježnica, there is a visible trend of declining population density, manifested in the neglect of "do(l)ci" - karstic areas with deeper soil with meadows and agricultural land and the subsequent overgrowth and closure of habitats. Another potential but not easily solvable problem is climate change, which can primarily have a negative impact on mountainous and colder habitat species that could disappear from this area with further warming. These include species such as *Coenonympha rhodopensis* Elwes, 1900, *Aricia anteros* (Freyer, 1838) and *Carcharodus lavatherae* (Esper, 1783). However, with further warming, it is likely that Mediterranean species will become even more present and expand in this area.

Figure 4. Some of the most iconic species recorded during this survey. **a)** *Papilio alexanor* feeding on *Carduus pycnocephalus* L. **b)** *Gegenes nostradamus* feeding in a village garden. **c)** *Polyommatus admetus* from the higher part of Mt. Snježnica. **d)** *Apatura metis* near Ljuta River.

In the Konavosko polje, the announced land consolidation poses a potential problem that will last for several years, with the aim of turning the Konavosko polje into a place of serious agricultural production as soon as possible. This could potentially endanger many species, especially *Lycaena ottomanus* (Lefèbvre, 1830), since Konavle region represents the only area where this species is present in Croatia and Konavosko polje represents the part of the region with the largest area of favourable habitats. The destruction of smaller parts of the habitat, such as some locations where the species was abundant a decade ago, has already been observed. However, progress cannot be fought against, but it can be directed. We hope that this work will at least slightly help in this regard and draw the attention of is important for the Public Institution for the Protection of Nature and Environment in the Dubrovnik and Neretva County and assist them in the better management of this Natura 2000 area.

Conclusions

Thanks to this research, the Konavle area has transitioned from being one of the least explored regions in Croatia to one of the best-explored areas, with 106 recorded species of Rhopalocera. Comparison with neighbouring regions, Trebinje - Orjen, revealed that approximately 120 species of Rhopalocera inhabit the entire area, yet the surrounding areas remain inadequately explored in comparison to the Konavle region. In Konavle, most sites with high conservation value, as well as most recorded species, fall within the boundaries of the Natura 2000 ecological network, thereby increasing the long-term prospects for Rhopalocera protection and survival in the area. In the northern part of the region, on Mount Sniježnica, a unique composition of Rhopalocera has been documented, differing from other better-explored mountains in Dalmatia, primarily due to the presence of a greater number of Mediterranean species. Furthermore, numerous previously unknown populations of species listed in Annex II of the Habitat Directive, such as *Euphydryas aurinia* (Rottemburg, 1775), have been recorded in the surveyed area, along with four additional species listed in Annex II of the Habitat Directive.

Acknowledgments

The funding for this research was partially provided by the Dubrovnik Natural History Museum during the collection of material for the museums' fundus, for which we sincerely thank them. Gratitude also goes to many friends and colleagues who have researched this area with us over the years: Ana Štih Koren, Mladen Zadravec, Barbara Horvatić, Boris Lauš, Ivona Burić, etc.

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.

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(Recibido para publicación / *Received for publication* 28-V-2024)
(Revisado y aceptado / *Revised and accepted* 30-VII-2024)
(Publicado / *Published* 30-IX-2025)

Table 1. List of species observed from Konavle with the locality numbers corresponding to the list of localities in Materials and methods section.

List of species	**Locality number**
Gegenes nostrodamus (Fabricius, 1793)	25
Gegenes pumilio (Hoffmannsegg, 1804)	1, 21, 25, 31, 36, 37, 38, 39, 40, 41
Carcharodus alceae (Esper, [1780])	1, 2, 3, 4, 11, 12, 13, 14, 16, 19, 25, 28, 30, 31, 32, 38, 39, 41
Muschampia lavatherae (Esper, [1783])	4, 6, 8, 9, 10, 15
Muschampia orientalis Reverdin, 1913	1, 4, 5, 6, 8, 10, 11, 12, 13, 15, 16, 25, 41
Erynnis tages (Linnaeus, 1758)	1, 4, 5, 6, 8, 10, 13, 15, 29, 30, 31
Pyrgus armoricanus (Oberthür, 1910)	1, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 15, 16, 25, 26, 30, 31, 39, 40
Pyrgus malvae (Linnaeus, 1758)	1, 4, 5, 8, 9, 10, 15, 28, 31, 36
Pyrgus sidae (Esper, 1784)	3, 4, 5, 6, 8, 9, 10, 15, 21, 27, 28
Spialia orbifer (Hübner, [1823])	2, 6, 8, 9, 10, 11, 13, 15, 16, 18, 26, 33
Thymelicus acteon (Rottemburg, 1775)	1, 3, 4, 5, 6, 8, 10, 11, 12, 14, 15, 17, 18, 21, 24, 25, 26, 27, 28, 30, 31, 32, 33, 36, 39
Thymelicus lineola (Ochsenheimer, 1808)	6, 8, 10, 15
Thymelicus sylvestris (Poda, 1761)	1, 2, 3, 4, 6, 8, 10, 12, 13, 15, 21, 22, 28, 30, 31, 32, 39, 40, 41
Ochlodes sylvanus (Esper, 1777)	4, 6, 8, 10, 12, 13, 15, 23, 31
Parnassius mnemosyne (Linnaeus, 1758)	5
Iphiclides podalirius (Linnaeus, 1758)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 21, 23, 25, 26, 27, 28, 29, 30, 31, 32, 33, 35, 36, 39, 40, 41
Papilio alexanor Esper, 1800	4, 5, 9, 10, 11, 13, 14, 17, 21, 24, 32
Papilio machaon Linnaeus, 1758	1, 3, 4, 5, 8, 9, 11, 13, 15, 18, 21, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 36, 38, 39, 40
Zerynthia polyxena ([Denis & Schiffermüller], 1775)	3, 4, 8, 9, 10, 15, 30, 31, 39
Leptidea sinapis (Linnaeus, 1758)	1, 2, 3, 4, 6, 8, 10, 12, 13, 15, 16, 19, 21, 22, 23, 24, 25, 26, 28, 29, 30, 31, 32, 33, 36, 39
Anthocharis cardamines (Linnaeus, 1758)	1, 2, 8, 9, 10, 12, 13, 15, 22, 23, 26, 28, 30, 31, 34
Aporia crataegi (Linnaeus, 1758)	2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 15, 19, 21, 22, 25, 26, 28, 30, 31, 33, 39, 40
Pieris balcana Lorkovic, 1970	3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 15, 21, 23, 25, 27, 29, 31, 41
Pieris brassicae (Linnaeus, 1758)	1, 2, 4, 5, 6, 8, 10, 11, 12, 13, 14, 15, 17, 19, 21, 23, 25, 26, 27, 28, 30, 31, 33, 36, 38, 39, 40, 41
Pieris ergane (Geyer, [1828])	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 18, 19, 21, 23, 25, 26, 27, 31, 32, 36, 37, 39, 40, 41
Pieris mannii (Mayer, 1851)	2, 4, 6, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 21, 22, 25, 26, 27, 28, 31, 32, 39, 40, 41

Pieris rapae (Linnaeus, 1758)	1, 2, 3, 4, 8, 10, 11, 12, 13, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 27, 30, 31, 32, 36, 39, 40, 41
Euchloe ausonia (Hübner, 1804)	23, 38, 39, 41
Pontia edusa (Fabricius, [1777])	1, 2, 3, 4, 13, 15, 18, 21, 26, 27, 28, 29, 30, 31, 32, 39
Colias alfacariensis Ribbe, 1905	4, 14, 30
Colias croceus (Geoffroy in Fourcroy, 1785)	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41
Gonepteryx cleopatra (Linnaeus, 1767)	1, 2, 6, 7, 25, 39
Gonepteryx rhamni (Linnaeus, 1758)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 36, 38, 39, 40, 41
Lycaena ottomanus (Lefèbvre, 1831)	3, 4, 5, 6, 8, 10, 11, 12, 13, 16, 21, 25, 30, 31, 39, 41
Lycaena phlaeas (Linnaeus, 1761)	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 21, 25, 26, 27, 29, 30, 31, 38, 39, 40, 41
Lycaena tityrus (Poda, 1761)	12
Callophrys rubi (Linnaeus, 1758)	4, 5, 8, 10, 12, 15, 26, 27, 28, 30, 31, 36, 38, 39
Favonius quercus (Linnaeus, 1758)	3, 4, 7, 8, 13, 25, 39
Satyrium acaciae (Fabricius, 1787)	4, 6, 8, 13, 31, 39
Satyrium ilicis (Esper, 1779)	1, 2, 3, 4, 6, 7, 8, 10, 12, 13, 14, 15, 18, 21, 23, 25, 27, 32, 33, 39, 40, 41
Satyrium spini ([Denis & Schiffermüller], 1775)	1, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 18, 21, 25, 32, 33, 39, 40, 41
Lampides boeticus (Linnaeus, 1767)	1, 4, 5, 12, 13, 16, 25, 31, 32, 39, 41
Leptotes pirithous (Linnaeus, 1767)	1, 3, 11, 13, 14, 16, 17, 23, 25, 26, 28, 29, 30, 31, 36, 37, 38, 39, 40, 41
Cacyreus marshalli Butler, 1898	1, 27, 28
Cupido argiades (Pallas, 1771)	25, 29, 30, 31
Cupido minimus (Fuessly, 1775)	1, 4, 5, 6, 7, 8, 9, 10, 11, 13, 15, 21, 27, 28, 31, 33
Cupido osiris (Meigen, 1829)	1, 8, 15, 33
Celastrina argiolus (Linnaeus, 1758)	3, 4, 5, 6, 8, 10, 11, 12, 13, 14, 15, 17, 23, 25, 26, 27, 29, 30, 31, 32, 33, 38, 39, 41
Pseudophilotes vicrama (Moore, 1865)	1, 4, 6, 7, 8, 10, 11, 13, 15, 21, 31, 40
Scolitantides orion (Pallas, 1771)	1, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 15, 21, 23, 27, 31, 39, 40, 41
Glaucopsyche alexis (Poda, 1761)	1, 2, 4, 5, 8, 10, 15, 21, 24, 25, 27, 28, 30, 31, 39, 40
Iolana iolas (Ochsenheimer, 1816)	3, 8, 10, 13, 15, 21, 22, 23, 30, 31, 32, 33, 36
Plebejus argus (Linnaeus, 1758)	1, 4, 6, 8
Plebejus idas (Linnaeus, 1761)	2, 3, 4, 5, 6, 7, 8, 10, 15
Aricia agestis ([Denis & Schiffermüller], 1775)	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 21, 23, 25, 26, 27, 28, 29, 30, 31, 32, 33, 39, 40, 41
Aricia anteros (Freyer, [1838])	4, 6, 8, 9, 10
Cyaniris semiargus (Rottemburg, 1775)	4, 5, 6, 7, 8, 10, 15

Lysandra bellargus (Rottemburg, 1775)	1, 2, 3, 4, 6, 8, 11, 12, 15, 16, 18, 25, 26, 28, 31, 32, 33, 39, 40
Lysandra coridon (Poda, 1761)	4, 6, 8, 12, 13
Polyommatus admetus (Esper, [1783])	4, 6, 8, 10
Polyommatus daphnis ([Denis & Schiffermüller], 1775)	4, 6, 8, 13
Polyommatus dorylas ([Denis & Schiffermüller], 1775)	4, 5, 6, 7, 8, 12, 13, 15
Polyommatus escheri (Hübner, [1823])	2, 7, 18, 31
Polyommatus icarus (Rottemburg, 1775)	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 21, 23, 25, 26, 27, 28, 29, 30, 31, 32, 33, 36, 38, 39, 40, 41
Polyommatus thersites (Cantener, 1835)	2, 3, 4, 6, 7, 8, 10, 11, 13, 21
Libythea celtis (Laicharting, 1782)	1, 3, 4, 6, 8, 9, 10, 11, 13, 14, 15, 19, 21, 22, 23, 24, 25, 27, 29, 30, 31, 33, 36
Charaxes jasius (Linnaeus, 1767)	1, 2, 11, 23, 31, 36, 39, 40, 41
Danaus chrysippus (Linnaeus, 1758)	14, 41
Apatura metis Freyer, 1829	25, 30, 31
Argynnis pandora ([Denis & Schiffermüller], 1775)	11, 21, 25
Argynnis paphia (Linnaeus, 1758)	3, 4, 6, 8, 12, 13, 16, 25
Fabriciana adippe ([Denis & Schiffermüller], 1775)	5, 6, 12, 13
Fabriciana niobe (Linnaeus, 1758)	2, 4, 5, 6, 7, 8, 10, 12, 13, 14, 15
Issoria lathonia (Linnaeus, 1758)	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 13, 14, 17, 18, 21, 25, 26, 28, 31, 39, 40
Vanessa atalanta (Linnaeus, 1758)	1, 2, 3, 4, 5, 7, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 35, 36, 37, 38, 39, 40, 41
Vanessa cardui (Linnaeus, 1758)	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 34, 36, 37, 39, 40, 41
Brenthis daphne (Bergsträsser, 1780)	4, 13
Brenthis hecate ([Denis & Schiffermüller], 1775)	4, 5, 6, 7, 8, 10, 13, 15
Aglais io (Linnaeus, 1758)	4, 13, 15, 25, 27, 30, 31, 39
Aglais urticae (Linnaeus, 1758)	5
Nymphalis antiopa (Linnaeus, 1758)	3, 4, 7, 8, 13, 15, 20, 23, 25, 27, 29, 30, 31, 32, 39
Nymphalis polychloros (Linnaeus, 1758)	3, 4, 6, 8, 10, 11, 13, 15, 17, 21, 23, 25, 26, 27, 30, 31, 39
Polygonia c-album (Linnaeus, 1758)	13, 15, 25, 30, 31
Polygonia egea (Cramer, 1775)	1, 4, 10, 11, 13, 19, 21, 22, 23, 25, 26, 31, 36, 39
Melitaea cinxia (Linnaeus, 1758)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, 19, 21, 26, 27, 28, 29, 30, 31, 39, 40, 41
Melitaea didyma (Esper, 1778)	1, 2, 3, 4, 5, 7, 8, 12, 13, 15, 18, 21, 25, 27, 28, 30, 31, 39, 40
Melitaea ornata Christoph, 1893	1, 2, 3, 6, 7, 8, 9, 30
Melitaea phoebe ([Denis & Schiffermüller], 1775)	12, 13, 15, 27, 30, 31

Euphydryas aurinia (Rottemburg, 1775)	1, 6, 7, 8, 9, 10, 12, 13, 21
Limenitis reducta Staudinger, 1901	1, 3, 4, 5, 6, 8, 10, 11, 12, 13, 15, 18, 21, 23, 25, 26, 27, 28, 29, 31, 33, 34, 36, 39, 40, 41
Lasiommata maera (Linnaeus, 1758)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 21, 26, 39
Lasiommata megera (Linnaeus, 1767)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 32, 33, 36, 37, 38, 39, 40, 41
Pararge aegeria (Linnaeus, 1758)	1, 3, 4, 6, 8, 9, 13, 15, 16, 17, 18, 23, 25, 26, 27, 28, 30, 31, 36, 38, 41
Coenonympha arcania (Linnaeus, 1761)	1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 18, 28
Coenonympha pamphilus (Linnaeus, 1758)	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 15, 16, 18, 21, 25, 26, 27, 28, 29, 30, 31, 32, 33, 39, 40
Coenonympha rhodopensis Elwes, 1900	5, 7
Kirinia roxelana (Cramer, [1777])	4, 6, 15
Pyronia tithonus (Linnaeus, 1767)	4, 12, 13, 16, 31, 32
Maniola jurtina (Linnaeus, 1758)	1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 14, 15, 16, 18, 19, 21, 22, 23, 25, 27, 28, 29, 30, 31, 32, 33, 39, 40, 41
Melanargia galathea (Linnaeus, 1758)	4, 5, 6, 7, 8, 10, 12, 13, 14, 15, 30, 31
Melanargia larissa (Geyer, [1828])	1, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 21, 29, 31
Satyrus ferula (Fabricius, 1793)	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 13, 14, 15, 18, 19, 21, 22, 24, 25, 26, 27, 31, 32, 33, 36, 39, 40, 41
Hipparchia semele (Linnaeus, 1758)	1, 2, 3, 4, 5, 6, 8, 19, 21, 25, 27, 28, 29, 30, 36, 39, 41
Hipparchia statilinus (Hufnagel, 1766)	1, 2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 15, 21, 26, 39
Hipparchia syriaca (Staudinger, 1871)	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 15, 19, 21, 22, 23, 25, 27, 29, 36, 37, 39, 41
Brintesia circe (Fabricius, 1775)	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 15, 18, 19, 21, 22, 23, 25, 28, 31, 33, 39, 40

SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 461-467 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1075 https://shilap.org
https://zoobank.org/CCE7E51E-0B3F-4669-96AC-2FAF72253277

Nueva contribución a la familia Geometridae de Filipinas e Indonesia, se describen un nuevo género y cuatro nuevas especies (Lepidoptera: Geometridae, Ennominae, Larentiinae)

Andrés Expósito-Hermosa

Resumen

Se describen un género y cuatro especies nuevas: *Tautela* Expósito, gen. nov., *Tautela stueningi* Expósito, sp. nov., *Polyclysta schmidtae* Expósito, sp. nov. y *Eurychoria parallelae* Expósito, sp. nov. de Indonesia, así como, *Peratostega uniformis* Expósito, sp. nov. de Filipinas. Se incluyen imágenes de los adultos, así como de la genitalia de las especies nuevas.

Palabras clave: Lepidoptera, Geometridae, Ennominae, Larentiinae, nuevo género, nuevas especies, Filipinas, Indonesia.

New contribution to the Geometridae family of the Philippines and Indonesia, describing one new genus and four new species (Lepidoptera: Geometridae, Ennominae, Larentiinae)

Abstract

One genus and four new species are described: *Tautela* Expósito, gen. nov., *Tautela stueningi* Expósito, sp. nov., *Polyclysta schmidtae* Expósito, sp. nov. and *Eurychoria parallelae* Expósito, sp. nov. from Indonesia, as well as *Peratostega uniformis* Expósito, sp. nov. from the Philippines. Images of the adults as well as the genitalia of the new species are included.

Keywords: Lepidoptera, Geometridae, Ennominae, Larentiinae, new genus, new species, Philippines, Indonesia.

Abreviaturas utilizadas

AEH	Colección Andrés Expósito Hermosa. Móstoles (Madrid), Eapaña
gen. nov.	genus novum
sp. nov.	species nova

Sistemática

***Tautela* Expósito, gen. nov.** (Figuras 1-2, 9, 12)

Especie tipo *Tautela stueningi* Expósito, sp. nov., por designación actual.
https://zoobank.org/56A4BB46-BC99-4153-945E-341F310DC12E

El macho (Figuras 1-2, 9) con porción de la cabeza en vista ventral: Espiritrompa larga. Palpos labiales ocultos por un denso haz de escamas de tono ocre claro. Las antenas son hasta 3/4 partes de su longitud fuertemente bipectinadas y el restante 1/4 sólo parcialmente, llegando a desaparecer el bipectinado en su parte distal. Frente y vertex ocre claro. Tórax marrón oscuro y patagia, también, ocre claro. En la zona de la fóvea se aprecia un ligero engrosamiento con tono oscuro y aspecto de trazo. Tibias posteriores con un denso pincel de pelos ocre claro, con cuatro espolones: destacando que los dos proximales son más gruesos que los dos distales, casi marginales.

Genitalia ♂ (Figura 12): Uncus simple y delgado con la base triangular, gnathos con aspecto digital. Valvas alargadas, costa dotada de un abultamiento y forma de diente en su zona proximal. En parte distal del sacculus se aprecia un proceso digital (válvula) muy característico. Juxta unida a la vesica del aedeagus. El aedeagus está dotado de dos cornuti: uno de ellos con forma de trazo grueso y con forma de espina delgado.

Etimología: El nombre genérico se le dedica al Dr. Claude Tautel (Muséum National d'Histoire Naturelle, Paris, Francia) y se le denomina *Tautela*.

Comentarios: El género nuevo presenta caracteres similares al género *Cryptomedasina* Sato, 1995 y su morfología externa como en *Yazakia* Warren, 1894.

***Tautela stueningi* Expósito, sp. nov. (Figuras 1-2, 9, 12)**
https://zoobank.org/CCE7E51E-0B3F-4669-96AC-2FAF72253277

Holotipo ♂: Indonesia, Lago Rana en Isla de Buru, a 1.350 m, III-2023, colector local. Genitalia AEH 3492. El holotipo es depositado en la colección del autor AEH en Móstoles, Madrid (España).

El macho (Figuras 1-2, 9) de 25 mm de envergadura. El fondo de las alas anteriores es de un tono marrón oscuro que en su zona proximal se va amortiguando. Con prominente punto discal de color negro. Hacía el borde externo las alas se van aclarando al ir predominando el tono ocre claro. En la zona postdiscal se halla una línea curva que discurre desde la costa hasta el centro del dorsum, con pequeñas ondulaciones y tono claro. Se aprecia, asimismo, paralela a la banda anterior, otra más ancha, de tono amarillento que se extiende hasta el ápice, por su parte superior al ángulo anal por la posterior. Las alas posteriores de un tono parecido a la línea de la zona postdiscal salpicadas de escamas marrones; una estrecha banda paralela al termen y un visible punto discal negro. El reverso es similar, pero de tono bastante más apagado del que destacan los puntos negros de su zona discal.

Genitalia ♂: Como se describe, para el género.

Hembra ♂ desconocida.

Distribución: Isla de Buru en Indonesia.

Etimología: El nombre específico se le dedica al Dr. Dieter Stüning del Leibniz Institute for the Analysis of Biodiversity Change, Zoological Research Museum Alexander Koenig, Adenauerallee Bonn, Alemania se denomina *stueningi*.

***Eurychoria parallelae* Expósito, sp. nov. (Figuras 3-4, 10, 13)**
https://zoobank.org/C4BF6AA2-A6EA-4B5F-865C-FF8C5B00238E

Holotipo ♂: Indonesia, Mybri vil. Arfak Mt. W. Papua, a 1.500 m, III-2015, colector local. Genitalia AEH 3497 (Colector local) El holotipo está depositado en la colección del autor AEH en Móstoles, Madrid (España).

El ♂ (Figuras 3-4, 10): De 35 mm de envergadura. Su morfología externa se asemeja bastante más a *E. flavirupta* Warren, 1903 que a *E. oenoptila* (Prout, 1916); pero la sp. nov. se separara inmediatamnete de amba por la presencia, en sus alas, de dos líneas de color marrón oscuro: las líneas de las anteriores tienen un paralelismo muy marcado, mientras que, las de las posteriores muestran una ligera curvatura hacia la zona del termen. Sin punto discal en las alas posteriores y con un pequeño trazo horizontal en el área basal.

La genitalia del ♂ (Figura 13): uncus terminado en forma de gancho y un visible proceso, cerca de la base, acabado en pico. La juxta, igualmente, está dotada de dos brazos anchos, con forma de punta de lanza y un prominente saliente en la base. Aedeagus con varios cornuti paralelos y otro, con forma de medialuna, cerca de la vesica, es de mayor tamaño.

La hembra ♂ es desconocida.

Distribución: W. de Papua en Indonesia.

Etimología: Se la denomina *parallelae* por las líneas paralelas (lineae parallelae) de sus alas.

Polyclysta schmidtae **Expósito, sp. nov.** (Figuras 5-6, 11, 14-16)

https://zoobank.org/D9C7760A-F9A6-402D-B6A4-BF0315740A3F

Holotipo ♂ (Figuras 5-6): INDONESIA, Lago Rana en Isla de Buru, a 1.350 m, III-2023, colector local. Genitalia AEH. 3490. Paratipos 3 ♂, INDONESIA, Lago Rana en Isla de Buru, a 1.350 m, III-2023, colector local. Genitalias AEH, 3496, 3507 y 3508. El holotipo y los paratipos están depositados en la colección del autor AEH en Móstoles, Madrid (España).

El ♂ (Figuras 5-6, 11): La envergadura de sus alas está comprendida en el intervalo de 29-30 mm, con antenas dentadas, espiritrompa desarrollada y palpos labiales alargados, el segmento distal cubierto de una menor densidad de escamas. Alas anteriores con las bandas más claras, la terminal menos estrecha, La banda mediana se va estrechando hacia el dorsum. Alas posteriores con un tono más apagado, pero bastante uniforme. Las alas posteriores son menos redondeadas que en las otras especies del género. En general, su morfología externa recuerda más a *P. hypogrammata* Guenée, 1858.

Genitalia ♂ (Figuras 14-16): Uncus con forma de bolo, parte superior redondeada y base con prominentes salientes laterales que apuntan hacia arriba. Valvas muy anchas y redondeadas. Al final de sacculus existe un proceso abundantemente piloso. Complejo anellus lóbulos (labides) desarrollado y densamente poblado de largos pelos. De la base del proceso salen profundas estrías alargadas que llegan hasta el final de la valva. Juxta elíptica, abierta por su parte superior, y con dos largos brazos. Saccus doble y muy desarrollado que sirve de origen de la densa, coremata, con abundante pelosidad. Aedeagus doblemente curvado, al menos con dos guarniciones de cornuti visibles: una en su zona central, con un haz con forma alargada y otra, cerca de la vesica, con un cornutus dentado.

La hembra es desconocida.

Distribución: Isla de Buru en Indonesia.

Etimología: El nombre específico se dedica a la Dra. Olga Schmidt (Zoologische Staatssammlung München, Múnich, Alemania) y se denomina *schmidtae.*

Peratostega uniformis **Expósito, sp. nov.** (Figuras 7-8, 17)

https://zoobank.org/98DD3663-A6CF-417D-AF8C-A7662C8AC357

Holotipo ♂: FILIPINAS, Valley Aurora, provincia Aurora, Isla de Luzón, a 2.000 m, 10-XI-2004, colector local. Genitalia AEH 3488. El holotipo, está depositado en la colección del autor AEH en Móstoles, Madrid (España).

Descripción (Figuras 7-8). En general, tanto la morfología externa como interna, se asemeja a *P. coctata* Warren, 1897, pero en el anverso de las alas anteriores no muestra el punto discal. Envergadura alar de 29 mm.

Genitalia ♂ (Figura 17): Preparación AEH 3488, la cápsula se dividió en dos partes al proceder a abrirla. Uncus bilobulado, pero con las dos porciones curvas, otro pequeño lóbulo y profunda hendidura central. Valvas vestigiales, pero con los procesos dorsales muy finos. Aedeagus alargado, con proceso, cerca de la vesica, dotado de abundantes espinas pequeñas.

La hembra es desconocida.

Distribución: Isla de Luzon en Filipinas.

Etimología: Se la denomina como *uniformis* que hace referencia a la constancia de tono de sus alas.

Agradecimientos

Se agradece la colaboración prestada por la Dra. Olga Schmidt (Múnich, Alemania), el Dr. Dieter Stüning (Bonn, Alemania), el Dr. Claude Tautel (Paris, Francia), el Dr. Rob de Vos (Leiden, Países Bajos) y el Dr. Antonio Vives (Madrid, España).

Conflicto de interés

El autor declara que no tiene ningún interés financiero ni relación personal que pudiera influir en el trabajo presentado en este artículo.

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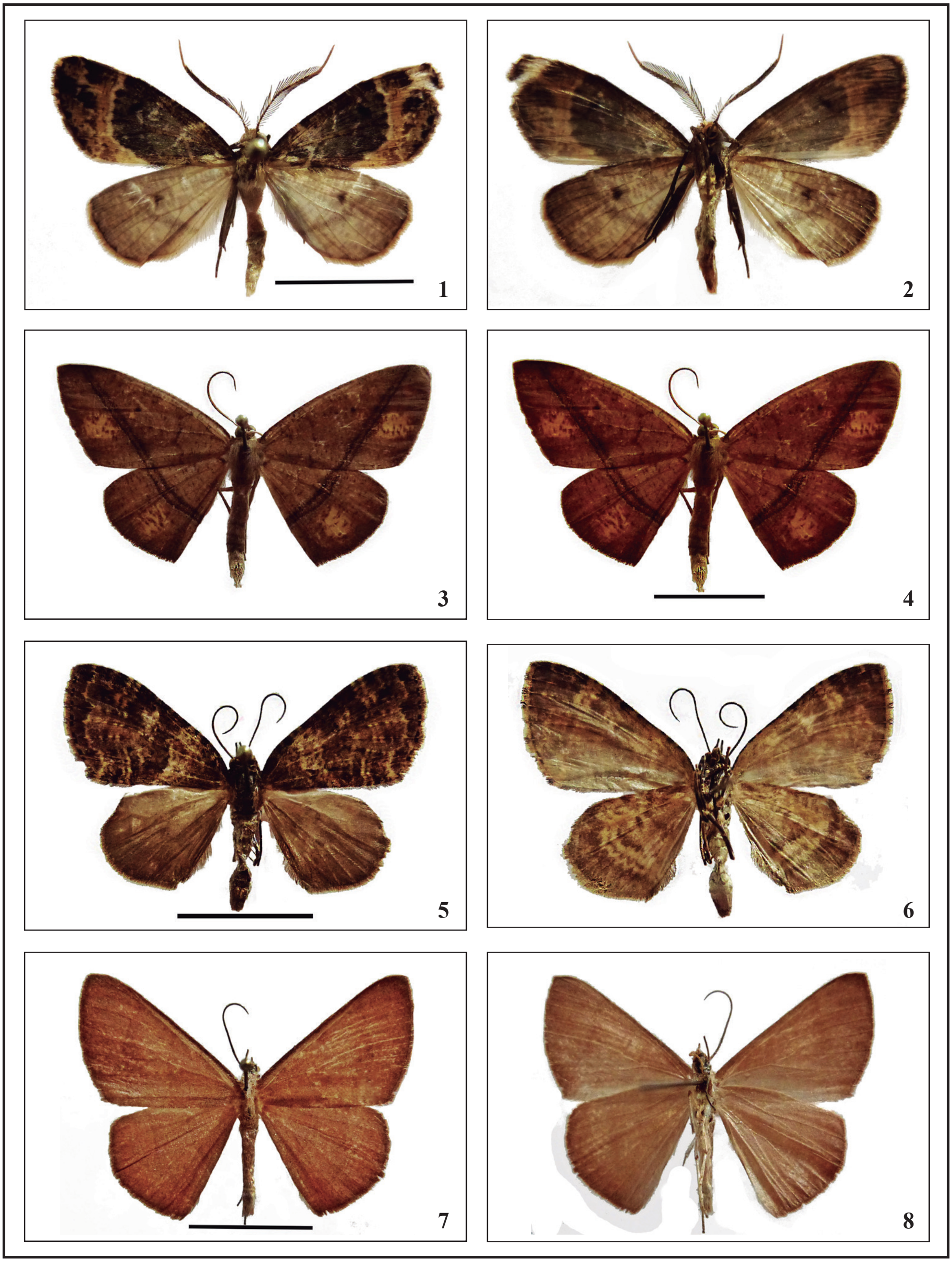
(Recibido para publicación / *Received for publication* 2-VI-2024)
(Revisado y aceptado / *Revised and accepted* 30-VII-2024)
(Publicado / *Published* 30-IX-2025)

Figuras 1-16. 1-2. *Tautela stueningi* Expósito, sp. nov., holotipo ♂. **1.** Anverso. **2.** Reverso. **3-4.** *Eurychoria parallelae* Expósito, sp. nov., holotipo ♂. **3.** Anverso. **4.** Reverso. **5-6.** *Polyclysta schmidtae* Expósito, sp. nov., holotipo ♂. **5.** Anverso. **6.** Reverso. **7-8.** *Peratostega uniformis* Expósito, sp. nov., holotipo ♂. **7.** Anverso. **8.** Reverso. (Figuras 1, 3, 5 y 7, trazo de 1 cm).



Figuras 9-16. 9-10. *Tautela stueningi* Expósito, sp. nov., holotipo ♂. **9.** Porción de la cabeza, vista ventral **10**. Porción de la cabeza. **11.** *Polyclysta schmidtae* Expósito, sp. nov., holotipo ♂. **12.** *Tautela stueningi* Expósito, sp. nov., genitalia ♂. Holotipo preparación AEH 3492. **13.** *Eurychoria parallelae* Expósito, sp. nov., holotipo ♂, genitalia ♂, preparación AEH 3497. **14.** *Polyclysta schmidtae* Expósito, sp. nov., holotipo ♂, genitalia ♂ cápsula con coremata extendida. Preparación AEH 3508. **15.** Aedeagus preparación AEH 3508. **16.** Aedeagus preparación AEH 3496. (Figuras 14-15, trazo de 1 mm).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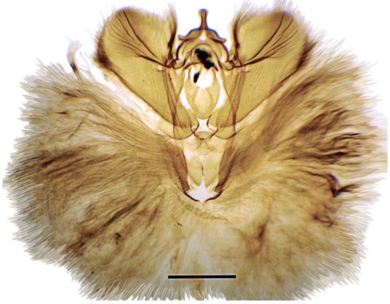
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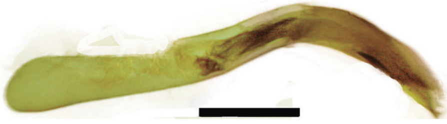
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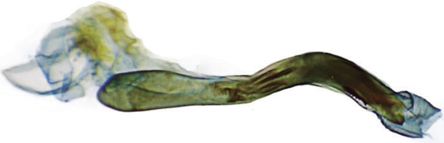
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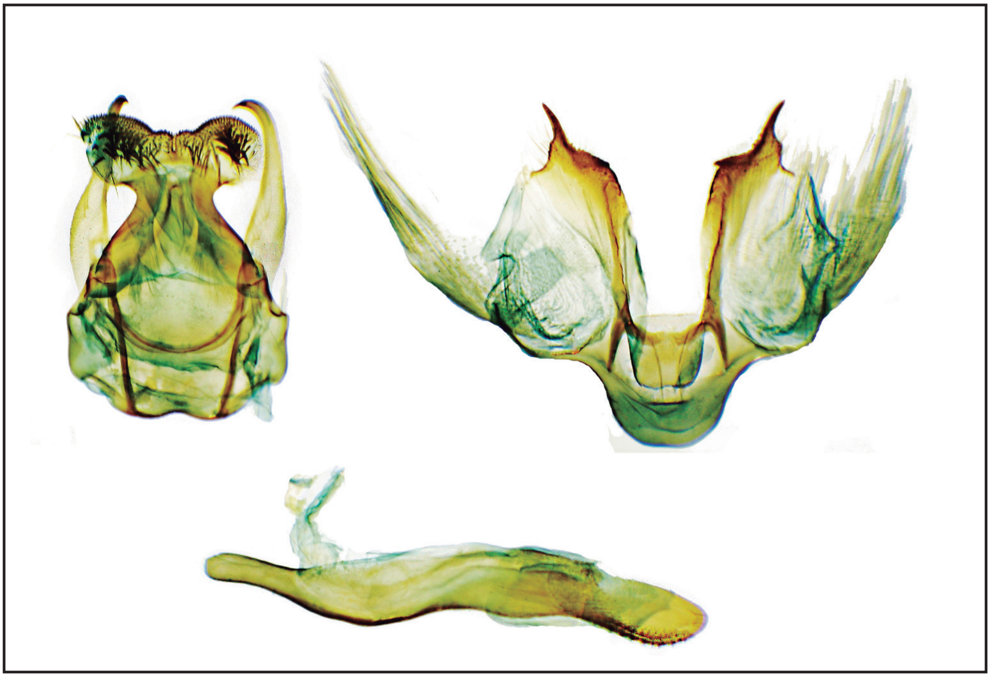
Figura 17. *Peratostega uniformis* Expósito, sp. nov., holotipo ♂, genitalia ♂, preparación AEH 3488.



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Internet:

De Prins, J., & De Prins, W. (2011). *Global taxonomic database of Gracillariidae (Lepidoptera).* http://www.gracillariidae.net

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SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 469-472 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1076 https://shilap.org
https://zoobank.org/986460BC-38AB-4D2D-B6FA-D88544271733

The enigmatic species *Gastropacha protracta* Herrich-Schäffer, [1856] identified as senior synonym of the Neotropical *Prorifrons hoppi* Draudt, 1927 (Lepidoptera: Lasiocampidae)

Vitor O. Becker

Abstract

The identity, provenance and placement of *Gastropacha protracta* Herrich-Schäffer, [1856] as a member of *Prorifrons* Barnes & McDunnough, 1911, comb. nov., and senior synonym of *P. hoppi* Draudt, 1927, syn. nov. is established. Illustrations are provided to enable its identification. *Gastropacha protracta* was erroneously described from South Africa, but the species is known from the Andes of South America.
Keywords: Lepidoptera, Lasiocampidae, *Gastropacha, Prorifrons,* synonymy, Neotropical.

La enigmática especie *Gastropacha protracta* Herrich-Schäffer, [1856] identificada como sinónimo mayor de la neotropical *Prorifrons hoppi* Draudt, 1927 (Lepidoptera: Lasiocampidae)

Resumen

Se establece la identidad, procedencia y colocación de *Gastropacha protracta* Herrich-Schäffer, [1856] como miembro de *Prorifrons* Barnes & McDunnough, 1911, comb. nov., y sinónimo principal de *P. hoppi* Draudt, 1927, syn. nov. Se proporcionan ilustraciones para permitir su identificación. *Gastropacha protracta* se describió erróneamente de Sudáfrica, pero la especie se conoce de los Andes de Sudamérica.
Palabras clave: Lepidoptera, Lasiocampidae, *Gastropacha, Prorifrons,* sinonimia, Neotropical.

A enigmática espécie *Gastropacha protracta* Herrich-Schäffer, [1856] identificada como sinônimo sênior da espécie neotropical *Prorifrons hoppi* Draudt, 1927 (Lepidoptera: Lasiocampidae)

Resumo

É estabelecida a identidade, proveniência e localização de *Gastropacha protracta* Herrich-Schäffer, [1856] como membro de *Prorifrons* Barnes & McDunnough, 1911, comb. nov., e sinônimo sênior de *P. hoppi* Draudt, 1927, syn. nov. São fornecidas ilustrações para permitir a sua identificação. *Gastropacha protracta* foi erroneamente descrita da África do Sul, mas a espécie é conhecida dos Andes da América do Sul.
Palavras-Chave: Lepidoptera, Lasiocampidae, *Gastropacha, Prorifrons,* sinonímia, Neotropical.

Introduction

Gastropacha protracta Herrich-Schäffer, [1856] has remained unrecognized and unplaced since its description. One of the reasons was the wrong type-locality, misleading all subsequent authors to look for specimens in the wrong places. The elucidation of these issues is the subject of this article.

Results and discussion

Examination of the images and the material available in the author´s (VOB) collection revealed the identity, provenance, and placement of this species.

Prorifrons protracta (Herrich-Schäffer, [1856] 1855), **comb. nov**. (Figures 1- 3)
Gastropacha protracta Herrich-Schäffer, [1856] 1855. *Samml. aussereur. Schmett., 1*(1), 473, pl. 82, fig. 473
LT: [VENEZUELA]: SOUTH AFRICA, "Port Natal", holotype ♂, no further data (ZMHB) [not examined].
= *Prorifrons hoppi* Draudt, 1927, in Seitz. *Die Gross-Schmett. Erde, 6*, 570, pl. 77. **syn. nov.**
LT: COLOMBIA, Chachatoy [Nariño], 2300 m, holotype ♂, ex Hopp col. [not examined].

Remarks: *G. protracta* was described from an unspecified number of specimens, presumably the single male referred to above. In the index of the same work ([1856], p. 83] Herrich-Schäffer synonymized it under *Lebeda bipars* Walker. Apparently, all the subsequent authors who listed the name, often in a different genus, had no further specimens available. Walker (1865, p. 551) listed it under *Gastropacha* Ochsenheimer, 1816, Kirby (1892, p. 815); under *Dendrolimus* Germar, 1812, Aurivillius (1927, p. 233) and Collier (1936, p. 302), under *Metanastria* Hübner, [1820] 1816). All these authors mentioned "Africa ?" as the type-locality. The type-locality "Port Natal" [S. Africa] is certainly wrong, as none of the authors who studied the fauna of this region (Aurivillius, 1927; Lajonquière, 1979), had any specimens available. Aurivillius (1927, p. 233) stated: "Herrich-Schaeffer places his *Gastropacha protracta* to *Chadisra bipars* Walker, 1862. This identification can, however, not be correct, and Herrich-Schäffer's species probably does not originate from South Africa, but from Asia, the Metanastria-species of which it resembles very much". However, none of the works that treat Asian or Indo-Australian Lasiocampidae include this species either (Inoue, 1982; Holloway, 1987, Kishida, 1992; Edwards, 1996). The figure presented by Herrich-Schäffer is excellent, and shows, with no doubt, a species of *Prorifrons* Barnes & McDunnough, 1911, a Neotropical Lasiocampidae genus, which species range from Mexico South to Argentina and Brazil. It is a good match in wing pattern and shape to *P. hoppi* Draudt, 1927, p. 570, pl. 77a, b), a species known from Colombia and Ecuador, at high elevations in the Andes. Considering that nearly all species described by Herrich-Schäffer came either from Venezuela (mostly from around Merida, also at high elevation, in the Andes) and from Brazil, supports the synonymy proposed here. In the author´s collection there is a series of seven males and two females, from Ecuador, a pair of which is illustrated here (figures 2-3).

Requests for an image were made to the Martin-Luther-Universität, Halle, Germany (MLUH), and to the Museum für Naturkunde, Berlin (MNHU). The first informed that no material was found in their collections. From the second, no answer was received so far. Fortunately, the excellent image (figure 1) in Herrich-Schäffer's work, reproduced here, allows the species identity.

Acknowledgements

Without the collaboration of Dr. Scott E. Miller (USNM), who also reviewed this manuscript and made several corrections and suggestions that improved it, this work could not be finished. Mônica Piovesan (Serra Bonita Reserve) prepared the illustrations. Dr. Antonio Vives, the editor of SHILAP Revta. lepid., did an excellent job to keep the high quality of the publication.

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.

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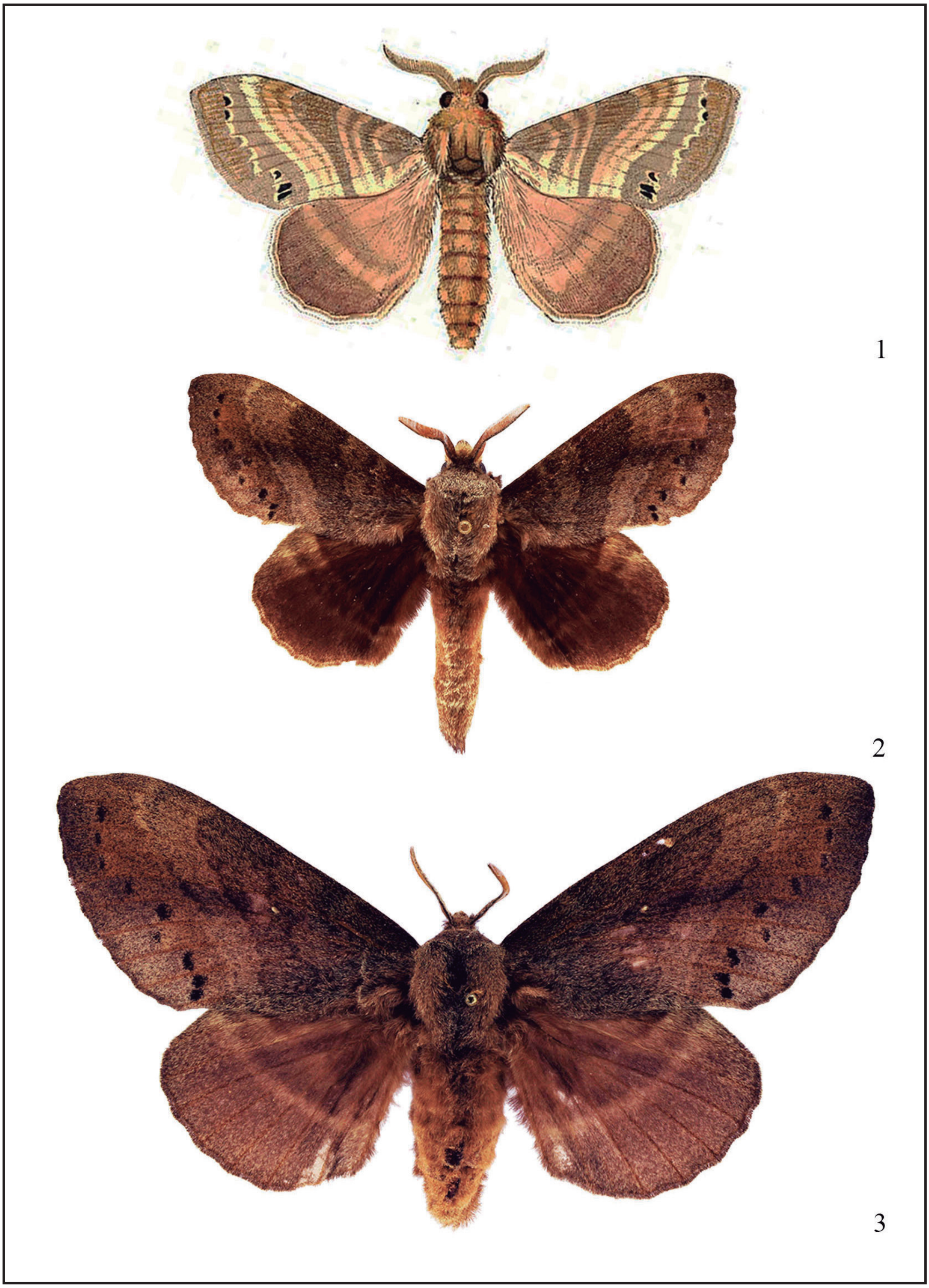
(Recibido para publicación / *Received for publication* 2-VII-2024)
(Revisado y aceptado / *Revised and accepted* 30-VIII-2024)
(Publicado / *Published* 30-IX-2025)

Figures 1-3. *Prorifrons protracta* (Herrich-Schäffer). **1.** Herrich-Schäffer´s original illustration. **2.** Male, dorsal view, Ecuador. **3.** Female, dorsal view, Ecuador, from the Sehested & Tonder collection



SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 473-476 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1077 https://shilap.org
https://zoobank.org/8532B081-1CAF-493D-9624-C2466725811F

Aporia ahura Nazari & Naderi, sp. nov., a new species from Central Alborz Mountains in Northern Iran and lectotype designation of *Pieris leucodice* var. *illumina* Grum-Grshimailo, 1890 (Lepidoptera: Pieridae)

Vazrick Nazari, Alireza Naderi & Vladimir A. Lukhtanov

Abstract

Since the publication of this name and the nomenclatural act in a recent paper co-authored by the authors in an online-only journal did not meet the criteria set forth by the ICZN, to make the name the act nomenclatural available, here we re-publish the description of this species and the lectotype designation with proper Zoobank accreditation.

Keywords: Lepidoptera, Pieridae, taxonomy, endemism, Palearctic Region.

Aporia ahura Nazari & Naderi, sp. nov., una nueva especie de las montañas centrales de Alborz en el norte de Irán y designación del lectotipo de *Pieris leucodice* var. *illumina* Grum-Grshimailo, 1890 (Lepidoptera: Pieridae)

Resumen

Dado que la publicación de este nombre y del acto nomenclatural en un artículo reciente de coautoría de los autores en una revista sólo en línea no cumplió los criterios establecidos por el CINZ, para que el nombre del acto sea nomenclaturalmente disponible, aquí volvemos a publicar la descripción de esta especie y la designación lectotipo con la debida acreditación de Zoobank.

Palabras clave: Lepidoptera, Pieridae, taxonomía, endemismo, Región Paleártica.

Introduction

In a recent paper published in Nazari et al. (2024, p. 15), where the Irano-Turanian *Aporia leucodice* species-group were studied, the first two authors of the present paper described a new species of *Aporia* Hübner, [1819] from Central Alborz Mountains in Northern Iran as *A. ahura* Nazari & Naderi, 2024. Unfortunately, since this name and the act were published in an electronic-only journal and the new name was not registered in ZooBank prior to its publication as required by the International Code of Zoological Nomenclature (ICZN 2012, https://www.iczn.org/the-code/electronic-publication-made-available-with-amendment-to-the-code/), the name and the act were nomenclaturaly unavailable. Attempts to submit corrections to this journal post-publication was unsuccessful.

To make the name *Aporia ahura* Nazari & Naderi, 2024 available, here we republish the description of the new species *verbatim* as it appeared in the original study but now with Zoobank registration and a few additional corrections. This should serve as the original description of the new name. For additional information, distribution map, and figures of the adults and genitalia, see Nazari et al (2024).

Aporia ahura Nazari & Naderi, sp. nov.

https://zoobank.org/42067835-6374-4A3D-8413-A0ECB0104EFD

Material: Holotype: ♂, Iran, Alborz Province, Dizin, Varangehrood, 2200 m, 18-VI-2008, leg. A. R. Naderi; SampleID 283b, dissection HA-2964. Not barcoded. Deposited in the coll. National Natural History Museum and Genetic Resources, Tehran, Iran. Paratypes (7 ♂, 5 ♀): Iran, Alborz Province, same data as holotype, 4 ♂, 1 ♀ coll. A. R. Naderi (SampleIDs ARPI-9999-030 to 032); 1 ♂, 3 ♀ leg. A. R. Naderi, coll. P. Zehzad (no SampleIDs); 1 ♂, leg. A. R. Naderi, coll. A. H. Harandi (no SampleIDs); 1 ♂, 2.000 m, 21-VI-2012, leg. A. R. Naderi, coll. P. Zehzad (no SampleIDs); 1 ♀, Chalus road, Dizin, 2.500 m, 2-VII-1994, leg. and coll. A. R. Naderi (barcoded, SampleID ARPI-9999-029).

Description: Male. Head black, frons white with black hairs. Antenna uniformly black, tip of the club white. Thorax black with gray hairs, abdomen black dorsally, grayish white ventrally. Legs black with white scales.

Forewing length 20-22 mm. Dorsal side of wings white; forewing with dark basal suffusion extending from base along the inner margin, veins black, a large black discoidal spot, and a broad marginal band extending from the apex to S2 with white internal scale-shaped patches. Hindwing rounded, white with narrow black margin, veins black only at marginal 1/3 and more intensively developed towards at the edge of the wings; weakly-developed postdiscal markings in the form of small arrows pointing outwards often present in S4-S6. Fringes on both wings gray, uneven. Ventral side of wings contrasted, forewing white except the apical area yellowish within the marginal band; veins grayish at base to more intense blackish towards the margin; discoidal spot and marginal band well-developed, blackish-brown; white internal patches within the marginal band wider than dorsal side and not scale-shaped. Hindwing yellowish, veins broadly suffused with gray scales, an additional streak present along the middle of S1; a continuous postdiscal band of chevrons of similar width extending from the inner margin to the upper half of S1.

Male genitalia: Heavily sclerotized. Ring slender, straight, perpendicular to saccus and tegumen; uncus broad at base, gradually narrowed into a pointed tip; saccus short and broad. Valve nearly triangulate, with dorsal base concave and ventral margin convex, tip blunt, fovea large and dorsoventrally elongate. Aedeagus robust, evenly curved with a trochanter at its ventral base. Juxta v-shaped with two arms widely apart. Female: Forewing length: 22-24 mm. Similar to the male, but wings often ore elongate, upperside dark marginal marking paler, discoidal spot often narrower than male. Ventral side of wings like male, dark markings paler

Female genitalia: Not examined.

Individual variation: The intensity of dark markings on both sides of the wings to some extent vary

Diagnosis: Like the *A. illumina*, forewings wider (narrower and somewhat more elongate in *A. illumina*), ground color and markings generally paler and less developed, UNH patch in S6 always well developed (usually small or obscured in *illumina*); male genitalia valve edge smooth, without pointed tip. Molecular characterization. *Aporia ahura* sp. nov. shows a COI barcode distance of 2.2±1.0% from *A. illumina*, differing from it by 21 fixed substitutions along the 658bp of the DNA barcode region. The available sequences for *A. ahura* sp. nov. (*n*=4) varied in length, nevertheless they showed variation in six additional sites resulting in four different haplotypes. In contrast, all barcoded specimens of *A. illumina* (*n*=12), even though originating from often distant localities, were barcode identical.

Distribution and bionomics: The new species is so far found only in Central Alborz mountains, Alborz province in Northern Iran. In addition to the type locality (Dizin), specimens from Marzanabad in Central Alborz belong to *A. ahura.* The new species inhabits altitudes between 2000-2500 m a.s.l. in mountain slopes with thick vegetation and *Juniperus* trees. Adults fly from mid-June to early July; they have a gentle flight and can often be seen nectaring on flowers of *Berberis* and *Colutea.*

Etymology: The species name *Ahura* (Lord) is an ancient Iranian (Avestan) designation for a particular class of Zoroastrian divinities that also includes *Ahuramazda*, the creator deity in Zoroastrianism.

Additionally, we formally designate here the lectotype of *Pieris leucodice* var. *illumina* Grum-Grshimailo, 1890. The designation of this lectotype is necessary for taxonomic purposes in connection with the description of *Aporia ahura* Nazari & Naderi, sp. nov. and in connection with the clarification of the taxonomic status of taxa related to *Aporia leucodice* described from Iran and Central Asia. For additional information and figures of the lectotype, see Nazari et al (2024).

Aporia illumina Grum-Grshimailo, 1890, **stat. nov.** (Figure 2c in Nazari et al. 2024)
Pieris leucodice var. *illumina* Grum-Grshimailo, 1890, 15
TL: “habitant les pentes septentrionales du Thian-Chan, des monts Alaп et la partie septentrionale de la Perse montagneuse”.

Lectotype ♂ (here designated): [white rectangular label: upperside of the label with black border, hand-written in black “Hyrcania”; underside of the label without border, type set “Alph.”[eraky collection]/ [large white label] “[Image of Royal crown] /Колл. Вел. Князя / Николая / Михаиловича” / red rectangular label “Lectotype *Pieris leucodide* var. *illumina* Grum-Grshimailo, 1890 Designated by V. Lukhtanov 2024”. Deposited in the coll. Zoological Institute, Russian Academy of Sciences (ZIN-RAS), St. Petersburg, Russia. Designated by V. Lukhtanov.

Additional notes: In the original study by Nazari et al. (2024), beside the incorrect year for the taxon *soracta* Moore, [1858] (mentioned as 1857), there is a discrepancy between what is stated in the Results section and the “Proposed taxonomic scheme” on p. 11, particularly in reference to the names *morosevitshae* (a synonym of *leucodice*) and *pseudoillumina* (a synonym of *illumina*). Here we present the corrected the taxonomic scheme as follows:

Aporia belucha Marshall, 1883
    ssp. *Aporia belucha* Marshall, 1883. *Proc. zool. Soc. Lond., 1882*(4), 760
    ssp. *Pieris leechii* Moore, 1903-1905 (“1904”). *Lep. Ind., 6,* 150
Aporia nabellica (Boisduval, 1836)
    ssp. *Pieris nabellica* Boisduval, 1836. *Hist. nat. Ins., Spec. gén. Lépid., 1*, 509
    ? ssp. *Aporia nabellica hesba* Evans, 1912 (no molecular data available). *J. Bombay nat. Hist. Soc., 21*(2), 559, (3), 976
Aporia soracta Moore, 1858 [“1857”]
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Acknowledgements

We thank Dr. Gerardo Lamas (Lima, Peru) for pointing out the issues with the original publication of this name. V. A. Lukhtanov was supported by the Russian Science Foundation Grant No 24-14-00047 (https://rscf.ru/project/24-14-00047/)

Conflict of Interest

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

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(Recibido para publicación / *Received for publication* 12-IX-2024)
(Revisado y aceptado / *Revised and accepted* 15-XII-2024)
(Publicado / *Published* 30-IX-2025)

SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 477-499 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1079 https://shilap.org
https://zoobank.org/C9500971-B2AC-485C-95AD-943ED16DF33C

Checklist of Papilionoidea fauna from Rajasthan, India (Insecta: Lepidoptera)

Jitendra Kumar, Prahlad Kumar Meena & Smriti Johari

Abstract

This study presents a comprehensive checklist of 204 species and subspecies, belonging to 101 genera across six families, derived from published literature on Papilionoidea fauna of Rajasthan, India. Notably, the checklist incorporates 21 species that are protected under the Wildlife (Protection) Amendment Act, 2022. This extensive inventory significantly enriches our knowledge of the diversity and distribution of Papilionoidea in Rajasthan.
Keywords: Insecta, Lepidoptera, Papilionoidea, Rajasthan, systematic, India.

Lista de control de la fauna de Papilionoidea de Rajastán, India (Insecta: Lepidoptera)

Resumen

Este estudio presenta una lista exhaustiva de 204 especies y subespecies, pertenecientes a 101 géneros de seis familias, derivadas de la literatura publicada sobre la fauna Papilionoidea de Rajastán, India. En particular, la lista incorpora 21 especies que están protegidas por la Ley de Enmienda (de Protección) de la Vida Silvestre de 2022. Este extenso inventario enriquece significativamente nuestro conocimiento de la diversidad y distribución de Papilionoidea en Rajastán.
Palabras clave: Insecta, Lepidoptera, Papilionoidea, Rajastán, sistemática, India.

Introduction

Rajasthan is India's largest state by area, covering 342,239 km², which accounts for about 10.4% of the country's total area. Approximately 61% of Rajasthan is desert, forming part of the Indian Thar Desert, hence it is often called 'Maru Pradesh'. Geographically, Rajasthan is situated in the northern and western hemispheres, predominantly north of the Tropic of Cancer, with coordinates ranging from 23º3' to 30º12' north latitude and 69º30' to 78º17' east longitude. It shares borders with five Indian states-Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, and Gujarat and has an international border with Pakistan. The Aravalli range, a remnant of ancient Gondwanaland, runs from northeast to southwest, dividing the state into two main regions: the arid plain in the northwest and the semi-arid plain along with the southeastern plateau in the east (Sharma & Mishra, 2021). Rajasthan has a tropical dry climate with an average annual rainfall of 57.8 cm. The vegetation in Rajasthan ranges from dry tropical forests to desert thorn scrubs and grasslands.

Due to their extensive knowledge, Lepidoptera are considered especially important in evolutionary biology and as indicators of biodiversity and conservation (de Jong et al., 1996). In India, the order Lepidoptera comprises 13,124 species, including 1,379 Papilionoidea species (Singh et al. 2024). With its varied landscapes, Rajasthan is home to a wide range of species, though the information on their diversity is scattered. In an earlier effort, (Trigunayat, 2008) listed 125 species of Papilionoidea described from Rajasthan.

After that, (Das et al. 2023) most recently confirmed the presence of 124 species in Rajasthan. Apart from them over the years, the following researchers have made a substantial contribution to our understanding of Rajasthan's Papilionoidea fauna: MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), and Varshney & Gupta (1996) were among the primary contributors. More recently, Kazmi et al. (2003), Palot & Soniya (2000, 2001, 2005), Trigunayat & Singh (1998), Maulik (2004), Sharma (2011, 2012, 2013, 2014, 2018), Kulshrestha & Jain (2016), Ghorpade (2016), Jangid et al. (2016), Rajpurohit et al. (2017), Singh et al. (2017), Choudhary et al. (2019), Bhagat (2020), Khandal & Sharma (2020), Kaur et al. (2020), Meena (2020), Panwar (2020), Sundar et al. (2020), Tripathi & Koli (2020), Chandra et al. (2021), Gehlot et al. (2021), Sengupta (2021), Meena et al. (2021), Prajapat & Meena (2021), Prajapat et al. (2021), Prajapat et al. (2023) and Panwar & Patel (2023).

This study aims to consolidate fragmented information on Papilionoidea documented in Rajasthan and present the first comprehensive species inventory with distributional records within the state.

Materials and Methods

Study area

Rajasthan is located in the northwestern part of India between 23.3º N and 30.12º N latitudes and 69.30º E and 78.17º E longitudes.

Methods

The current checklist of Papilionoidea species in Rajasthan was assembled through a comprehensive examination of published literature. No specimens were collected during the study. The taxa are organized according to the updated classification system proposed by van Nieukerken et al. (2011). The checklist is organized systematically up to the subfamily level and then alphabetically. The scientific names of the described species and subspecies included herein have been updated from Funet.fi (Savela, 2024) and Lepindex (Beccaloni et al. 2024). In addition to the scientific names, the referenced sources and distribution of each species and subspecies have also been provided in the corresponding columns in Table 1. Reliable references were used to cross-check the known range of the species under consideration: Evans (1932), Wynter-Blyth (1957), Varshney & Smetacek (2015), and Kehimar (2016).

Results

The checklist incorporated 204 species and subspecies from 101 genera across six Papilionoidea families documented in the study area. A detailed list of reported species, their references, and distributional records within Rajasthan is provided (Table 1). The distribution by family reveals Lycaenidae as the most prevalent, with 61 species and subspecies (29.9%) across 5 subfamilies and 35 genera. The family Nymphalidae follows this with 57 species and subspecies (27.9%) across 8 subfamilies and 27 genera, Pieridae with 39 species and subspecies (19.1%) across 2 subfamilies and 16 genera, Hesperiidae with 32 species and subspecies (15.7%) across 3 subfamilies and 19 genera, Papilionidae with 14 species and subspecies (6.9%) in 1 subfamily and 3 genera, and Riodinidae with 1 species (0.5%) in 1 subfamily and 1 genus. Among these, 21 species (10.3%) are protected under India's Wildlife (Protection) Amendment Act, 2022 (Anonymous, 2022). Specifically, one species is listed under Schedule I, while 20 are listed under Schedule II of the above act (Table 1). In the protected category, the family Nymphalidae has the most representation with 9 species, followed by Lycaenidae with 6 species, Papilionidae with 3 species, and Pieridae with 3 species.

The checklist underscores the importance of Rajasthan as a hotspot for Papilionoidea diversity, with varying habitats supporting a wide range of species despite having inhospitable environmental conditions. Further studies are warranted to elucidate the ecological requirements of various species in Rajasthan.

Table 1. Systematic checklist of Papilionoidea from Rajasthan (India).

Scientific name	Reference(s)	Distribution	WPA-2022 status
Family PAPILIONIDAE **Subfamily Papilioninae**			
Graphium agamemnon agamemnon (Linnaeus, 1758)	MacPherson (1927), Kushwaha et al. (1963), Sharma (2014), Sharma & Dhadeech (2014), Jangid et al. (2016), Kulshrestha & Jain (2016), Choudhary et al. (2019), Bhagat (2020), Prajapat et al. (2023)	Ajmer, Jaipur, Jhalawar, Kota, Mount Abu, Pratapgarh, Sirohi, Udaipur	
Graphium agamemnon menides (Fruhstorfer, 1904)	Gupta & Thakur (1986)	Mount Abu, Pali, Udaipur	
Graphium doson (C. & R. Felder, 1864)	Sharma (2014), Sharma (2018), Prajapat et al. (2023)	Jaipur, Mount Abu, Udaipur	
Graphium nomius (Esper, 1799)	MacPherson (1927), Gupta & Thakur (1986), Kazmi et al. (2003), Gasse (2013), Varshney & Smetacek (2015), Bhagat (2020)	Jaipur, Jodhpur, Mount Abu, Kota	
Graphium sarpedon (Linnaeus, 1758)	Sharma (2012), Sharma (2014)	Mount Abu, Pali, Udaipur	Sch-II
Graphium teredon (C. & R. Felder, [1865])	Das et al. (2023)	Rajasthan	
Pachliopta aristolochiae (Fabricius, 1775)	MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat & Saxena (2009) Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Kulshrestha & Jain (2016), Ghorpade (2016), Jangid et al. (2016), Sharma (2018), Bhagat (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Alwar, Barmer, Bharatpur, Dholpur, Jaipur, Jaipur, Jhalawar, Jodhpur, Kota, Mount Abu, Pali, Pratapgarh, Rajsamand, Sirohi, Sriganganagar, Udaipur	
Pachliopta hector Linnaeus, 1758	MacPherson (1927), Trigunayat & Singh (1998), Sharma (2014), Ghorpade (2016), Jangid et al. (2016), Sharma (2018)	Ajmer, Bharatpur, Hanumangarh, Jaipur, Jodhpur, Mount Abu, Sirohi, Sriganganagar	Sch-II
Papilio demoleus Linnaeus, 1758	MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Sharma (2012), Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Kulshrestha & Jain (2016), Ghorpade (2016), Jangid et al. (2016), Rajpurohit et al. (2017), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Alwar, Barmer, Bharatpur, Bikaner, Churu, Dholpur, Jaipur, Jhalawar, Jodhpur, Kota, Mount Abu, Nagaur, Pali, Pratapgarh, Rajsamand, Sirohi, Udaipur	
Papilio machaon Linnaeus, 1758	Trigunayat & Singh (1998)	Jaipur	Sch-II

Papilio polymnestor Cramer, [1775]	Trigunayat (2008), Gehlot et al. (2021)	Jodhpur	
Papilio polyctor Boisduval, 1838	Sharma (2014)	Mount Abu	
Papilio polytes polytes (Linnaeus, 1758)	Kushwaha et al. (1963), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Trigunayat & Saxena (2009) Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Jangid et al. (2016), Rathoure (2016), Sharma (2018), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Bharatpur, Bikaner, Churu, Dholpur, Jaipur, Jalore, Jhunjhunu, Jodhpur, Mount Abu, Neem Ka Thana, Pali, Pratapgarh, Rajsamand, Sirohi, Sriganganagar, Udaipur	
Papilio polytes romulus Cramer, [1775]	MacPherson (1927), Gupta & Thakur (1986), Kazmi et al. (2003), Maulik (2004), Ghorpade (2016), Choudhary et al. (2019), Bhagat (2020)	Barmer, Bharatpur, Jhunjhunu, Jodhpur, Kota, Mount Abu, Udaipur	
Family PIERIDAE **Subfamily Pierinae**			
Appias albina (Boisduval, 1838)	Kulshrestha & Jain (2016), Ghorpade (2016), Jangid et al. (2016), Bhagat (2020)	Ajmer, Bharatpur, Jhalawar, Kota	Sch-II
Appias libythea (Fabricius, 1775)	MacPherson (1927), Trigunayat (2008), Gasse (2013), Varshney & Smetacek (2015), Jangid et al. (2016), Choudhary et al. (2019)	Ajmer, Mount Abu, Udaipur	
Aporia agathon (Gray, 1831)	Trigunayat (2008)	Bharatpur	
Belenois aurota (Fabricius, 1793)	MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Kulshrestha & Jain (2016), Ghorpade (2016), Jangid et al. (2016), Rajpurohit et al. (2017), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Kaur et al. (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Alwar, Bharatpur, Bundi, Churu, Dholpur, Dungarpur, Jaipur, Jhunjhunu, Jodhpur, Jhalawar, Mount Abu, Pali, Pratapgarh, Rajsamand, Sirohi, Udaipur	
Cepora nerissa nerissa (Fabricius, 1775)	MacPherson (1927), Kushwaha et al. (1963), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Gasse (2013), Sharma (2014), Sharma & Dhadeech (2014), Ghorpade (2016), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Prajapat et al. (2023)	Ajmer, Alwar, Barmer, Bharatpur, Bikaner, Dholpur, Jaipur, Jodhpur, Kota, Mount Abu, Pali, Pratapgarh, Sirohi, Sriganganagar, Udaipur	
Cepora nerissa evagete (Cramer, [1779])	Varshney & Smetacek (2015)	Rajasthan	
Cepora nadina (Lucas, 1852)	Trigunayat & Saxena (2009)	Dholpur	Sch-II

Colotis amata amata (Fabricius, 1775)	MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Gasse (2013), Sharma (2014), Varshney & Smetacek (2015), Jangid et al. (2016), Bhagat (2020), Kaur et al. (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Bharatpur, Churu, Dholpur, Jaipur, Jodhpur, Mount Abu, Kota, Pali, Udaipur	
Colotis amata modesta (Butler, 1876)	Singh et al. (2017)	Udaipur	
Colotis danae danae (Fabricius, 1775)	MacPherson (1927), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Gasse (2013), Ghorpade (2016), Jangid et al. (2016), Bhagat (2020), Kaur et al. (2020)	Ajmer, Bharatpur, Churu, Dholpur, Jaipur, Jodhpur, Jodhpur, Mount Abu, Kota	
Colotis danae dulcis (Butler, 1876)	Gupta & Thakur (1986), Ghorpade (2016)	Bharatpur	
Colotis etrida (Boisduval, 1838)	MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Gasse (2013), Sharma (2014), Varshney & Smetacek (2015), Ghorpade (2016), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Kaur et al. (2020), Prajapat et al. (2023)	Ajmer, Barmer, Bharatpur, Churu, Dholpur, Jaipur, Jalore, Jhalawar, Jodhpur, Mount Abu, Kota, Nagaur, Pali, Pilan, Sawai Madhopur, Udaipur	
Colotis eucharis (Fabricius, 1775)	Trigunayat & Singh (1998), Palot & Soniya (2001), Trigunayat (2008), Trigunayat & Saxena (2009) Sharma (2014), Sharma (2018), Prajapat et al. (2023)	Bharatpur, Dholpur, Jaipur, Jodhpur, Pali, Rajsamand, Sriganganagar, Udaipur	
Colotis fausta fausta (Olivier, 1804)	MacPherson (1927), Trigunayat & Singh (1998), Palot & Soniya (2001), Varshney & Smetacek (2015), Ghorpade (2016), Kaur et al. (2020), Prajapat et al. (2023)	Bharatpur, Churu, Jaipur, Jodhpur, Mount Abu	
Colotis fausta faustina (C. & R. Felder, [1865])	Gupta & Thakur (1986), Gasse (2013)	Jodhpur, Mount Abu	
Colotis fausta fulvia (Wallace, 1867)	Choudhary *et al.* (2019)	Udaipur	
Colotis phisadia (Godart, 1819)	Varshney & Smetacek (2015), Kaur et al. (2020)	Churu	

Colotis protractus Butler, 1876	MacPherson (1927), Gupta & Thakur (1986), Maulik (2004), Gasse (2013), Varshney & Smetacek (2015), Choudhary et al. (2019)	Jaisalmer, Jodhpur, Udaipur	
Colotis vestalis (Butler, 1876)	MacPherson (1927), Kushwaha et al. (1963), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Sharma (2014), Ghorpade (2016), Jangid et al. (2016), Choudhary et al. (2019), Bhagat (2020), Gehlot et al. (2021)	Ajmer, Alwar, Bharatpur, Jaipur, Jodhpur, Kota, Udaipur	
Delias eucharis (Drury, 1773)	MacPherson (1927), Kushwaha et al. (1963) Gupta & Thakur (1986), Trigunayat (2008), Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Prajapat et al. (2023)	Ajmer, Alwar, Bharatpur, Jaipur, Jodhpur, Mount Abu, Pali, Pratapgarh, Rajsamand, Sirohi, Udaipur	
Hebomoia glaucippe (Linnaeus, 1758)	Sharma (2014), Rajpurohit et al. (2017), Bhagat (2020)	Jodhpur, Kota, Sirohi	
Ixias marianne (Cramer, [1779])	MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Gasse (2013), Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Kulshrestha & Jain (2016), Jangid et al. (2016), Rathoure (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Prajapat et al. (2023)	Ajmer, Alwar, Barmer, Bharatpur, Bikaner, Dholpur, Jaipur, Jhalawar, Jodhpur, Mount Abu, Kota, Neem Ka Thana, Pali, Pratapgarh, Rajsamand, Sikar, Sirohi, Sriganganagar, Udaipur	
Ixias pyrene (Linnaeus, 1764)	MacPherson (1927), Kushwaha et al. (1963), Trigunayat & Singh (1998), Palot & Soniya (2001), Trigunayat (2008), Trigunayat & Saxena (2009), Gasse (2013), Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Varshney & Smetacek (2015), Ghorpade (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020)	Ajmer, Alwar, Bharatpur, Dholpur, Jaipur, Jodhpur, Mount Abu, Kota, Pali, Pratapgarh, Sirohi, Sriganganagar, Udaipur	
Leptosia nina (Fabricius, 1793)	Trigunayat & Singh (1998), Palot & Soniya (2001), Trigunayat (2008), Trigunayat & Saxena (2009) Sharma (2014), Sharma & Dhadeech (2014), Ghorpade (2016), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020)	Ajmer, Bharatpur, Dholpur, Jaipur, Kota, Pratapgarh, Rajsamand, Udaipur	

Pareronia valeria (Cramer, 1776)	Trigunayat (2008), Sharma (2014), Ghorpade (2016), Sharma (2018)	Ajmer, Bharatpur, Sirohi	
Pieris brassicae (Linnaeus, 1758)	Trigunayat & Singh (1998), Trigunayat (2008), Trigunayat & Saxena (2009) Sharma (2014), Sharma & Dhadeech (2014), Ghorpade (2016), Sharma (2018)	Ajmer, Barmer, Bharatpur, Churu, Dholpur, Jaipur, Jodhpur, Pratapgarh, Rajsamand, Sriganganagar, Udaipur	
Pieris canidia canidia (Linnaeus, 1768)	Trigunayat (2008), Trigunayat & Saxena (2009), Sharma (2014), Sharma (2018), Kaur et al. (2020)	Ajmer, Bharatpur, Churu, Dholpur, Jaipur, Rajsamand, Sirohi, Sriganganagar	
Pieris canidia indica Evans, 1926	Ghorpade (2016)	Bharatpur	
Pontia glauconome (Klug, 1829)	Mukherjee et al. (2021)	Jaisalmer	
Prioneris thestylis (Doubleday, 1842)	Kushwaha et al. (1963), Trigunayat (2008)	Udaipur	
Coliadinae			
Catopsilia pomona (Fabricius, 1775)	MacPherson (1927), Kushwaha et al. (1963), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma (2014), Sharma & Dhadeech (2014), Kulshrestha & Jain (2016), Ghorpade (2016), Jangid et al. (2016), Rajpurohit et al. (2017), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Bharatpur, Dholpur, Hanumangarh, Jaipur, Jhalawar, Jodhpur, Kota, Mount Abu, Pratapgarh, Sirohi, Sriganganagar, Udaipur	
Catopsilia pyranthe (Linnaeus, 1758)	MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Kulshrestha & Jain (2016), Ghorpade (2016), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Bharatpur, Dholpur, Jaipur, Jhalawar, Jhunjhunu, Jodhpur, Kota, Mount Abu, Pali, Pratapgarh, Rajsamand, Sirohi, Udaipur	
Colias fieldii Ménétriés, 1855	Trigunayat & Singh (1998), Trigunayat & Saxena (2009), Sharma (2014), Sharma & Dhadeech (2014), Ghorpade (2016), Sharma (2018)	Bharatpur, Dholpur, Jaipur, Pratapgarh, Sirohi, Sriganganagar	
Eurema andersoni (Moore, 1886)	Trigunayat (2008), Ghorpade (2016), Jangid et al. (2016),	Ajmer, Bharatpur	Sch-II
Eurema blanda (Boisduval, 1838)	Sharma (2014), Jangid et al. (2016), Sharma (2018)	Sirohi, Ajmer, Sriganganagar	
Eurema brigitta brigitta (Stoll, 1780)	Palot & Soniya (2001), Trigunayat & Saxena (2009), Jangid et al. (2016), Choudhary et al. (2019)	Ajmer, Bharatpur, Dholpur, Udaipur	

Eurema brigitta rubella (Wallace, 1867)	MacPherson (1927), Gupta & Thakur (1986), Trigunayat & Singh (1998), Trigunayat (2008), Ghorpade (2016), Choudhary et al. (2019)	Ajmer, Alwar, Bharatpur, Jodhpur, Udaipur	
Eurema hecabe (Linnaeus, 1758)	MacPherson (1927), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma & Dhadeech (2013), Sharma & Dhadeech (2014), Sharma (2014), Kulshrestha & Jain (2016), Ghorpade (2016), Jangid et al. (2016), Rathoure (2016), Rajpurohit et al. (2017), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Alwar, Bharatpur, Dholpur, Dungarpur, Jaipur, Jhalawar, Jhunjhunu, Jodhpur, Mount Abu, Neem Ka Thana, Kota, Pali, Pratapgarh, Rajsamand, Sirohi, Sriganganagar, Udaipur	
Eurema laeta (Boisduval, 1838)	MacPherson (1927), Trigunayat & Singh (1998), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Gasse (2013), Sharma (2014), Varshney & Smetacek (2015), Ghorpade (2016), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Alwar, Bharatpur, Dholpur, Dungarpur, Jaipur, Jhalawar, Jodhpur, Kota, Mount Abu, Pali, Sriganganagar, Sirohi, Udaipur	
Familia NYMPHALIDAE **Subfamilia Danainae**			
Danaus chrysippus (Linnaeus, 1758)	MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Maulik (2004), Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Kulshrestha & Jain (2016), Ghorpade (2016), Jangid et al. (2016), Rathoure (2016), Rajpurohit et al. (2017), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Kaur et al. (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Alwar, Barmer, Bharatpur, Bhilwara, Churu, Dungarpur, Jaipur, Jalore, Jhalawar, Jhunjhunu, Jodhpur, Mount Abu, Kota, Nagaur, Neem Ka Thana, Pali, Pratapgarh, Rajsamand, Sriganganagar, Udaipur	

Danaus genutia (Cramer, 1779)	MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat & Saxena (2009), Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Ghorpade (2016), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Gehlot et al. (2021)	Ajmer, Alwar, Bharatpur, Bikaner, Chittorgarh, Dholpur, Dungarpur, Hanumangarh, Jaipur, Jhunjhunu, Jodhpur, Kota, Mount Abu, Pali, Pratapgarh, Rajsamand, Sirohi, Udaipur	
Euploea core Cramer, [1780])	MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat & Saxena (2009), Sharma & Dhadeech (2014), Sharma (2014), Ghorpade (2016), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020)	Ajmer, Barmer, Bharatpur, Dholpur, Jaipur, Jhunjhunu, Jodhpur, Kota, Mount Abu, Nagaur, Pali, Pratapgarh, Rajsamand, Sikar, Sirohi, Sriganganagar, Udaipur	
Parantica aglea (Stoll, 1782)	Trigunayat & Singh (1998), Sharma (2014), Kulshrestha & Jain (2016), Ghorpade (2016), Bhagat (2020)	Bharatpur, Jaipur, Jhalawar, Kota, Sirohi	
Tirumala limniace limniace (Cramer, [1775])	MacPherson (1927), Kushwaha et al. (1963), Trigunayat & Singh (1998), Palot & Soniya (2001), Trigunayat & Saxena (2009), Sharma (2014), Sharma & Dhadeech (2014), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Bharatpur, Dholpur, Jaipur, Jodhpur, Mount Abu, Pratapgarh, Sriganganagar, Udaipur	
Tirumala limniace leopardus (Butler, 1866)	Trigunayat & Singh (1998), Kazmi et al. (2003), Ghorpade (2016)	Bharatpur, Jaipur, Jodhpur, Sirohi	
Tirumala limniace exotica (Gmelin, 1790)	Sharma (2012)	Mount Abu	
Tirumala septentrionis (Butler, 1874)	Sharma (2014), Ghorpade (2016), Sharma (2018)	Bharatpur, Hanumangarh, Sriganganagar, Sirohi	
Satyrinae			
Lethe rohria rohria (Fabricius, 1787)	Trigunayat (2008), Sharma (2014)	Mount Abu	
Lethe rohria neelgheriensis (Guérin-Méneville, 1843)	MacPherson (1927), Gasse (2013), Varshney & Smetacek (2015)	Mount Abu	
Melanitis leda leda (Linnaeus, 1758)	Kushwaha et al. (1963), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma (2014), Sharma & Dhadeech (2014), Ghorpade (2016), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Gehlot et al. (2021)	Ajmer, Alwar, Barmer, Bharatpur, Dholpur, Hanumangarh, Jodhpur, Kota, Pali, Pratapgarh, Mount Abu, Sriganganagar, Udaipur	

Melanitis leda ismene (Cramer, [1775])	MacPherson (1927), Gupta & Thakur (1986), Trigunayat & Singh (1998), Ghorpade (2016)	Bharatpur, Jaipur, Jhunjhunu, Jodhpur, Mount Abu, Sirohi, Udaipur	
Melanitis phedima (Cramer, [1780])	MacPherson (1927), Gupta & Thakur (1986), Trigunayat & Singh (1998), Trigunayat (2008), Ghorpade (2016)	Ajmer, Bharatpur, Sirohi, Udaipur	
Melanitis zitenius (Herbst, 1796)	Trigunayat (2008)	Rajasthan	Sch-II
Mycalesis mineus mineus (Linnaeus, 1758)	MacPherson (1927), Palot & Soniya (2001), Trigunayat (2008), Sharma (2014), Sharma (2018), Bhagat (2020)	Alwar, Bharatpur, Jodhpur, Mount Abu, Kota	
Mycalesis mineus polydecta (Cramer, [1777])	Chandra et al. (2021)	Thar Desert (of Rajasthan)	
Mycalesis perseus (Fabricius, 1775)	Sharma (2014), Trigunayat & Saxena (2009), Rathoure (2016)	Dholpur, Neem Ka Thana, Sirohi	
Mycalesis visala Moore, [1858]	Trigunayat (2008)	Rajasthan	
Ypthima asterope (Klug, 1832)	MacPherson (1927), Trigunayat (2008), Sharma (2014), Jangid et al. (2016), Sharma (2018), Prajapat et al. (2023)	Ajmer, Alwar, Jaipur, Jodhpur, Mount Abu, Pali	
Ypthima baldus (Fabricius, 1775)	Trigunayat (2008), Sharma (2014), Sharma (2018)	Ajmer, Sriganganagar	
Ypthima huebneri Kirby, 1871	Trigunayat & Saxena (2009), Sharma (2014), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019)	Ajmer, Dholpur, Pali, Sirohi, Udaipur	
Heliconiinae			
Acraea violae (Fabricius, 1775)	Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Gasse (2013), Sharma (2014), Kulshrestha & Jain (2016), Ghorpade (2016), Jangid et al. (2016), Rathoure (2016), Bhagat (2020)	Ajmer, Banswara, Bharatpur, Churu, Dholpur, Jaipur, Jalore, Jhalawar, Jodhpur, Kota, Pali, Sriganganagar, Udaipur	
Argynnis hyperbius (Linnaeus, 1963)	MacPherson (1927), Trigunayat & Singh (1998), Trigunayat & Saxena (2009), Gasse (2013), Sharma (2014), Varshney & Smetacek (2015), Ghorpade (2016), Jangid et al. (2016), Sharma (2018)	Ajmer, Bharatpur, Dholpur, Jaipur, Jodhpur, Mount Abu	
Cupha erymanthis (Drury, 1773)	Sharma (2014)	Mount Abu	

Phalanta phalantha (Drury, [1773])	MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Ghorpade (2016), Jangid et al. (2016), Rathoure (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020)	Ajmer, Alwar, Barmer, Bharatpur, Churu, Dholpur, Jaipur, Jodhpur, Mount Abu, Kota, Neem Ka Thana, Pali, Pratapgarh, Sirohi, Sriganganagar, Udaipur	
Nymphalinae			
Hypolimnas bolina (Linnaeus, 1758)	MacPherson (1927), Kushwaha et al. (1963), Trigunayat & Singh (1998), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma (2014), Sharma & Dhadeech (2014), Ghorpade (2016), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Gehlot et al. (2021)	Ajmer, Bharatpur, Dholpur, Hanumangarh, Jaipur, Jodhpur, Mount Abu, Kota, Pratapgarh, Sriganganagar, Udaipur	
Hypolimnas misippus (Linnaeus, 1764)	MacPherson (1927), Kushwaha et al. (1963), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Ghorpade (2016), Rathoure (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Bharatpur, Dholpur, Bikaner, Jaipur, Jodhpur, Kota, Nagaur, Neem Ka Thana, Pali, Pratapgarh, Mount Abu, Udaipur	Sch-II
Junonia almana (Linnaeus, 1758)	MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Ghorpade (2016), Jangid et al. (2016), Rajpurohit et al. (2017), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Alwar, Barmer, Bharatpur, Churu, Dholpur, Hanumangarh, Jaipur, Jodhpur, Kota, Mount Abu, Pali, Pratapgarh, Mount Abu, Sriganganagar, Udaipur	

Junonia atlites (Linnaeus, 1963)	MacPherson (1927), Palot & Soniya (2001), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma (2014), Sharma & Dhadeech (2014), Kulshrestha & Jain (2016), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020)	Ajmer, Alwar, Bharatpur, Dholpur, Jaipur, Jhalawar, Kota, Pratapgarh, Mount Abu, Sriganganagar, Udaipur	
Junonia hierta (Fabricius, 1798)	MacPherson (1927), Kushwaha et al. (1963), Gupta & Thakur (1986), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Ghorpade (2016), Jangid et al. (2016), Rajpurohit et al. (2017), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Alwar, Bharatpur, Bundi, Churu, Dholpur, Jaipur, Jhunjhunu, Jodhpur, Mount Abu, Kota, Pali, Pratapgarh, Mount Abu, Sirohi, Udaipur	
Junonia iphita (Cramer, [1779])	Kushwaha et al. (1963), Trigunayat (2008), Sharma (2014), Sharma & Dhadeech (2014), Ghorpade (2016), Sharma (2018), Choudhary et al. (2019)	Ajmer, Alwar, Bharatpur, Hanumangarh, Jaipur, Pratapgarh, Sriganganagar, Sirohi, Udaipur	
Junonia lemonias lemonias (Linnaeus, 1758)	MacPherson (1927), Kushwaha et al. (1963), Trigunayat & Singh (1998), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Sharma & Dhadeech (2013), Sharma (2014), Sharma & Dhadeech (2014), Varshney & Smetacek (2015), Kulshrestha & Jain (2016), Ghorpade (2016), Jangid et al. (2016), Rajpurohit et al. (2017), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Alwar, Bharatpur, Jaipur, Jhalawar, Jodhpur, Kota, Mount Abu, Pali, Pratapgarh, Sirohi, Udaipur	
Junonia lemonias vaisya (Fruhstorfer, 1912)	Gupta & Thakur (1986), Varshney & Smetacek (2015)	Jodhpur, Mount Abu, Sirohi	
Junonia orithya orithya (Linnaeus, 1758)	MacPherson (1927), Kushwaha et al. (1963), Palot & Soniya (2001), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma & Dhadeech (2014), Kulshrestha & Jain (2016), Jangid et al. (2016), Rajpurohit et al. (2017), Choudhary et al. (2019), Bhagat (2020), Kaur et al. (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Bharatpur, Churu, Dholpur, Jaipur, Jhalawar, Jodhpur, Mount Abu, Kota, Pratapgarh, Udaipur	
Junonia orithya swinhoei Butler, 1885	Gupta & Thakur (1986), Gasse (2013), Ghorpade (2016)	Bharatpur, Jodhpur, Mount Abu, Sirohi, Udaipur	
Kaniska canace (Linnaeus, 1963)	Sengupta (2021)	Alwar	

Vanessa cardui (Linnaeus, 1758)	MacPherson (1927), Kushwaha et al. (1963), Trigunayat & Singh (1998), Kazmi et al. (2003), Trigunayat (2008), Sharma & Dhadeech (2014), Sharma (2014), Ghorpade (2016), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Prajapat et al. (2023)	Ajmer, Bharatpur, Hanumangarh, Jaipur, Jodhpur, Pali, Pratapgarh, Mount Abu, Sriganganagar, Udaipur	
Vanessa indica (Herbst, 1794)	Sharma (2014)	Mount Abu	
Limenitidinae			
Athyma perius (Linnaeus, 1758)	MacPherson (1927), Sharma (2014), Trigunayat (2008)	Mount Abu	
Euthalia aconthea (Cramer, [1777])	Trigunayat & Singh (1998), Trigunayat (2008), Sharma (2014), Gehlot et al. (2021)	Jaipur, Jodhpur, Udaipur	Sch-II
Moduza procris (Cramer, [1777])	Gehlot et al. (2021)	Jodhpur	
Neptis hylas hylas (Linnaeus, 1758)	Kushwaha et al. (1963), Trigunayat (2008), Sharma (2012), Sharma & Dhadeech (2013), Sharma (2014), Sharma (2018), Gehlot et al. (2021)	Ajmer, Barmer, Jaipur, Jodhpur, Mount Abu, Pali, Pratapgarh, Sirohi, Sriganganagar, Udaipur	
Neptis hylas varmona (Moore, 1872)	Jangid et al. (2016), Bhagat (2020)	Ajmer, Kota	
Neptis jumbah Moore, [1858]	Trigunayat (2008)	Rajasthan	Sch-II
Phaedyma columella (Cramer, [1780])	Trigunayat (2008)	Rajasthan	Sch-II
Symphaedra nais (Forster, 1771)	MacPherson (1927), Trigunayat (2008), Gasse (2013), Sharma (2014), Sharma & Dhadeech (2014), Varshney & Smetacek (2015), Jangid et al. (2016), Gehlot et al. (2021)	Ajmer, Jodhpur, Pratapgarh, Mount Abu, Udaipur	
Biblidinae			
Ariadne ariadne ariadne (Linnaeus, 1963)	Sharma (2014), Sharma & Dhadeech (2014), Sharma (2018)	Alwar, Bharatpur, Churu, Jalore, Jodhpur, Pratapgarh, Mount Abu, Sriganganagar, Udaipur	
Ariadne ariadne indica (Moore, 1884)	Sharma (2018)	Kota	
Ariadne merione merione (Cramer, [1777])	MacPherson (1927), Palot & Soniya (2001), Trigunayat & Saxena (2009), Sharma & Dhadeech (2013), Sharma (2014), Sharma (2018), Choudhary et al. (2019)	Alwar, Bharatpur, Dholpur, Pali, Mount Abu, Sriganganagar, Udaipur	
Ariadne merione tapestrina (Moore, 1884)	Ghorpade (2016)	Bharatpur	
Byblia ilithyia (Drury, [1773])	Trigunayat (2008), Jangid et al. (2016)	Ajmer	
Charaxinae			
Charaxes bernardus (Fabricius, 1793)	Gehlot et al. (2021)	Jodhpur	Sch-II

Charaxes solon (Fabricius, 1793)	MacPherson (1927), Kushwaha et al. (1963), Trigunayat (2008), Gasse (2013), Varshney & Smetacek (2015)	Kota, Mount Abu, Udaipur	Sch-II
Polyura agraria (Swinhoe, 1887)	Das et al. (2023)	Rajasthan	
Polyura athamas (Drury, 1773)	Kushwaha et al. (1963), Trigunayat (2008), Sharma (2014)	Sirohi, Udaipur	Sch-II
Polyura bharata (C. & R. Felder, [1867])	Das et al. (2023)	Rajasthan	
Apaturinae			
Dilipa morgiana (Westwood, 1850)	Jangid et al. (2016)	Ajmer	Sch-I
Family RIODINIDAE **Subfamily Nemeobiinae**			
Dodona durga (Kollar, [1844])	Sharma (2014), Sharma (2018)	Ajmer, Mount Abu, Jodhpur, Nagaur	
Family LYCAENIDAE **Subfamily Polyommatinae**			
Acytolepis puspa (Horsfield, 1828)	Sharma (2014), Jangid et al. (2016)	Ajmer	
Anthene lycaenina lycambes (Hewitson, 1878)	Trigunayat (2008), Chandra et al. (2021)	Rajasthan	Sch-II
Azanus jesous (Guérin-Méneville, 1849)	Trigunayat & Singh (1998), Trigunayat (2008), Sharma (2014), Jangid et al. (2016), Prajapat et al. (2023)	Ajmer, Jaipur	
Azanus ubaldus (Stoll, [1782])	MacPherson (1927), Trigunayat & Singh (1998), Palot & Soniya (2001), Trigunayat (2008), Gasse (2013), Ghorpade (2016), Jangid et al. (2016), Choudhary et al. (2019), Kaur et al. (2020), Prajapat et al. (2023)	Ajmer, Bharatpur, Bharatpur, Churu, Jaipur, Jodhpur, Udaipur	
Azanus uranus Butler, 1886	MacPherson (1927), Trigunayat & Singh (1998), Trigunayat (2008), Gasse (2013), Jangid et al. (2016), Kaur et al. (2020), Prajapat et al. (2023)	Ajmer, Churu, Jaipur, Jodhpur	
Castalius rosimon (Fabricius, 1775)	MacPherson (1927), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma (2014), Sharma & Dhadeech (2014), Kulshrestha & Jain (2016), Jangid et al. (2016), Sharma (2018), Choudhary et al. (2019), Bhagat (2020)	Ajmer, Alwar, Barmer, Dholpur, Hanumangarh, Jhalawar, Jodhpur, Kota, Pratapgarh, Mount Abu, Sriganganagar, Udaipur	
Catochrysops strabo (Fabricius, 1793)	MacPherson (1927), Trigunayat (2008), Sharma & Dhadeech (2014), Sharma (2014), Jangid et al. (2016), Sharma (2018)	Ajmer, Alwar, Bikaner, Jalore, Jodhpur, Pali, Pratapgarh, Mount Abu, Udaipur	
Celastrina huegelii (Moore, 1882)	Sharma (2014)	Mount Abu	
Chilades lajus (Stoll, [1780])	MacPherson (1927), Trigunayat (2008), Sharma (2014), Ghorpade (2016), Jangid et al. (2016), Choudhary et al. (2019)	Ajmer, Bharatpur, Jodhpur, Mount Abu, Udaipur	

Chilades parrhasius parrhasius (Fabricius, 1793)	Gasse (2013), Varshney & Smetacek (2015), Jangid et al. (2016)	Ajmer	
Chilades parrhasius minuta (Evans, 1932)	Trigunayat & Singh (1998)	Jaipur	
Cupido lacturnus (Godart, [1824])	Trigunayat (2008)	Rajasthan	
Euchrysops cnejus (Fabricius, 1798)	MacPherson (1927), Palot & Soniya (2001), Kazmi et al. (2003), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma (2014), Sharma & Dhadeech (2014), Ghorpade (2016), Jangid et al. (2016), Choudhary et al. (2019), Bhagat (2020), Kaur et al. (2020)	Ajmer, Bharatpur, Churu, Dholpur, Jaipur, Jodhpur, Kota, Pali, Pratapgarh, Mount Abu, Udaipur	
Freyeria putli (Kollar, [1844])	MacPherson (1927), Trigunayat & Singh (1998), Trigunayat & Saxena (2009), Ghorpade (2016)	Bharatpur, Dholpur, Jaipur, Jodhpur, Mount Abu	
Freyeria trochylus (Freyer, 1845)	Trigunayat (2008), Jangid et al. (2016), Choudhary et al. (2019), Kaur et al. (2020)	Ajmer, Bharatpur, Churu, Udaipur	
Jamides bochus (Stoll, 1782)	MacPherson (1927), Trigunayat (2008), Jangid et al. (2016)	Ajmer, Jodhpur	
Jamides celeno (Cramer, 1775)	Trigunayat (2008), Trigunayat & Saxena (2009), Sharma (2014), Jangid et al. (2016), Ghorpade (2016)	Ajmer, Bharatpur, Dholpur, Rajsamand	
Lampides boeticus (Linnaeus, 1767)	MacPherson (1927), Trigunayat (2008), Trigunayat & Saxena (2009), Sharma (2014), Sharma & Dhadeech (2014), Kulshrestha & Jain (2016), Ghorpade (2016), Jangid et al. (2016), Rajpurohit et al. (2017), Sharma (2018), Choudhary et al. (2019), Bhagat (2020), Kaur et al. (2020), Gehlot et al. (2021), Prajapat et al. (2023)	Ajmer, Barmer, Bharatpur, Churu, Dholpur, Jaipur, Jhalawar, Jodhpur, Mount Abu, Kota, Nagaur, Pali, Pratapgarh, Sriganganagar, Udaipur	
Leptotes plinius (Fabricius, 1793)	MacPherson (1927), Palot & Soniya (2001), Trigunayat (2008), Jangid et al. (2016), Ghorpade (2016), Choudhary et al. (2019), Bhagat (2020), Prajapat et al. (2023)	Ajmer, Bharatpur, Jaipur, Jodhpur, Mount Abu, Kota, Udaipur	
Luthrodes contracta (Butler, 1880)	Das et al. (2023)	Rajasthan	
Luthrodes ella (Moore, 1881)	Das et al. (2023)	Rajasthan	
Luthrodes pandava (Horsfield, [1829])	MacPherson (1927), Trigunayat & Singh (1998), Palot & Soniya (2001), Trigunayat (2008), Ghorpade (2016), Jangid et al. (2016), Choudhary et al. (2019), Kaur et al. (2020), Prajapat et al. (2023)	Ajmer, Bharatpur, Churu, Jaipur, Udaipur	
Megisba malaya malaya (Horsfield, [1828])	Trigunayat (2008)	Rajasthan	Sch-II
Megisba malaya sikkima Moore, 1884	Chandra et al. (2021)	Thar Desert (of Rajasthan)	

Neopithecops zalmora (Butler, [1870])	Trigunayat (2008)	Rajasthan	
Prosotas dubiosa indica (Evans, 1925)	Jangid et al. (2016)	Ajmer	Sch-II
Prosotas nora (C. Felder, 1860)	MacPherson (1927), Trigunayat (2008), Sharma (2014), Jangid et al. (2016)	Ajmer, Jodhpur	
Pseudozizeeria maha (Kollar, 1848)	MacPherson (1927), Palot & Soniya (2001), Trigunayat & Singh (1998), Trigunayat (2008), Ghorpade (2016), Jangid et al. (2016), Choudhary et al. (2019)	Ajmer, Bharatpur, Hanumangarh, Jaipur, Mount Abu, Sriganganagar, Udaipur	
Talicada nyseus (Guérin-Méneville, 1843)	Sharma (2014)	Mount Abu	
Tarucus balkanica (Freyer, 1844)	Das et al. (2023)	Rajasthan	
Tarucus callinara Butler, 1886	MacPherson (1927), Gupta & Thakur (1986), Choudhary et al. (2019), Kaur et al. (2020)	Churu, Jodhpur, Mount Abu, Udaipur	Sch-II
Tarucus extricatus Butler, 1886	Kazmi et al. (2003)	Jodhpur	
Tarucus indicus Evans, 1932	Trigunayat (2008), Gasse (2013), Varshney & Smetacek (2015)	Rajasthan	
Tarucus nara (Kollar, 1848)	Trigunayat (2008), Sharma (2014), Sharma & Dhadeech (2014), Varshney & Smetacek (2015), Jangid et al. (2016), Choudhary et al. (2019), Kaur et al. (2020), Prajapat et al. (2023)	Ajmer, Churu, Jaipur, Mount Abu, Pratapgarh, Udaipur	
Tarucus theophrastus (Fabricius, 1793)	MacPherson (1927), Palot & Soniya (2001)	Bharatpur, Jodhpur, Mount Abu	
Tarucus venosus Moore, 1882	Trigunayat (2008), Ghorpade (2016)	Bharatpur	
Zizeeria karsandra (Moore, 1865)	Trigunayat & Singh (1998), Trigunayat (2008), Sharma (2014), Ghorpade (2016), Jangid et al. (2016), Kaur et al. (2020)	Ajmer, Bharatpur, Churu, Jaipur	
Zizina otis otis (Fabricius, 1787)	Trigunayat (2008), Sharma (2014), Jangid et al. (2016), Choudhary et al. (2019)	Ajmer, Bharatpur, Mount Abu, Udaipur	
Zizina otis indica (Murray, 1874)	MacPherson (1927), Ghorpade (2016)	Bharatpur, Mount Abu	
Zizula hylax (Fabricius, 1775)	MacPherson (1927), Trigunayat & Singh (1998), Palot & Soniya (2001), Trigunayat (2008), Trigunayat & Saxena (2009), Ghorpade (2016), Jangid et al. (2016), Choudhary et al. (2019), Prajapat et al. (2023)	Ajmer, Bharatpur, Dholpur, Jaipur, Jodhpur, Mount Abu, Udaipur	
Theclinae			
Arhopala atrax (Hewitson, 1862)	Jangid et al. (2016)	Ajmer	
Arhopala amantes (Hewitson, 1862)	Trigunayat (2008)	Rajasthan	
Cigaritis acamas acamas (Klug, 1834)	Trigunayat (2008), Sharma (2014)	Alwar	
Cigaritis acamas hypargyros (Butler, 1886)	Gasse (2013), Chandra et al. (2021)	Rajasthan	
Cigaritis ictis (Hewitson, 1865)	MacPherson (1927), Trigunayat (2008), Gasse (2013), Varshney & Smetacek (2015)	Mount Abu	

Cigaritis lilacinus (Moore, 1884)	Sundar et al. (2020)	Southern Rajasthan	
Cigaritis vulcanus (Fabricius, 1775)	MacPherson (1927), Trigunayat (2008), Trigunayat & Saxena (2009), Gasse (2013), Ghorpade (2016), Jangid et al. (2016), Choudhary et al. (2019), Bhagat (2020)	Ajmer, Bharatpur, Dholpur, Mount Abu, Kota, Udaipur	
Deudorix isocrates (Fabricius, 1793)	MacPherson (1927), Kushwaha et al. (1963), Trigunayat (2008)	Mount Abu, Udaipur	
Pratapa deva (Moore, [1858])	Sharma (2014)	Aravalli range (of Rajasthan)	Sch-II
Rapala iarbus iarbus (Fabricius, 1787)	Trigunayat (2008), Tripathi & Koli (2020)	Bhilwara	
Rapala iarbus sorya (Kollar, 1848)	MacPherson (1927), Gasse (2013)	Mount Abu, Jodhpur	
Rapala manea (Hewitson, 1863)	Meena (2020)	Udaipur	
Rathinda amor (Fabricius, 1775)	Trigunayat (2008)	Rajasthan	
Surendra vivarna (Horsfield, [1829])	Trigunayat (2008)	Rajasthan	
Tajuria cippus (Fabricius, 1798)	Trigunayat (2008), Choudhary et al. (2019)	Udaipur	Sch-II
Zesius chrysomallus Hübner, 1821	Trigunayat (2008), Sharma (2014)	Mount Abu	
Miletinae			
Spalgis epius (Westwood, 1852)	Trigunayat (2008), Sharma (2014)	Ajmer	
Curetinae			
Curetis acuta acuta Moore, 1877	Trigunayat (2008), Rajpurohit et al. (2017)	Udaipur	
Curetis acuta dentata Moore, 1879	Trigunayat (2008)	Rajasthan	
Curetis thetis (Drury, [1773])	Trigunayat (2008)	Rajasthan	
Lycaeninae			
Heliophorus tamu (Kollar, [1844])	Trigunayat (2008)	Rajasthan	
Family HESPERIIDAE **Subfamily Hesperiinae**			
Arnetta vindhiana (Moore, [1884])	MacPherson (1927), Evans (1949), Gasse (2013), Varshney & Smetacek (2015)	Mount Abu	
Borbo cinnara (Wallace, 1866)	MacPherson (1927), Sharma (2014)	Ajmer, Mount Abu	
Caltoris kumara (Moore, 1878)	Palot & Soniya (2001), Trigunayat (2008), Ghorpade (2016)	Bharatpur	
Parnara bada (Moore, 1878)	MacPherson (1927), Trigunayat (2008), Ghorpade (2016)	Bharatpur, Mount Abu	
Parnara guttatus (Bremer & Grey, [1852])	Sharma (2014), Jangid et al. (2016), Sharma (2018)	Ajmer, Alwar, Barmer, Jodhpur, Pali, Sriganganagar	
Pelopidas conjuncta (Herrich-Schäffer, 1869)	Chandra et al. (2021)	Thar Desert (of Rajasthan)	
Pelopidas mathias (Fabricius, 1798)	MacPherson (1927), Evans (1949), Kushwaha et al. (1963), Kazmi et al. (2003), Sharma (2014), Jangid et al. (2016), Prajapat et al. (2023)	Ajmer, Barmer, Jaipur, Jodhpur, Mount Abu, Udaipur	

Potanthus dara (Kollar, [1844])	MacPherson (1927)	Mount Abu	
Potanthus pseudomaesa (Moore, [1881])	Evans (1949), Gasse (2013), Varshney & Smetacek (2015)	Mount Abu	
Suastus gremius (Fabricius, 1798)	MacPherson (1927), Palot & Soniya (2001), Trigunayat (2008), Trigunayat & Saxena (2009), Ghorpade (2016), Jangid et al. (2016), Bhagat (2020)	Ajmer, Bharatpur, Dholpur, Kota, Mount Abu	
Taractrocera maevius maevius (Fabricius, 1793)	Trigunayat & Singh (1998), Trigunayat (2008)	Bharatpur, Jaipur	
Taractrocera maevius sagara (Moore, [1865])	Ghorpade (2016)	Bharatpur	
Telicota augias (Linnaeus, 1963)	Chandra et al. (2021)	Thar Desert (of Rajasthan)	
Telicota bambusae (Moore, 1878)	Chandra et al. (2021)	Thar Desert (of Rajasthan)	
Udaspes folus (Cramer, [1775])	MacPherson (1927), Trigunayat & Singh (1998), Trigunayat (2008), Ghorpade (2016)	Bharatpur, Jaipur, Mount Abu	
Pyrginae			
Caprona ransonnetii (Felder, 1868)	MacPherson (1927)	Mount Abu	
Celaenorrhinus ambareesa (Moore, [1866])	Chandra et al. (2021)	Thar Desert (of Rajasthan)	
Coladenia indrani indrani (Moore, [1866])	Chandra et al. (2021)	Thar Desert (of Rajasthan)	
Coladenia indrani indra Evans, 1926	Khandal & Sharma (2020)	Sawai Madhopur	
Ernsta zebra (Butler, 1888)	Panwar (2020), Panwar & Patel (2023), Prajapat et al. (2023)	Ajmer, Chittorgarh, Dungarpur, Pali, Pratapgarh, Rajasamand, Sirohi, Udaipur	
Pseudocoladenia dan (Fabricius, 1787)	MacPherson (1927)	Mount Abu	
Sarangesa dasahara dasahara Moore, [1866]	MacPherson (1927), Choudhary et al. (2019)	Mount Abu, Udaipur	
Sarangesa dasahara adona (Evans, 1949)	Evans (1949), Gasse (2013), Varshney & Smetacek (2015)	Mount Abu	
Sarangesa purendra purendra Moore, 1882	MacPherson (1927), Jangid et al. (2016), Choudhary et al. (2019)	Ajmer, Mount Abu, Udaipur	
Sarangesa purendra pandra (Evans, 1949)	Evans (1949), Gasse (2013), Varshney & Smetacek (2015)	Mount Abu	
Sarangesa sati de Nicéville, 1891	de Niceville (1891), Khandal & Sharma (2020)	Sawai Madhopur	
Spialia galba (Fabricius, 1793)	MacPherson (1927), Sharma (2014), Jangid et al. (2016), Kaur et al. (2020)	Ajmer, Churu, Mount Abu	
Spialia doris evanida (Butler, 1880)	Meena et al. (2021)	Jaisalmer	
Coeliadinae			
Badamia exclamationis (Fabricius, 1775)	MacPherson (1927), Trigunayat (2008), Trigunayat & Saxena (2009), Ghorpade (2016), Choudhary et al. (2019)	Bharatpur, Dholpur, Mount Abu	
Hasora chromus (Cramer, 1780)	MacPherson (1927), Trigunayat & Saxena (2009), Jangid *et al.* (2016)	Ajmer, Dholpur, Mount Abu	
Hasora vitta vitta (Butler, 1870)	Trigunayat (2008)	Bharatpur	
Hasora vitta indica Evans, 1932	Ghorpade (2016)	Bharatpur	

Abbreviation used:

WPA-2022 = Wildlife (Protection) Amendment Act, 2022 of India.
Sch-I = Schedule-I; Sch-II = Schedule-II.

Discussion

The current study provides Rajasthan's first thorough inventory of Papilionoidea species, incorporating previously dispersed data and distributional records and considerably enhancing the state's known diversity. The checklist of 204 species and subspecies across 101 genera and six families marks a substantial increase from earlier records by Trigunayat (2008) and Das et al. (2023), who listed 125 and 124 species, respectively. However, as already indicated, both investigations mentioned above only included species data. This expansion underscores the rich biodiversity of Rajasthan's Papilionoidea and highlights the importance of continued research and conservation efforts.

Certain species were excluded from the list: *Kallima paralekta* (Horsfield, [1829]) of the Nymphalidae family, *Hesperilla ornata* (Leach, 1814), *Gegenes nostrodamus* (Fabricius, 1793), and *Spialia doris* (Walker, 1870) of the Hesperiidae family. *K. paralekta* is endemic to Indonesia and was reported from Jodhpur by Gehlot et al. (2021) based on photographic records without physical specimens. The genus *Kallima* Doubleday, 1849, includes four species in the Indian subcontinent: *K. horsfieldi, K. albofasciata, K. knyvetti*, and *K. inachus* (Varshney & Smetacek, 2015; Kehimkar, 2016). *H. ornata* was reported from Bikaner (Bhati & Srivastava, 2016), but this identification may be erroneous as *H. ornata* is typically found along the non-tropical eastern coast of Australia (Braby, 2004), making its presence in India doubtful. *G. nostrodamus* and *S. doris* were excluded because they were recorded from Deesa (Rajputana) (Evans, 1949), now part of Gujarat state.

A noteworthy aspect of the findings is the documentation of 21 species listed under Schedule I and II of the Wildlife (Protection) Amendment Act, 2022. The inclusion of protected species highlights Rajasthan's ecological significance and the necessity for stringent conservation measures in light of ongoing habitat loss and climate change.

Conclusion

This study significantly enhances our understanding of Papilionoidea diversity in Rajasthan, providing crucial baseline information for future ecological and conservation research. Further research should focus on detailed ecological studies to understand lesser-known species' habitat preferences and life cycles.

Acknowledgements

The authors are grateful to the Director, Zoological Survey of India, Kolkata for providing the necessary facilities for carrying out this study. The authors also thank the Office-in-charges, Desert Regional Centre, Jodhpur, and Principal, Janki Devi Bajaj Government Girls College Kota for the necessary encouragement and support.

Conflict of Interest

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

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(Recibido para publicación / *Received for publication* 3-VI-2024)
(Revisado y aceptado / *Revised and accepted* 1-IX-2024)
(Publicado / *Published* 30-IX-2025)

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SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 501-511 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1080 https://shilap.org
https://zoobank.org/EE6DE20B-EA91-4D15-B96E-4EA22EE44FF7

First record of *Bassania amethystata* Walker, 1860 as a potential defoliating insect on the invasive species *Ulex europaeus* L. in Colombia (Lepidoptera: Geometridae)

María Camila Ángel-Vallejo, Ghennie Tatiana Rodríguez-Rey, Leidys Murillo-Ramos, Eliana Jimena García-Marín, Natalia Aguirre-Acosta, Anderson Muñoz-Quintero, Lucimar Gomes-Dias & Carolina Feuillet-Hurtado

Abstract

Understanding the association between species biology and their host enables comprehension of the mechanisms underlying species adaptation and evolution, as well as their potential application in biological control. During a population structure study of the invasive plant *Ulex europaeus* L. in the Cordillera Central of Colombia, we documented a larva of the Lepidoptera order feeding on the flower buds. The larva was captured and its development was monitored until it reached the adult stage for identification purposes. Morphological identification revealed the larval as *Bassania amethystata* Walker, 1860. However, molecular analyses showed taxonomic uncertainties for this species and others in the genus. Consequently, the larva of *B. amethystata* could potentially serve as a biological control agent for the invasive plant. By attacking the buds, the larva could affect flowering, fruiting, and formation of the seed bank of the populations. However, additional research is necessary to investigate the larva's specificity and preferences for flower buds and its adaption capacity in other regions where invasions occur. Finally, studies on the taxonomic relationships within the genus *Bassania* Walker, 1860 are needed.

Keywords: Lepidoptera, Geometridae, natural history, herbivory, natural enemy, Colombia.

Primer registro de *Bassania amethystata* Walker, 1860 como un insecto defoliador potencial en la especie invasora *Ulex europaeus* L. en Colombia (Lepidoptera: Geometridae)

Resumen

Entender la asociación entre la biología de las especies y sus hospederos permite comprender los mecanismos subyacentes a la adaptación y evolución de las especies, así como su potencial aplicación en el control biológico. Durante un estudio de la estructura poblacional de la planta invasora *Ulex europaeus* L. en la Cordillera Central de Colombia, se documentó una larva del orden Lepidoptera alimentándose de los botones florales de la especie. La larva fue capturada y su desarrollo fue monitoreado hasta alcanzar la etapa adulta. Se identificó morfológicamente a la larva como *Bassania amethystata* Walker, 1860. Sin embargo, los análisis moleculares revelaron incertidumbres taxonómicas tanto para esta especie como para otras del mismo género. En consecuencia, la larva de *B. amethystata* podría desempeñar potencialmente un papel como agente de control biológico para la especie invasora. Al atacar los botones florales, la larva podría afectar la floración, la fructificación y la formación del banco de semillas de las poblaciones. No obstante, es necesario realizar investigaciones adicionales sobre la especificidad y preferencias de la larva para los botones florales, así como su capacidad de adaptación en otras regiones donde se producen las invasiones. Finalmente, se requieren estudios sobre las relaciones taxonómicas dentro del género *Bassania* Walker, 1860.

Palabras clave: Lepidoptera, Geometridae, historia natural, herbivoría, enemigo natural, Colombia.

Introduction

The genus *Bassania* Walker, 1860, is a small genus, currently consisting of 13 described species, distributed from Mexico to Argentina in tropical and subtropical forests (Pitkin, 2002; Rajaei et al. 2022). Species of *Bassania* are considered economically important pests and have been reported attacking plantations of *Pinus patula* Schltd, *Eucalyptus* sp., and *Cupressus* sp. (Madrigal, 1981; Sociedad Colombiana de Entomología y Fundación Nacional de Entomología Forestal, 1983). Currently, four species of *Bassania* are reported in Colombia: *B. crocallinaria* Oberthür, 1883, *B. schreiteri* Schaus, 1923, *B. hilaris subturpis* Dognin, 1913 and *B. amethystata* Walker, 1860 (Bernal & Martínez, 2023). However, the species *B. crocallinaria* was excluded from the genus (Brehm et al. 2019; Pitkin, 2002) and *B. schereiteri* (Chalup, 2011) seems to be an endemic species of the Yungas ecoregion, therefore, the record of this species for Colombia could be a misidentification. Consequently, there is lack of studies focused on the biology, morphology, and descriptions of the species. Additionally, there is an absence of research focused on interactions with their hosts and their potential role in biological control processes.

The host association and species biology have a great potential to understanding the mechanism underlying species adaptation and evolution (Menken et al. 2010). However, we often lack natural history data, specially to comprehend the close association between insects and their hosts specificity and their potential role in biological control (Lenteren et al. 2006). Among insects, the Geometridae could serve as a model group to understanding such species interactions due to their status as a mega diverse group of herbivorous insects in the Andean forests (Brehm et al. 2003, 2005). Nevertheless, in the order Lepidoptera and in most insect species, our knowledge of their natural history is limited (Wagner et al. 2021). Therefore, their diversity patterns, host association, and specificity need to be further explored (Dyer et al. 2007).

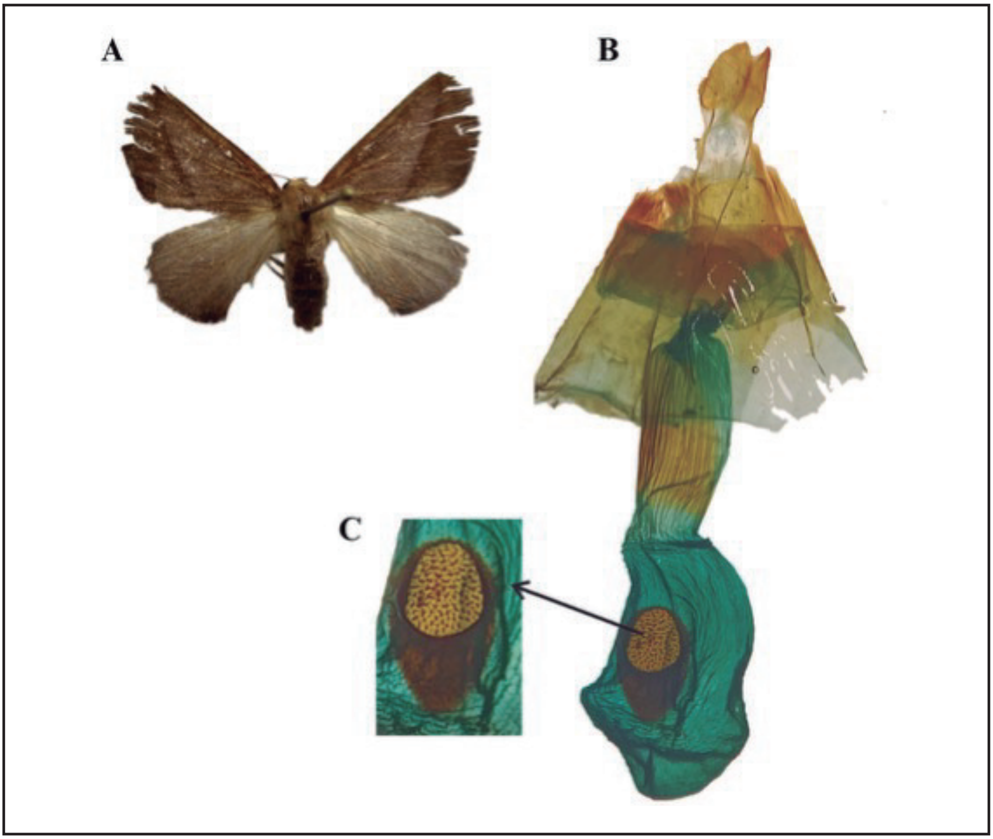
In this study, we report a case of herbivory by *B. amethystata* feeding on flower buds of the invasive species *Ulex europaeus* L. in Colombia. *U. europaeus* is a shrub native to Western Europe listed as one of the 100 most invasive species worldwide (León Cordero et al. 2016). In Colombia, this species was introduced in the 1950s to be used as a living fence in the departments of Cundinamarca, Antioquia, Boyacá and Tolima (Amaya-Villarreal & Renjifo, 2010; Barrera-Cataño et al. 2019; Ocampo-Zuleta & Solorza-Bejarano, 2017). However, due to its temperature requirements and life history characteristics, such as high growth and reproduction rates, this species is invading Andean, high Andean and paramo ecosystems (Barrera-Cataño et al. 2019; Hill et al. 2008). Considering all the above, this study aims to investigate the taxonomic and molecular identification, biology, and behavior of *B. amethystata* in Colombia. Additionally, considering the importance of identifying potential natural enemies of the invasive plant *U. europaeus,* we present the first record of larva of *B. amethystata* feeding on flower buds.

Materials and methods

Study area

The study area is situated on the Alaska property, Pajonales rural district of the municipality of Murillo - Tolima, in the center of Colombia (04º52’28.6”N, 075º08’45.0”W), at an altitude of 2667 meters. The orobiomes found in the region include nival, paramo and Andean ecosystems (Morales-Rivas et al. 2007). However, these ecosystems are under threat due to the presence of several invasive processes of *U. europaeus* along roads, productive land, and in the upper part of the Lagunilla River basin, located at an altitude of 3700 meters. In the study area, there has been an invasion of *U. europaeus* for 33 years, extending for approximately 1 km. The shrubs within the invasion reach heights of up to 3.40 meters and are surrounded by exotic species such as patula pine and eucalyptus planted nearby. Additionally, agricultural, fish farming, and livestock activities are conducted in both the municipality and the study area, leading to significant anthropic intervention (Alcaldía Municipal Murillo, 2019).

Figure 1. Adult of *Bassania amethystata*. **A**) dorsal view of female adult reared in this study. **B**) we display the genitalia dissection. We can observe the Corpus bursae subtriangular. **C**) signum large, hollow, denticulate, and oval as showed in Pitkin (2002) for *B. amethystata*.



Sampling and breeding

As part of the research project "Population status, reproductive biology and genetic diversity of the invasive plant *Ulex europaeus,* in populations of the Colombian Central Cordillera", three 60-meter transects were installed in the study area to measure the population structure of the species. Additionally, visual inspections were carried out on plants, buds, flowers, and fruits to look for signs of herbivore, aiming to identify potential animals that consume the plant and could act as natural enemies. Subsequently, a larva from the order Lepidoptera was manually captured and stored in a plastic container with *U. europaeus* buds, which were replaced every three days. The larva's development was monitored until its adult stage for identification purposes.

Identification

Genitalia dissection was prepared following methods outlined by Sihvonen (2005). The abdomen was briefly immersed in 10% KOH solution and heated for 5 minutes to remove fat and soft tissues, it was then cleaned in water and ethanol. The larva was identified as female, and the structures were stained with Chlorazol black before being mounted in Euparal (Figure 1). Morphological identification was carried out by comparing our genitalia dissection with photos of *Bassania* type species published in the Neotropical review of Ennominae (Pitkin, 2002), from the Smithsonian National Museum of Natural History (USNM), and dissections published by Chalup (2011). Moreover, we consulted specialist Vitor O. Becker to further confirm our identifications. The reared adult specimen was deposited in the Entomological Collection of the Biology Program at Universidad de Caldas CEBUC (registration number RNC 188).

Additionally, molecular analyses were conducted on a fragment of the mitochondrial gene Cytochrome Oxidase subunit I (COI). Genomic DNA (gDNA) was extracted from one leg of the specimen using the saline extraction protocol (Miller et al. 1988). Subsequently, the concentration and quality of the extracted gDNA were evaluated using the NanoDrop ND-2000 spectrophotometer (Thermo Scientific™). The primers LCO1490 (5'-GGTCAACAAATCATAAAGATATTGG-3') (Folmer et al. 1994) and C1-N-2191 (5'-CCCGGTAAAATTAAAATATAAACTTC-3') (Simon et al. 1994) were used to amplify the 5' end of the COI gene. The amplification reaction included 2 µl of gDNA, 1 U of GoTaq DNA polymerase, 1X reaction buffer, 200 µM of dNTP Mix, 2.5 mM of MgCl2, and 0.3 µM of each primer in a final volume of 20 µL.

A negative control was included to detect possible contaminations, and PCR was performed under the following conditions: initial denaturation at 95ºC for 5 minutes, followed by 35 denaturation cycles at 95ºC for 30 seconds, hybridization at 50ºC for 35 seconds, and extension at 72ºC for 45 seconds, followed by a final extension of 10 minutes at 72ºC. The amplified product was visualized by electrophoresis in a 2.0% agarose gel stained with Midori Green, using the 100bp Opti-DNA Marker molecular weight marker. Subsequently, the amplified fragment was purified and sequenced in both directions by Macrogen, Inc., Korea. The obtained electropherograms were edited with the SeqMan II 4.0 software (DNASTAR Inc.), and the consensus sequence was deposited in the GenBank (access number: OR502635).

For molecular analyses, a BLAST similarity search was initially performed through the NCBI database (National Center for Biotechnology Information, http://www.ncbi.nlm.nih.gov/). Subsequently, an alignment of 639 bp was obtained using the Clustal W algorithm implemented in the Mega 7.0 program (Kumar et al. 2016). This alignment included, in addition to the sequence of the specimen obtained in this study, 39 sequences from the genus *Bassania* and a sequence from the genus *Isochromodes* available in the BOLD (Barcode of Life Database, www.barcodinglife.org). The alignment was visually inspected and translated to identify both editing errors and the presence of stop codons that could indicate the amplification of NuMts (nuclear mitochondrial sequences). From the generated alignment, the Kimura-2-Parameter (K2P) substitution model was used to estimate genetic distances between species or monophyletic clades in the Mega software, and phylogenetic relationships were reconstructed through the maximum likelihood method using the IQ -Tree program (Nguyen et al. 2015; Trifinopoulos et al. 2016; http://iqtree.cibiv.univie.ac.at/). The substitution model TPM2u+F+G4 was determined by the BIC criteria implemented in ModelFinder (Kalyaanamoorthy et al. 2017), and 1000 ultrafast bootstrap replicates were performed (Hoang et al. 2018).

Results and discussion

The adult larva, which feedis on flower buds of *Ulex europaeus,* was morphologically identified as *Bassania amethystata* (Figure 1). Additionally, a crypsis (camouflage) was observed at the time of capture. When the larva felt threatened, it positioned itself horizontally, holding onto its prolegs and stretching its entire body, mimicking a branch (Figure 2). This behaviour could be observed for 50 minutes. Particularly in the species of the Geometridae family, this cryptic behaviour is well-developed, their larvae assume feeding or resting postures that imitate a part of the host plant (Greeney et al. 2012).

Regarding the larva's development, on the ninth day after its capture, it entered the prepupa stage: its body shortened and thickened, taking on a dark brown hue. Subsequently, on the 11th day, the larva formed the chrysalis, which lasted for 22 days before the adult metamorphosis occurred. In total, the larva's development from capture to its adult stage lasted 35 days. This duration of the life cycle documented here is similar to that reported for *B. schreiteri* under laboratory conditions, where the prepupa stage lasts from 2 to 5 days and metamorphosis into the adult is reached after 25 days (Madrigal, 1981).

Molecularly, the BLAST analysis of the COI gene sequence obtained for the adult larva confirmed a high similarity to sequences from the genus *Bassania* (Identity = 93.3-94.7%; E-value = 0). However, phylogenetic reconstruction by maximum likelihood (Figure 3) and estimates of K2P genetic distance (Table 1) revealed that the adult morphologically identified as *B. amethystata* is more closely related to BOLD sequences taxonomically identified as *B. schreiteri* collected in Antioquia, Colombia (0.9%

genetic divergence) than to sequences identified as *B. amethystata* collected in Cuzco, Peru (5.6% genetic divergence). Additionally, a monophyletic clade was recovered with strong statistical support for the sequences taxonomically identified as *B. amethystata* and *B. olivacea* collected in Zamora Chinchipe, Ecuador (Figure 3). The species *B. amethystata* is distributed from Costa Rica to Peru (GBIF, 2023) while the species *B. schreiteri* appears to be exclusive to the Yungas ecoregion in Peru, Bolivia, and Argentina (Chalup, 2011). Taxonomic uncertainties and the limited number of studies and specialists on Neotropical moths suggest that the taxonomic identifications of the BOLD data for this group are not reliable.

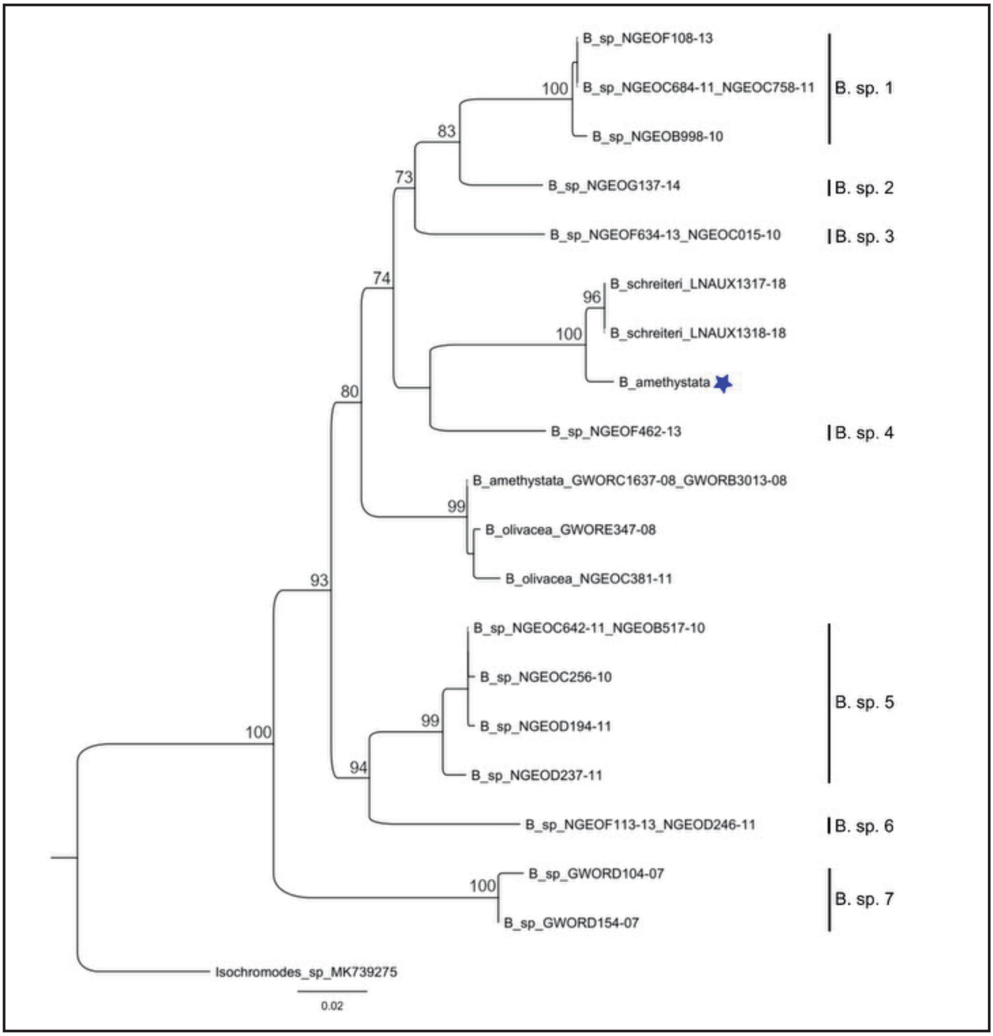
Figure 2. Larva of *Bassania amethystata.* **A**) feeding on flower buds of *Ulex europaeus*. **B**) Crypsis behaviour.

Table 1. Kimura-2-Parameters genetic distance (%) for *Bassania* monophyletic species and clades estimated from a COI fragment. *Sequence recovered for the adult of larva feeding on the flower buds of *Ulex europaeus*.

	1	2	3	4	5	6	7	8	9	10	11	12	13
*B. amethystata**	–												
B. amethystata	5.6	–											
B. crocallinaria	11.9	10.9	–										
B. olivacea	5.6	0.6	11.0	–									
B. schreiteri	0.9	4.8	12.3	4.9	–								
B. sp. 1	6.8	5.6	10.9	5.8	6.4	–							
B. sp. 2	7.2	5.0	10.7	5.2	7.1	4.4	–						
B. sp. 3	5.8	4.9	11.0	5.0	6.0	5.2	4.9	–					
B. sp. 4	5.7	5.2	11.5	5.2	5.0	5.8	4.5	5.4	–				
B. sp. 5	6.8	5.6	10.5	5.6	6.5	6.3	5.9	5.8	5.3	–			
B. sp. 6	8.2	5.7	10.9	5.7	7.9	7.2	6.2	7.5	6.4	4.9	–		
B. sp. 7	8.7	7.6	11.9	8.1	7.7	7.9	8.9	8.7	9.0	8.0	9.0	–	
B. sp. 8	8.8	8.3	7.9	8.5	9.0	7.9	7.5	8.5	8.2	7.7	8.1	9.1	–
B. sp. 9	9.5	8.6	9.3	9.0	10.1	8.7	9.0	8.8	9.0	7.3	8.6	9.6	4.5

Adults of *B. amethystata* typically exhibit a brown or reddish coloration, characterized by a semiparallel dark line on the outer margin of the forewings and a thorax covered in a dense layer of scales (Madrigal, 1981; Pitkin, 2002). In the male genitalia, the uncus features an inverted T-shape with a sharp end, small and circular socii, gnathos with an expanded middle area, thin branches, several rows of spines arranged in the middle region, valves with processes absent, furcation deviated to the left, arched, or undulating (Chalup, 2011). In females, the genitalia have a subtriangular and elongated corpus bursae. The signum can be large, hollow, denticulate, and oval (Pitkin, 2002). Species of the genus *Bassania* have been reported on multiple native and introduced host plants in the Neotropics, including plants of the Ericaceae, Euphorbiaceae, Melastomaceae, and Solanaceae families, as well as in patula pine and cypress plantations, among others (Madrigal, 1981).

Figure 3. Maximum likelihood tree for *Bassania* from a fragment of the COI. The numbers in the nodes represent the bootstrap. Bootstraps < 70% are not shown. Identical sequences were collapsed. The star indicates the sequence recovered for the adult of larva feeding on the flower buds of *Ulex europaeus*.



Although *U. europaeus* is one of the most aggressive and widely distributed invasive species worldwide, there are few biological control programs targeting it. Fourteen biological controllers have been tested since 1940, specifically specialist seed predators and foliage-consuming species aimed at suppressing plant reproduction and growth (Broadfield & McHenry, 2019). Particularly, as a biological control strategy, natural enemies of *U. europaeus* have been introduced into invaded areas, such as *Cydia succedana* ([Denis & Schiffermüller], 1775) (Lepidoptera) in New Zealand and *Exapion ulicis* (Forster, 1771) (Coleoptera) and *Agonopterix ulicetella* (Fabricius, 1794) (Lepidoptera) in Chile (Hill & Gourlay, 2002; Norambuena et al. 2000, 2001). However, the mobilization and introduction of exotic natural enemies may have unforeseen impacts that could potencially lead future biological invasions (Thomas & Reid, 2007).

Due to the invasions of *U. europaeus* in Colombia, *B. amethystata*, as a native natural enemy, should not be introduced into the country. Moreover, as a pest species, there is a significant availability of individuals (Bustillo, 2008). By attacking the flower buds of *U. europaeus*, the larva affects both flowering and fruiting in populations, thus limiting recruitment to the existing seed bank and favoring seed depletion (Hill et al., 2001). Reducing the seed bank is crucial in control programs as it directly corelates with decreasing population growth. Invasive populations of *U. europaeus*, older than 40 years, can produce approximately 15,000 seeds m2, which remain viable and persistent for more than 50 years (Aguilar-Garavito, 2015; Beltrán & Barrera-Cataño, 2014), making control efforts for preventing their establishment. However, due to the species' capacity for vegetative propagation through runners and root cuttings, complementary control and eradication strategies should be employed (Roberts & Florentine, 2021).

In conclusion, the larva of the *B. amethystata* shows potential as a candidate for biological control of invasive populations of *U. europaeus* in Colombia. However, further research is needed to determine the specificity and preference of the larva for *U. europaeus* flowers, as well as the actual percentage of flowers predated. Additionally, it is crucial to evaluate the larva's adaptation capacity in different geographical areas where invasions occur. Finally, taxonomic reviews of the genus are necessary to delimit its species and clarify its evolutionary relationships, as the limited number of studies and specialists in Neotropical moths render BOLD data for this group unreliable.

Acknowledgements

We would like to thank the Ministerio de Ciencia, Tecnología e Innovación (Minciencias) and Universidad de Caldas for funding the project (0643120): "Population status, reproductive biology and genetic diversity of the invasive plant *Ulex europaeus* L., in populations of the Colombian Central Cordillera", as well as for the support provided to MCAV and EJGM as young researchers. We would also like to express our gratitude to Vitor O. Becker for his assistance in identifying the individual. Finally, we would like to thank the Fúquene family, owners of the Alaska property, for their hospitality and for allowing us access to their property to carry out this research.

Conflict of Interest

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

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(Recibido para publicación / *Received for publication* 3-IV-2024)
(Revisado y aceptado / *Revised and accepted* 30-VIII-2024)
(Publicado / *Published* 30-IX-2025)

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SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 513-519 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1081 https://shilap.org
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Ocurrencia de *Utetheisa ornatrix* (Linnaeus, 1758) una especie especializada en *Crotalaria juncea* L. en Magdalena, Colombia (Lepidoptera: Erebidae, Arctiinae)

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Resumen

En el Caribe colombiano se ha promovido la siembra de *Crotalaria juncea* L. como abono verde. Este trabajo registra la presencia de *Utetheisa ornatrix* (Linnaeus, 1758) asociada a varias parcelas cultivadas con esta planta en el departamento del Magdalena (Colombia), se presenta una diagnosis para reconocerla, se aportan nuevos registros de distribución para el país. Se discuten otros aspectos de su biología.
Palabras clave: Lepidoptera, Erebidae, Arctiinae, *Utetheisa ornatrix, Crotalaria juncea,* diversidad, Colombia.

Occurrence of *Utetheisa ornatrix* (Linnaeus, 1758) a species specialised on *Crotalaria juncea* L. in Magdalena, Colombia (Lepidoptera: Erebidae, Arctiinae)

Abstract

In the Colombian Caribbean, *Crotalaria juncea* L. has been promoted as a green manure. This paper records the presence of *Utetheisa ornatrix* (Linnaeus, 1758) associated with several plots cultivated with this plant in the department of Magdalena (Colombia). It also presents a diagnosis for the recognition of the species, while providing new distribution records for the country. Other aspects of their biology are discussed.
Keywords: Lepidoptera, Erebidae, Arctiinae, *Utetheisa ornatrix*, *Crotalaria juncea*, diversity, Colombia.

Introducción

En varios países neotropicales se ha venido promoviendo la siembra de plantas del género *Crotalaria* L. como abono verde, gracias a sus beneficios en la fijación de nutrientes y su efecto nematicida (Betancourth et al. 2011; Colombo et al. 2020; Cruz et al. 2020; de Oliveira et al. 2020). En el departamento del Magdalena (Colombia), en el marco de proyectos de investigación en agroecología se establecieron varias parcelas de la especie *Crotalaria juncea* L. para mejorar las condiciones de los suelos y promover sombra a hortalizas de porte bajo (Sepúlveda-Cano, datos sin publicar). Esta planta, al igual que otras del género *Crotalaria*, es rica en pirrozilina, un alcaloide distribuido en toda la planta (Drussourd et al. 1991). Este alcaloide es utilizado por las larvas de *Utetheisa ornatrix* (L.) (Lepidoptera: Arctiinae), y ha sido ampliamente estudiado por el efecto sobre los mecanismos de defensa del insecto, así como procesos involucrados en la reproducción (por ejemplo, como la estimulación de producción de huevos, formación de nuevos óvulos) (Dussourd et al. 1991; LaMunyon & Eisner, 1993; LaMunyon, 1997; Lim & Greenfield, 2007; Ferro et al. 2006; González et al. 1999; Iyengar & Eisner, 1999; Trigo et al. 2018). Se ha reportado que las larvas de *U. ornatrix* adquieren estos alcaloides al consumir semillas de *Crotalaria* evadiendo este mecanismo de defensa de la planta y usándolos para su beneficio hasta la etapa adulta (Drussourd et al. 1991; García et al. 2001). La habilidad para defenderse de depredadores y algunas características biológicas de la especie, como el peso de la pupa, están mediados por la especie de *Crotalaria* de la que se alimentan las larvas (Pareje, 2022) y por las condiciones de estrés a las que estén expuestas las plantas hospederas (Moreno et al. 2021). En este sentido, *U. ornatrix* es considerada una de las principales plagas de este abono verde (Días et al. 2009; Signoretti et al. 2008).

Utetheisa ornatrix se distribuye ampliamente en América del Norte al este de las Montañas Rocosas, extendiéndose por América del Sur (GBIF, 2024; Pease, 1968). La especie tiene amplias variaciones en el patrón de coloración alar entre individuos, una característica necesariamente común en Lepidoptera donde es frecuente que el patrón de coloración sea relativamente estable dentro de cada especie (Gawne & Nijhout, 2019). Ciertos autores han determinadoo que presenta diversos patrones de coloración que no obedecen a su distribución geográfica (Brou, 2009).

Materiales y métodos

Entre enero y diciembre de 2022 se visitaron 33 parcelas en once municipios del departamento del Magdalena (Caribe colombiano) cultivadas con cuatro subparcelas de *Vigna ungiculata* (L.) Walp*., Crotalia juncea, Zea mays* L. y *Pueraria thomsonii* (Benth.) Wiersema ex D. B. Wars*,* cada una de 625 m^2. En cada cultivo se realizó una exploración y recolección manual de los ejemplares encontrados de *U. ornatrix*. Estas se llevaron al laboratorio de entomología de la Universidad del Magdalena para montaje e identificación con las descripciones de Brou (2009) y Grados et al. (2021). Se realizó un registro fotográfico en campo y se describieron los daños realizados por las larvas de U. ornatrix en caso de haber estado presentes. Se recolectaron ejemplares amparados en el permiso marco de la Autoridad Nacional Ambiental de Colombia número 1.293 de 2013. Todos fueron depositados en la Colección Biológica de la Universidad del Magdalena (Santa Marta, Colombia).

Figura 1. Adulto de *Utetheisa ornatrix.* **a**) Hembra, vista dorsal. **b**) Hembra, vista ventral. **c**) Macho, vista dorsal. **d**) Macho, vista ventral.

Resultados

Se recolectaron 36 adultos de la especie *U. ornatrix* en siete de los once municipios visitados, la mayoría fueron encontrados sobre plantas de *C. juncea* (n=13) y las demás en fríjol (n=5), en maíz (n=1) o sobrevolando estaciones de muestreo en la matriz (n=17). Los estados inmaduros (n=116), aunque no se recolectaron, en el 100% de las observaciones se registraron sobre *C. juncea.*

Diagnosis: Macho (Figuras 1a, 1b). Cuerpo blanco con una mancha negra sobre la región frontoclipeal, mancha negra en el vértex frecuentemente presente, dos manchas negras (también en forma de puntos) y a veces una mancha rosa en las patagias, dos o tres manchas en forma de puntos negros en cada tégula, seis más en vista dorsal del tórax y algunas veces de cuatro a seis en los esternos torácicos. Antenas filiformes. Patas blancas con áreas negras, especialmente en los tarsómeros. Vista dorsal del ala anterior rosa pálido con una banda rojiza entrecortada e intercalada con puntos negros en el margen costal, termen frecuentemente con una banda rojiza ubicada entre dos líneas de puntos negros; en vista ventral toda la superficie rojiza, mancha postdiscal negra y alargada y dos manchas más cerca al ápice; termen con línea de manchas redondeadas negras. Las alas posteriores anchas, blancas excepto el margen costal el cual es de color rosa dorsalmente y rojizo en vista ventral; termen con mancha irregular negra visible dorsal y ventralmente desde el ápice hasta el tornus. Hembra (Figura 1c, 1d). Coloración y forma similar al macho, excepto por el mayor tamaño de las manchas negras de las dos alas en vista ventral y la presencia en muchas ocasiones de una mancha negra postdiscal pequeña y alargada en la cara ventral del ala posterior.

Material examinado: COLOMBIA, Magdalena, Ariguaní, Finca Panorama, 74º11’13”W 9º55’3”N, en *Crotalaria juncea*, 2 ♂, 3 ♀ , 8-VI-2022, Col: Sepúlveda-Cano, P.A.; Benavides, L. Haydar, R., Álvarez, J. Guamal, Finca Asomupropan, 74º14’56”W 9º10’17”N en *C. juncea,* 1 ♂, 2 ♀, 19-V-2022, mismos colectores; Finca Dios da para todos, 74º4’11”W 9º20’10”N; 2 ♀ , 19-V-2022, mismos colectores; Pivijay, IED Agropecuario José María Herrera, 74º36’15”W 10º27’50”N, en *C. juncea,* 3 ♂, 2 ♀, 8-VI-2022, mismos colectores; Finca Jerusalén, 74º27’3”W 10º26’35”N, en *C. juncea*, 7 ♂♂, 2 ♀♀, mismos colectores; Plato, Finca Villa Maná, 74º44’23”W 9º48’20”N, en *C. juncea*, 2 ♂, 1 ♀, 25-VI-2022, mismos colectores; Finca La Fé, 74º37’45”W 9º51’44”N, 1 ♂, 24-I-2022, mismos colectores; San Sebastián de Buenavista, Finca Bellavista, 74º21’9”W 9º15’56”N, en fríjol, 1 ♂, 19-V-2022, mismos colectores; Santa Ana, Finca Burro viejo, 74º33’39”W 9º19’42”N, en mezcla de abonos verdes, 2 ♂, 1♀, 20-V-2022, mismos colectores; Finca el Redil, 74º38’13”W 9º23’43”N, en *C. juncea*, 1 ♀, 20-V-2022, mismos colectores; Sitionuevo, Finca Aguaviva, 74º42’7”W 10º47’34”N, 1 ♂, 20-XII-2022, mismos colectores; Finca la Bendición de Dios, 74º42’25”W 10º59’15”N, 2-VI-2022, mismos colectores 1 ♀; Finca Macondo 1, 74º44’31”W 10º57’31”N, 1 ♂, 1 ♀, 2-VI-2022, mismos colectores.

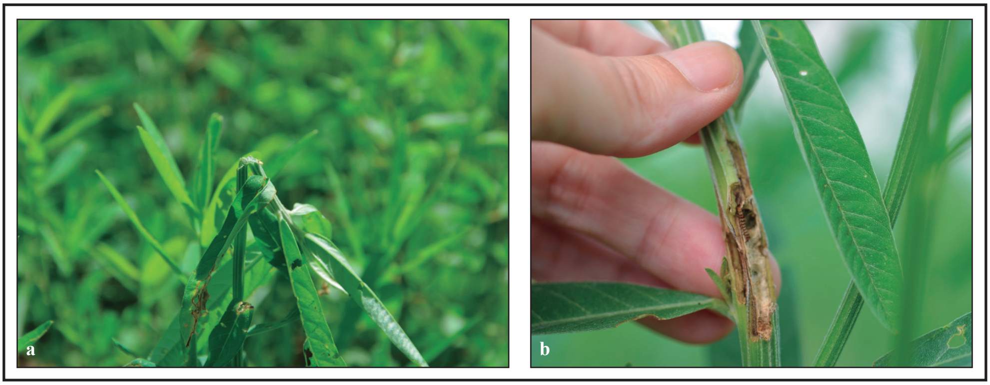
Durante las visitas se registraron varias generaciones de esta especie coexistiendo. Si bien no se recolectaron estados inmaduros, durante los muestreos se observaron larvas (n= >100 observaciones) mayormente y en forma consistente en el tercio apical de los tallos de *C. juncea*, alimentándose por uno de los lados, promoviendo el quiebre del tallo en todos los casos (Figuras 2a y 2b) y estimulando el brote de ramas por debajo del daño en la mayoría de las plantas. También se observaron larvas en hojas y frutos, en menor proporción.

Discusión

Desde 1968 se reconocen cinco subespecies de *U. ornathrix* (L.), asignadas con base en las variaciones y restricciones geográficas de sus patrones de coloración en cuanto a cinco aspectos: el color del pigmento del ala anterior, la distribución del pigmento blanco del ala anterior, las manchas negras del ala anterior, los márgenes negros del ala posterior y el color predominante del ala posterior de la siguiente forma: *U. ornatrix bella* (L., 1758) restringida a Estados Unidos, *U. ornatrix ornatrix* (L., 1758) en Centro y Sudamérica, *U. ornatrix venusta* (Dalman, 1823) en las Antillas Mayores, *U. ornathrix stretchii* (Butler, 1877) sólo en Puerto Rico y *U. ornatix saint-croixensis* Pease, 1973 en Islas Vírgenes (EE.UU.) (Pease, 1968). Todos los ejemplares recolectados en el departamento del Magdalena corresponden a la subespecie *U. ornatrix ornatrix* compartiendo el mismo patrón descrito para la subespecie presente en Sudamérica.

La preferencia alimentaria observada de las larvas de las especies fue *C. juncea*, ratifican su especialización en plantas del género *Crotalaria*, lo cual ha sido ampliamente documentado (Choi et al. 2007; Córdova-Ballona et al. 2022; del Campo et al. 2005; Gallo et al. 2002; García et al. 2001; Hurtado, 2009; Prada et al. 2021). Sin embargo, aunque la mayoría de autores las registran alimentándose de hojas, flores y frutos (Castro & Montalvão, 2018; Córdova-Ballona et al. 2022; Ferro et al. 2006*,* Franco & Cogni, 2013; Hurtado 2009), en nuestras observaciones predominó la alimentación en tallos (n>100) y sólo encontramos cinco casos en los que larvas de primer o segundo estado se estaban alimentando en hojas. Esto, posiblemente influenciado por el hecho que, durante nuestros muestreos la mayoría de las plantas no estaban en floración. Algunos autores sugieren que en las hojas, las larvas pueden consumir una mayor cantidad del alcaloide que les proporciona defensa ante depredadores aunque les hace más vulnerables al canibalismo (Bogner & Eisner, 1991).

Figura 2. Daño de *Utetheisa ornatrix* en *Crotalaria juncae.* **a**) Quiebre del ápice de la planta por el daño de la larva. **b**) Larva alimentándose en el tercio apical del tallo.



De acuerdo con las observaciones de este estudio, si bien las larvas ocasionaron lesiones a los tallos, no se sugeriría considerar a la especie como plaga o de mayor importancia económica en el caso particular de cultivos de *C. juncea* para abono verde, ya que las plantas se cortan e incorporan antes de su floración. Debemos tener en cuenta que las plantas produjeron nuevas ramas luego del daño ocasionado por el insecto, sin aparente pérdida de biomasa. Sin embargo, a futuro se deberían hacer evaluaciones que permitan cuantificar tal pérdida, si es el caso. Si las plantas han de usarse para la obtención de semillas, al igual que otros autores en el pasado, se debería evaluar su impacto dado que podría ser limitante para la reproducción de la planta (Bair et al. 1957; Castro & Montalvão, 2018).

De acuerdo con el GBIF (2024) América cuenta con 7.626 registros de *U. ornathrix* en 12 conjuntos de datos distribuidos en 53 países. En Colombia, se habían documentado 48 observaciones de la especie en los departamentos de Cundinamarca, Antioquia, Arauca, Boyacá, Casanare, Magdalena, Meta, Caldas, Quindío, Córdoba, Atlántico, Sucre, Norte de Santander, Risaralda y Valle del Cauca (GBIF, 2024; Ortega-Galván et al., 2017); en este trabajo se amplía el registro para los municipios Ariguaní, Guamal, Pivijay, Plato, Sitionuevo, Santa Ana y San Sebastián de Buenavista.

Agradecimientos

Este trabajo fue financiado por el Sistema General de Regalías de Colombia como parte del proyecto "Desarrollo, transferencia de tecnología y conocimiento para la innovación, atendiendo las problemáticas asociadas con la oferta de productos hortofrutícolas, derivadas de la emergencia económica, social y ecológica causada por el COVID-19 en el departamento de Magdalena", con código BPIN 2020000100768.

Conflicto de interés

Los autores declaran que no tienen ningún interés financiero conocido, ni relaciones personales, que pudieran haber influido en el trabajo que se presenta en este artículo.

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(Recibido para publicación / *Received for publication* 29-V-2024)
(Revisado y aceptado / *Revised and accepted* 30-VII-2024)
(Publicado / *Published* 30-IX-2025)

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SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 521-532 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1084 https://shilap.org
https://zoobank.org/23B3800E-D39A-43F5-9F68-FBB990BAB97E

Análisis de la distribución de *Ancylosis sareptalla* (Herrich-Schäffer, 1861) en la península ibérica y descripción de *Ancylosis albaladejoi* Gastón, Huemer & Vives, sp. nov. (Lepidoptera: Pyralidae, Phycitinae)

Javier Gastón, Peter Huemer & Antonio Vives Moreno

Resumen

Se revisa la distribución actual de *Ancylosis sareptalla* (Herrich-Schäffer, 1861) en la península ibérica y se describe *Ancylosis albaladejoi* Gastón, Huemer & Vives, sp. nov. Se presentan los caracteres diferenciales entre ambas especies; las diferencias se refieren al aspecto externo y a la genitalia.
Palabras clave: Lepidoptera, Phycitinae, *Ancylosis albaladejoi*, descripción, nueva especie, península ibérica.

Analysis of the distribution of *Ancylosis sareptalla* (Herrich-Schäffer, 1861) in the Iberian Peninsula and description of *Ancylosis albaladejoi* Gastón, Huemer & Vives, sp. nov. (Lepidoptera: Pyralidae, Phycitinae)

Abstract

The current distribution of *Ancylosis sareptalla* (Herrich-Schäffer, 1861) in the Iberian Peninsula is reviewed and *Ancylosis albaladejoi* Gastón, Huemer & Vives, sp. nov. is described. The differential characters between both species are presented; the differences refer to external appearance and genitalia.
Keywords: Lepidoptera, Phycitinae, *Ancylosis albaladejoi,* description, new species, Iberian Peninsula.

Análise da distribuição de *Ancylosis sareptalla* (Herrich-Schäffer, 1861) na Península Ibérica e descrição de *Ancylosis albaladejoi* Gastón, Huemer & Vives, sp. nov. (Lepidoptera: Pyralidae, Phycitinae)

Resumo

A distribuição atual de *Ancylosis sareptalla* (Herrich-Schäffer, 1861) na Península Ibérica é revista e *Ancylosis albaladejoi* Gastón, Huemer & Vives, sp. nov. é descrita. São apresentadas as características diferenciais entre ambas as espécies; as diferenças referem-se à aparência externa e aos órgãos genitais.
Palavras-chave: Lepidoptera, Phycitinae, *Ancylosis albaladejoi*, descrição, nova espécie, Península Ibérica.

Introducción

Ancylosis sareptalla (Herrich-Schäffer, 1861) es una especie confundida frecuentemente con otra especie críptica; *Ancylosis albidella* Ragonot, 1888, cuyo estatus es discutible. Ambas especies, de gran similitud, sobre todo en sus estructuras de genitalia tanto de machos como de hembras, han pasado por pertenecer inicialmente a taxones diferentes, para posteriormente incluir a la segunda especie como sinonimia de la primera (Leraut, 2014). La controversia posterior desarrollada entre otros autores terminó restituyendo a *Ancylosis albidella* como buena especie (Plant, 2016). La cuestión se centraba básicamente en la existencia o no de un pequeño proceso presente en el borde ventral de las valvas de los machos, justo en el extremo del sacculus. Dicho proceso es muy ostensible en *Ancylosis albidella* y menos visible en *Ancylosis sareptalla*, pudiendo incluso desaparecer, como en la imagen que representa Roesler (1973). Estas consideraciones sobre la presencia o no del proceso en el borde ventral de las valvas de los machos, pueden haber provocado equivocaciones en las identificaciones de ambos taxones. Bidzilya et al. (2019) manifiesta sus dudas sobre la veracidad en la identidad de un ejemplar de *Ancylosis albidella* citado por primera vez de España (Huelva) en la localidad de Torre la Higuera (Asselbergs, 1999). Nosotros compartimos esta opinión y consideramos que *Ancylosis albidella* no vuela en la península ibérica.

La presente investigación se deriva de los resultados obtenidos durante los estudios morfológicos y moleculares de ejemplares capturados por el primero de los autores en la desembocadura de la margen izquierda del río Guadalquivir, en la localidad de Sanlúcar de Barrameda (Cádiz), además de otros ejemplares donados por otros colegas que citamos en los agradecimientos y que proceden de la misma localidad o de la próxima de Marismas de Trebujena (Cádiz). En nuestro caso, todos los especímenes estudiados son, por morfología externa, adscribibles a *Ancylosis sareptalla*. Sin embargo, una vez hechas las preparaciones de genitalia, pudimos comprobar que las diferencias con *Ancylosis sareptalla* o *Ancylosis albidella* eran claramente visibles, sobre todo en las hembras, lo que nos llevó a pensar que estábamos ante una nueva especie, muy próxima a ambas, cuyos tejidos secuenciamos y que procedemos a designar.

De Portugal, se ha citado *Ancylosis sareptalla* de Vila Nova de Milfontes, Baixo Alentejo (Corley et al. 2020), además en el BoldSystems de Odemira, Baixo Alentejo y Vila do Ovispo en Faro. También en el BoldSystems se ha inscrito *Ancylosis albidella* (Asselbergs det.), de Aljezur, Faro. Hemos solicitado a Martin Corley información gráfica de este material y lo hemos comparado con el material obtenido por nosotros.

Material y métodos

El material utilizado para el estudio se ha obtenido mediante muestreos nocturnos y diurnos, con trampas de luz actínica distribuidas en los biotopos apropiados. 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.

El montaje de los órganos genitales se ha efectuado siguiendo a Robinson (1976), con modificaciones. Se han utilizado los microscopios NIKON Eclipse E400 y las cámaras digitales NIKON D3100 para fotografías de las preparaciones y SONY α100 DSLR-A100K con objetivo AF 100 MACRO 1:2,8 (32) para las fotografías de ejemplares montados. Para el retoque fotográfico hemos utilizado el programa de Adobe, Photoshop ©.

Se procesaron y secuenciaron tejidos de 18 muestras en el Centro Canadiense de Código de Barras de ADN (CCDB, Guelph, Canadá) para obtener códigos de barras de ADN utilizando el protocolo estándar descrito por deWaard et al. (2008), disponible en www.dnabarcoding.ca/pa/ge/research/protocols. Además, se utilizaron para el análisis 10 secuencias públicas de BOLD (https://boldsystems.org/; Ratnasingham & Hebert, 2007). Los datos de los especímenes, las coordenadas GPS, las imágenes, las secuencias, los números de acceso al Genbank y los archivos de seguimiento están disponibles a través del conjunto de datos público DS-ANCYLESP New *Ancylosis* species from Spain, dx.doi.org/10.5883/DS-ANCYLESP. Las secuencias se compararon con la biblioteca de referencia de códigos de barras de Lepidoptera utilizando el motor de identificación (BOLD-ID). La base de datos de códigos de barras de referencia para Pyralidae utilizada por BOLD-ID es validada continuamente por especialistas para facilitar la identificación de especies.

Las secuencias se asignaron a números de índice de código de barras (BIN), unidades taxonómicas operativas basadas en algoritmos que proporcionan un indicador preciso de las especies (Ratnasingham & Hebert, 2013). Los BIN se calcularon automáticamente para los registros de BOLD que cumplen con el estándar de código de barras de ADN. Los grados de variación intraespecífica e interespecífica en los fragmentos de código de barras de ADN se calcularon según el modelo de sustitución de nucleótidos de dos parámetros de Kimura, utilizando las herramientas analíticas de BOLD Systems v. 4.0 (http://www.boldsystems.org). El cálculo de la distancia intraespecífica se normalizó aún más utilizando las herramientas de cálculo de BOLD para reducir el sesgo de muestreo a nivel de especie. Se construyó un árbol de unión de vecinos a partir de los datos de códigos de barras de ADN del conjunto de datos utilizando MEGA 11 (Tamura et al. 2021) bajo el modelo de dos parámetros de Kimura para sustituciones de nucleótidos.

Abreviaturas

CINZ	Comisión Internacional de Nomenclatura Zoológica
JG	Javier Gastón (Vizcaya, España)
MNCN	Museo Nacional de Ciencias Naturales, Madrid, España
TLMF	Tiroler Landesmuseum Ferdinandeum, Innsbruck, Austria
SMNK	Staatliches Museum für Naturkunde, Karlsruhe, Alemania
prep. gen.	preparación de genitalia
sp. nov.	especie nueva
fot.	fotografía

Resultados

Ancylosis albaladejoi Gastón, Huemer & Vives, sp. nov.

https://zoobank.org/4EE2088C-7C0D-4E46-B10F-CC4BF0F84B77

Material estudiado: Holotipo, 1 ♀, ESPAÑA, CÁDIZ, La Algaida, a 5 m, Sanlúcar de Barrameda, 4-IV-1999, J. Gastón leg. y col., prep. gen. 9196JG, depositado en el Museo Nacional de Ciencias Naturales, en Madrid, España (MNCN).

Paratipos, 7 ♂, 8 ♀: ESPAÑA, Cádiz, La Algaida, Sanlúcar de Barrameda, a 5 m, 2 ♀, 4-IV-1999, J. Gastón leg. y col.; ídem, 1 ♀, prep. gen. 10699JG; ídem, 1 ♀, prep. gen. 9197JG, Barcoding TLMF_Lep_33618; ídem, 1 ♀, 1-IV-2022, T. Farino leg, J. Gastón col, prep. gen. 9195JG, Barcoding TLMF_Lep_33616; Marismas de Trebujena, a 2 m, Sanlúcar de Barrameda, 1 ♂, 21-II-2020, D. Grundy leg. J. Gastón col., prep. gen. 10709JG. PORTUGAL, Algarve, Carrapateira, 1 ♂, 18-IV-1993, M. Corley col, prep. gen., GP365 (determinado como *A. albidella* por Asselbergs); Ídem, 1 ♀, M. Corley col, prep. gen. 365, GP1272 (determinado como *A. sareptalla* por Asselbergs); Vale Santo, Vila do Bispo, Sagres, 1 ♂, 15-IV-2019, J. Nunes leg., M. Corley col, prep. gen., GP5744. Baixo Alentejo, Vila Nova de Milfontes, 1 ♂, 28-V-2019, M. Corley col, prep. gen., GP5736, Barcoding INV08833 (publicado como *A. sareptalla* en Corley et al. (2020). Beira Litoral, Lagoa de S. José, Mata do Urso, Carriço, Pombal, Leiria, a 47 m, 1 ♀, 28-VII-2017, J. Rosete col. prep. gen., GP5436, Barcoding INV05886 (identificado como *A. sareptalla* en Corley et al. (2018); idem, 1 ♂, 31-III-2018, J. Rosete col.; ídem, 1 ♂, 31-III-2018, J. Rosete col., prep. gen., GP5516; ídem, 1 ♀, 23-VI-2018, J. Rosete col. (ejemplar sin abdomen); ídem, 1 ♂, 11-VIII-2018 J. Rosete col.

Diagnosis: Especie muy próxima a *Ancylosis sareptalla* (Herrich-Schäffer, 1861) (figuras 4, 5, 7 y 10) y *Ancylosis albidella* Ragonot, 1888, con las que comparte patrones morfológicos externos, especialmente con la primera, manteniendo, sin embargo, claras diferencias en la genitalia de ambas, especialmente en la de las hembras. En estas dos especies, el ductus bursae es alargado, sensiblemente cilíndrico y membranoso con algunas pequeñas espinas de base extendida en la parte anterior, justo en el encuentro con el corpus bursae que es predominantemente esférico y en el que se manifiestan dos grupos de abigarradas espinas de base extendida forrando las paredes de forma simétrica y dejando un estrecho canal membranoso en el centro que se abre hacia el extremo anterior del corpus bursae, donde no llegan los grupos de espinas. El encuentro entre el ductus bursae y el corpus bursae es brusco, no progresivo. En el caso de *Ancylosis albaladejoi*, sp. nov. el ductus busae es troncocónico fundiéndose suavemente en el contacto con el corpus bursae, apareciendo éste casi como una prolongación del propio ductus bursae; los dos grupos de espinas presentes en el interior del corpus bursae están mucho menos definidos y compactos, haciendo casi invisible el canal central membranoso. En la genitalia del macho las diferencias son bastante más sutiles, el proceso del margen ventral de las valvas se presenta en mayor o menor medida en las tres especies (aunque es más acusado en *Ancylosis albidella*). Las diferencias de *Ancylosis albaladejoi*, sp. nov. con sus dos parientes se centran en la geometría de las valvas, de bordes paralelos y cucullus poco apuntado y bastante achatado, en la forma de la seta central de la culcita, en el Gnathos y en el menor tamaño del aedeagus que presenta una parte anterior más bulbosa. Este se remata por su parte superior en forma apuntada y redondeada en *Ancylosis albaladejoi*, sp. nov., mientras que es menos apuntado y más redondeado en las otras dos especies.

Descripción del adulto (figuras 1-2): Envergadura, macho 23 mm (n=1), hembra 24,8 mm (n=6). Cabeza bien desarrollada con pelos escamiformes de color ocre claro, compactos en la frente y en la zona alta del epicráneo, incluyendo las órbitas oculares. Palpos labiales bien desarrollados con una longitud que es vez y media la de la cabeza, dirigidos hacia adelante y densamente recubiertos de pelos de color ocre claro. Antenas filiformes recubiertas de pequeñas cerdas de color ocre; el escapo es de pequeño tamaño. Abdomen recubierto de escamas de color ocre oscuro. Alas anteriores con un fondo de escamas de color ocre muy claras salpicadas puntualmente de pequeñas escamas negras; las venas que rodean la celda están recubiertas con escamas de color ocre oscuro; banda de escamas negras en la zona postbasal que partiendo del borde dorsal, donde conectan puntualmente, avanzan hacia el borde costal de forma zigzagueante e inclinándose bruscamente hacia la zona basal del ala; mácula de escamas negras bien visible el parte distal de la celda; línea de escamas negras levemente zigzagueantes en la zona postdiscal y paralelas al margen exterior del ala: otra banda de escamas ocre amarillentas en la banda submarginal. Alas posteriores con ápice redondeado; de color ocre claro uniforme con tendencia a oscurecerse levemente hacia el margen externo que está bordeado con una doble línea de escamas más oscuras.

Genitalia del macho (figura 6): Gnathos con brazos laterales basales bien formados y parte terminal superior con su extremo apuntado y levemente redondeado; tegumen levemente trapezoidal; valvas bien definidas cono bordes paralelos rematadas con cucullus poco redondeado (achatado) y margen costal superior con pliegue ligeramente esclerotizado: leve proceso en el 2/3 del margen ventral de la valva, sacculus bien definido definido; sacus casi cuadrangular; culcita con la seta central del 8º segmento poco acusada y con forma ligeramente triangular: aedeagus cilíndrico, estrecho y alargado

Genitalia de la hembra (figuras 8-9): Papilas anales cortas pero muy desarrolladas; VIII segmento cuadrangular, esclerotizado con el esternito prolongado hacia su parte anterior en contacto con el ostium; antrum membranoso con forma de copa, levemente estrechado en su contacto con el ductus bursae; apófisis posteriores y anteriores de bastante longitud; ductus bursae membranoso, largo, con forma troncocónica, ensanchándose en su parte anterior hasta confundirse con el corpus bursae; el corpus bursae es ovoidal y visualmente es como una prolongación del ductus bursae. El interior del corpus bursae presenta dos grupos agrupados, pero no compactos, de minúsculas espinas de base ensanchada que llegan a invadir la parte anterior del ductus bursae, y que nunca llegan hasta la base del corpus bursae. Esta, es membranosa e invade como una escotadura parte del centro del corpus bursae, separando de una forma poco perceptible los dos grupos de espinas.

Biología: No se conocen los estados inmaduros, ni las plantas nutricias de las orugas. Los adultos vuelan probablemente en una sola generación desde finales de abril a finales de mayo.

Distribución: En base al material estudiado, la especie se distribuye en España desde las zonas costeras o muy próximas a la costa, en el norte de la provincia de Cádiz (margen izquierdo del río Guadalquivir frente al parque nacional de Doñana) y en Huelva. Gracias a Martin Corley, hemos podido estudiar los ejemplares de Portugal, Algarve, Baixo Alentejo y Beira Litoral, comprobando por sus estructuras de genitalia que dichas poblaciones se corresponden con la misma especie que vuela en España, dato avalado por el árbol filogenético como pertenecientes al mismo BIN (Figura 11).

Datos genéticos: BIN BOLD:ABV3903 (n = 13). Según la divergencia COI, la nueva especie comparte su BIN y se superpone en gran medida en su código de barras de ADN con *A. saraptella* (0,31 % de divergencia). El BIN más cercano es una especie no identificada de Ancylosis en BOLD (BIN BOLD:AEW2568 con una distancia p del 4,83 % (n=1). Un análisis de brechas de códigos de barras de 14 *Ancylosis* spp. muestra, según la especie, una divergencia interespecífica de entre el 5 y el 8 % (excepcionalmente solo el 2,3 %) con respecto al vecino más cercano. Aparte de la nueva especie y *A. sareptalla*, sólo *A. yerburii* y *A. labeculella* comparten el BIN. Sin embargo, para esta última pareja de especies aún están pendientes los controles morfológicos.

Discusión

Mientras que durante casi 250 años las especies de insectos se diferenciaban principalmente por sus características morfológicas, en las últimas dos décadas se ha ido imponiendo cada vez más la delimitación de especies mediante secuencias genéticas, en particular el denominado "código de barras de ADN", como método adicional (Hebert et al. 2003). Las diferencias en las secuencias de códigos de barras superiores al 2 % se consideran en muchos grupos de invertebrados un indicio de diferencias interespecíficas (Hausmann et al. 2011). Sin embargo, estas divergencias deben considerarse únicamente como pautas generales y, en algunos grupos de especies, se encuentran diferencias mucho mayores que las evaluadas como intraespecíficas, que pueden superar incluso el 10 % (Huemer & Karsholt 2018, Simonsen & Huemer, 2014). Por el contrario, los códigos de barras idénticos (=compartición de códigos de barras) de dos o, excepcionalmente, de varias especies indican especies evolutivamente jóvenes, o también hibridación e introgresión (Hausmann & Huemer, 2011). Así, Huemer & Hebert (2016) no encontraron ninguna divergencia interespecífica en 43 de las 2.565 especies estudiadas de la zona central de los Alpes y 41 especies mostraron una divergencia baja, inferior al 1 %, con respecto a su vecino más cercano. Entre los taxones estudiados sin divergencias o con divergencias poco pronunciadas se encontraban representantes individuales de taxones superiores muy diferentes, como los de los géneros *Erebia* Dalman, 1816 (Nymphalidae), *Adscita* Retzius, 1783 (Zygaenidae), *Apotomis* Hübner, [1825] (Tortricidae) o *Catoptria* Hübner*,* [1825] y *Scoparia* Haworth, 1811 (Crambidae). *Ancylosis albaladejoi* Gastón, Huemer & Vives, sp. nov. y *A. sareptalla* encajan perfectamente aquí, aunque en el gran estudio mencionado de los Alpes no se conoció ningún caso de código de barras compartido o solapamiento de códigos de barras en Pyralidae. A pesar de la gran coincidencia entre ambas especies- para la también cercana *A. albidella* no se dispone actualmente de secuencias genéticas- en el código de barras de ADN, no hay duda alguna sobre la separación entre especies. Sobre todo, la genitalia de la hembra, pero también en la de los machos, difieren notablemente. Las dos *Ancylosis* confirman así la urgencia de una taxonomía integradora para delimitar las especies utilizando secuencias genéticas y morfología y, en la medida de lo posible, también información biológica.

Ancylosis sareptalla (Herrich-Schäffer, 1861)
Epischnia sareptalla Herrich-Schäffer, 1861. *Neue Schmett*., 28, fig. 145
LT: [RUSIA] Sarepta
= *Epischnia sareptella*; Wocke, 1861, *in* Staudinger & Wocke. *Cat. Lep. Eur*., 22, *grafía posterior incorrecta*
= *Ancylosis barbella* Lederer, 1863. *Wien. ent. Mon., 7*, 43, pl. 1, fig. 9
LT: BULGARIA, Vakry
= *Epischnia sareptella*; Wocke, 1871, *in* Staudinger & Wocke. *Cat. Lep. Eur*., 226, *lapsus calami*
= *Ancylosis albidella* Ragonot, 1888. *Nouv. Phycitidae*, 30
LT: [UZBEKISTÁN], Marghilan [Margelan]
= *Ancylosis sareptella*; Rebel, 1901, *in* Staudinger & Rebel. *Catal. pal. Lep*., 17, *lapsus calami*
= *Ancylosis sareptella*; Hampson, 1901. In N. M. Romanoff. *Mem. Lep., 8*, 225, *lapsus calami*
= *Ancylosis sareptella*; Lhomme, 1935. *Cat. Lepid. Fr. Belg., 2*, 17, *lapsus calami*
= *Ancylosis sareptella*; Roesler, 1973, *in* Amsel, Gregor & Reisser. *Microlep. Palaeartic., 4*, 323, *lapsus calami*
= *Ancylosis sareptella gulbaharensis* Roesler, 1973, *in* Amsel, Gregor & Reisser. *Microlep. Palaearctic., 4*, 325, pl. 15, fig. 127a.
TL: AFGANISTÁN, Gulbahar
= *Ancylosis sareptella*; Leraut, 1980. *List Syst. Syn. Lep. Fr. Bel.* Cors., 113, *lapsus calami*
= *Ancylosis sareptella*; Sinev, 1986, *in* Medvedev. *Keys Insects Eur. USSR, IV*(III), 326, *lapsus calami*
= *Ancylosis sareptella*; Karsholt & Razowski, 1996. *Lep. Eur*., 178, *lapsus calami*
= *Ancylosis sareptella*; Slamka, 1997. *Zünsl. Mittel*., 10, *lapsus calami*
= *Ancylosis sareptalla*; Nuss et al., 2003-2024. https://www.pyraloidea.org
= *Ancylosis sareptella*; Vives Moreno, 2014. *Cat. Sys. Syn. Lep.*, 410, *lapsus calami*
= *Ancylosis sareptalla*; Leraut, 2014. *Moths Eur., 4*, 395
= *Ancylosis sareptalla*; Rennwald & Rodeland, 2014. *Ancylosis sareptalla* - LepiWiki
= *Ancylosis sareptalla*; Beccaloni et al. 2018. LepIndex - sareptalla
= *Ancylosis sareptalla*; Bidzilya et al. 2019. *Zootaxa, 4657*(3), 444
= *Ancylosis sareptella*; Sinev, 2019, *Cat. Lep. Russia*, 175, *lapsus calami*
= *Ancylosis sareptalla*; GBIF (2023). https://www.gbif.org/es/species/7214335

Nota: La ortografía correcta, según la CINZ (1999), del nombre introducido originalmente en la literatura como *Epischnia sareptalla* Herrich-Schäffer, 1861 y por Wocke (1861, *in* Staudinger & Wocke) en el mismo año como *E. sareptella*, es controvertida y actualmente objeto de un estudio detallado por parte de Rennwald et al. (in litt.).

Distribución: *Ancylosis albaladejoi,* sp. nov., habita en una zona que comprende la franja atlántica al oeste y suroeste de la Península, claramente distante y con biotopos diferentes a los correspondientes de las únicas citas que se conocen de *Ancylosis sareptalla,* que se establecen en el parque natural de las Lagunas de Ruidera, en la región de Castilla-La Mancha, en las provincias de Albacete y Ciudad Real (Lepiforum, eV, 2025) y en Vallbona d'Anoia, Barcelona (Pérez de Gregorio et al. 2023); también tenemos los siguientes datos encontrados en GBIF (2023), en: Alicante, Villena, a 526 m, 25-VI-2023, D. Molina Molina leg.; Almería, Adra, a 4 m, 7-VII-2022, Faluke leg.; Barcelona, San Pedro de Torelló (Sant Pere de Torelló), a 621 m, 23-IV-2023, J. Fans leg.; Castellón de la Plana, Sierra de Irta, 25-VI-2022, F. Arnau leg.; Guadalajara, Tordellego, a 1245 m, 23-VII-2022, P. A. Lázaro Molina leg.; Huesca, Castillazuelo, a 368 m, 16-VIII-2023, P. Antonio Lázaro leg.; Valencia, Bocairente (Bocairent), a 622 m, 2-VI-2022, F. García Alonso leg.; Sierra de la Ombría-Pou Clar, 12-VII-2022, A. Conca Ferrás leg.; Zaragoza, Navardún, a 526 m., 11-IV-2022, P. Soria Bellido leg.

Por los datos ofrecidos anteriormente habría que eliminar la presencia de *Ancylosis sareptalla* de Portugal, donde sería sustituida por *Ancylosis albaladejoi,* sp. nov. Bidzilya et al. (2019) incluye entre el material estudiado de *Ancylosis sareptalla* una cita de Sanlúcar de Barrameda, Cádiz, depositado en el SMNK en Alemania. Es muy probable que se trate de *Ancylosis albaladejoi,* sp. nov. y no de *A. sareptalla*. Sobre las citas de *Ancylosis albidella* (actualmente se considera una sinonímia de *Ancylosis sareptalla*) de Torre de Higuera, Huelva en España (Asselbergs, 1999) y Aljezur, Faro en Portugal, queda demostrado que se refieren ambas a *Ancylosis albaladejoi*, sp. nov., por lo que se elimina ese taxón de la fauna de la península ibérica. El mapa de distribución actual de *Ancylosis albaladejoi* Gastón, Huemer & Vives, sp. nov. y *Ancylosis sareptalla* (Herrich-Schäffer, 1861) se representa en la Figura 12.

Etimología: Se dedica esta especie a Gonzalo Albaladejo, biólogo y colaborador en diferentes salidas al campo.

Siguiendo a Vives Moreno (2014), *Ancylosis albaladejoi* Gastón, Huemer & Vives, sp. nov., debería de situarse delante de *A. imitella* Hampson, 1901 *in* Ragonot, sustituyendo a *A. albidella* Ragonot, 1888.

Agradecimientos

Agradecemos la colaboración y la ayuda prestada por las siguientes personas e Instituciones: a Teresa Farino (España) y Dave Grundy (Reino Unido) por proporcionarnos material de estudio, a Emili Requena por aportarnos registros de *Ancylosis sareptalla* de Cataluña (España), al Dr. Oleksiy Bidzilya (Ucrania), Martin Corley (Reino Unido) y João Nunes (Portugal) por facilitarnos documentación gráfica de *Ancylosis sareptalla*, a Friedmar Graf (Alemania) por autorizarnos el uso de sus fotografías editadas en Lepiforum y por proporcionarnos muestras destinadas a las secuencias genéticas, a la Dra. Susana Cobacho (MNCN, España) por asesorarnos en la parte genética del trabajo, a la Dra. Amparo Blay (MNCN, España), por su ayuda en la consulta del material depositado en esta institución, al Dr. Miguel Ángel Alonso de Zarazaga (MNCN, España) por su ayuda con la CINZ y a la Dirección General de Medio Ambiente de Andalucía por las autorizaciones concedidas para la realización de los muestreos. Por último, los autores agradecen a Paul D. N. Hebert y a su equipo del Centro Canadiense de Código de Barras de ADN (Guelph, Canadá), cuyo trabajo de secuenciación fue posible gracias a la financiación de Genome Canada a través de Ontario Genomics, así como al Ministerio de Investigación e Innovación de Ontario y al NSERC por su apoyo a la plataforma informática BOLD y a varios colegas que han puesto a disposición del público sus datos de código de barras.

Conflicto de interés

Los autores declaran que no tienen ningún interés financiero ni relación personal que pudiera influir en el trabajo presentado en este artículo.

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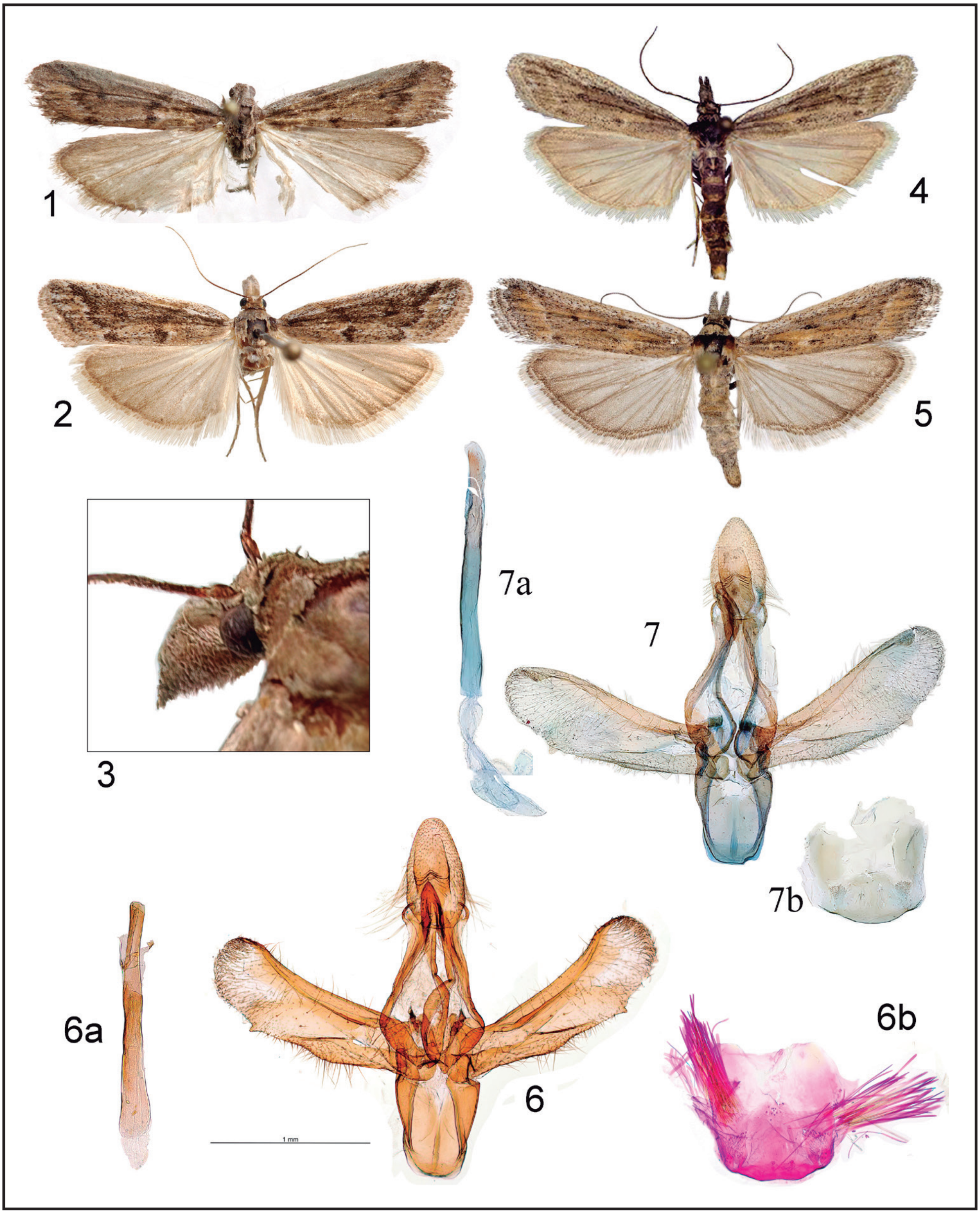
(Recibido para publicación / *Received for publication* 9-I-2025)
(Revisado y aceptado / *Revised and accepted* 10-II-2025)
(Publicado / *Published* 30-IX-2025)

Figuras 1-7. Adultos y genitalia del macho. **1.** *Ancylosis albaladejoi* Gastón, Huemer & Vives, 2025, Paratipo ♂, Marismas de Trebujena, Cádiz, España. **2.** *Ancylosis albaladejoi* Gastón, Huemer & Vives, 2025, Holotipo ♀, La Algaida, Sanlúcar de Barrameda, Cádiz, España. **3.** *Ancylosis albaladejoi* Gastón, Huemer & Vives, 2025, ♂, Carrapateira, Algarve, Portugal, detalle de cabeza y palpos, imagen cedida por Martin Corley. **4.** *Ancylosis sareptalla* (Herrich-Schäffer, 1861) ♂, Kherson reg., imagen cedida por el Dr. Oleksiy Bidzilya. **5.** *Ancylosis sareptalla* (Herrich-Schäffer, 1861) ♀, Lagunas de Ruidera, Albacete, España, imagen cedida por Friedmar Graf. **6.** *Ancylosis albaladejoi* Gastón, Huemer & Vives, 2025, Paratipo, prep. gen. 10709JG. **6a.** Ídem, aedeagus. **6b.** ídem, culcita. **7.** *Ancylosis sareptalla* (Herrich-Schäffer, 1861), imagen cedida por el Dr. Oleksiy Bidzilya.



Figuras 8-10. Genitalia de la hembra. **8.** *Ancylosis albaladejoi* Gastón, Huemer & Vives, 2025, Holotipo, prep. gen. 9196JG. **9.** *Ancylosis albaladejoi* Gastón, Huemer & Vives, 2025, Paratipo, prep. gen. 9195JG. **10.** *Ancylosis sareptalla* (Herrich-Schäffer, 1861), imagen cedida por Friedmar Graf.

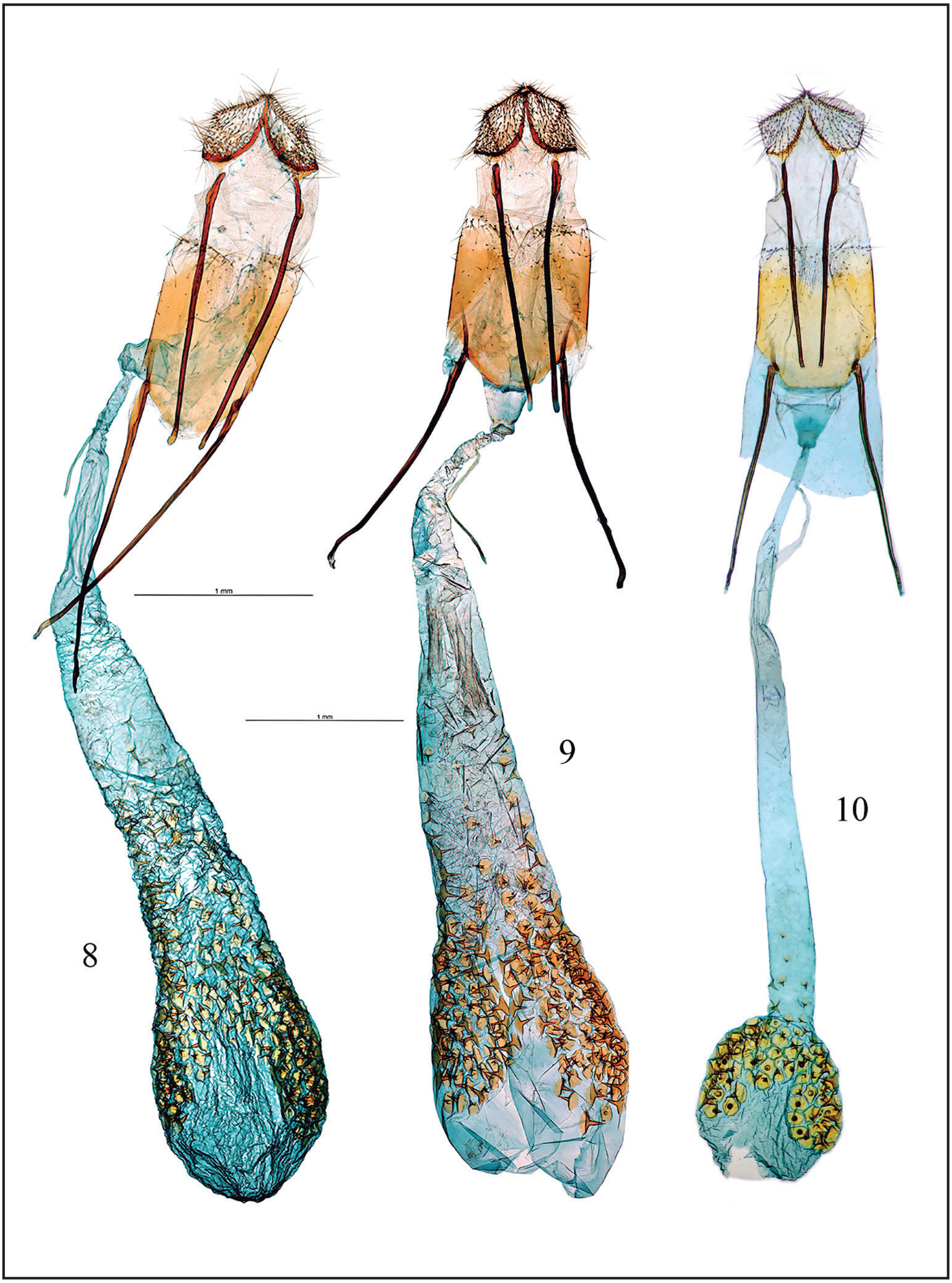


Figura 11. Árbol de unión de vecinos de especies seleccionadas del *Ancylosis* (Kimura 2-parámetros), construido con MEGA 11 (Tamura et al. 2021), con *Nyctegretis lineana* (Scopoli, 1763) como grupo externo. Fuente: datos de código de barras de ADN de BOLD (Base de datos del código de barras de la vida; Ratnasingham 2018).

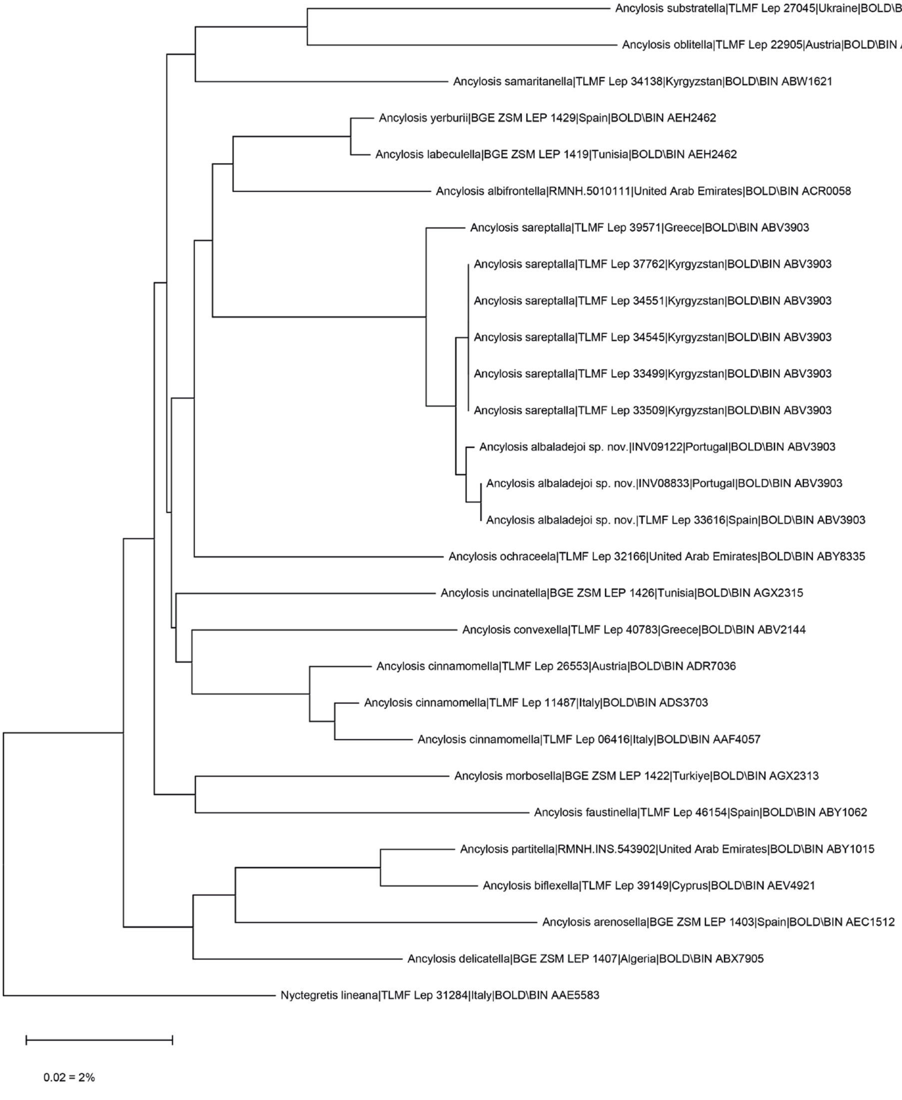
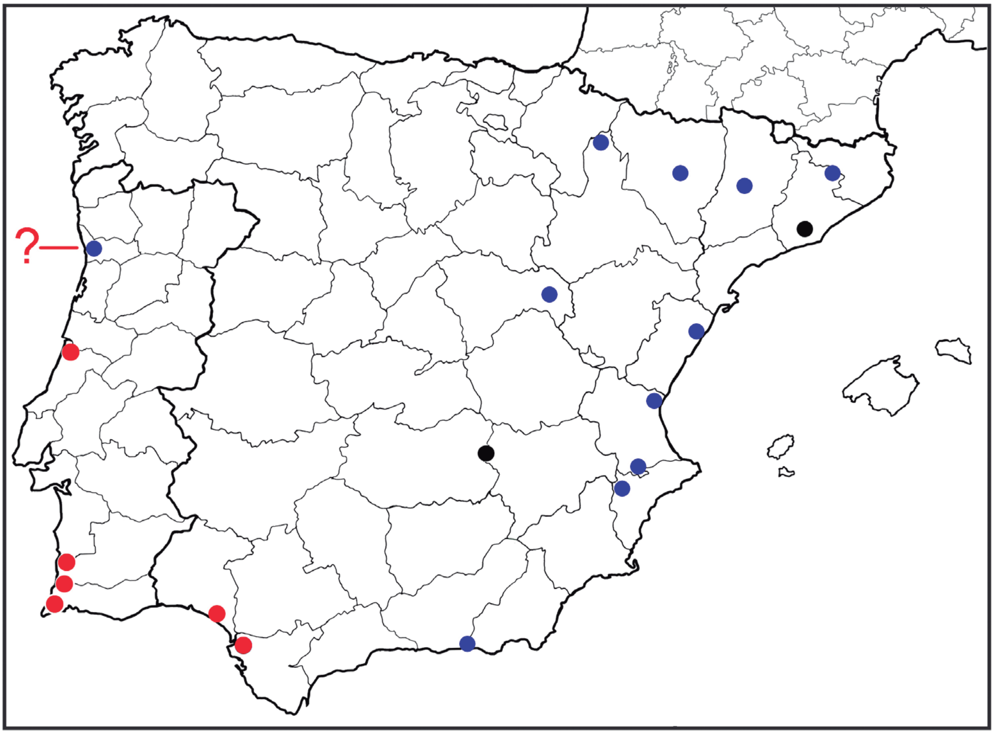


Figura 12. Mapa de distribución en la península ibérica de los ejemplares examinados de *Ancylosis albaladejoi* Gastón, Huemer & Vives, 2025, (círculos rojos) y *Ancylosis sareptalla* (Herrich-Schäffer, 1861), (círculos negros). Los círculos azules representan las citas (no examinadas) de *Ancylosis sareptalla* (Herrich-Schäffer, 1861) obtenidas del portal de internet GBIF.



SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 533-542 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1085 https://shilap.org
https://zoobank.org/1E919B90-059A-4318-864C-98892D250445

Multigene analysis of *Leucoma wiltshirei* Collenette, 1938 using combined mitochondrial and nuclear DNA sequences (Lepidoptera: Erebidae)

Asadollah Hosseini-Chegeni & Majid Tavakoli

Abstract

The study focuses on molecular identification of *Leucoma wiltshirei* Collenette, 1938, a significant pest in Iranian oak stands. It employs DNA sequencing of mitochondrial and nuclear gene fragments for accurate identification. The 12S rRNA gene region is highlighted for its suitability in identifying *Leucoma* Hübner, [1822] species. The analysis revealed genetic characteristics and diversity within the *Leucoma wiltshirei* gene fragments, contributing valuable information for species identification and understanding their evolutionary relationships.

Keywords: Lepidoptera, Erebidae, *Leucoma*, genetic identification, mtDNA, nDNA, Oak pest, phylogenetic analysis, taxonomic uncertainties, Zagros forests, Iran.

Análisis multigénico de *Leucoma wiltshirei* Collenette, 1938 utilizando secuencias combinadas de ADN mitocondrial y nuclear (Lepidoptera: Erebidae)

Resumen

El estudio se centra en la identificación molecular de *Leucoma wiltshirei* Collenette, 1938, una plaga importante en los robledales iraníes. Se emplea la secuenciación del ADN de fragmentos de genes mitocondriales y nucleares para una identificación precisa. Se destaca la región del gen 12S rRNA por su idoneidad para identificar especies de *Leucoma* Hübner, [1822]. El análisis reveló características genéticas y diversidad dentro de los fragmentos génicos de *Leucoma wiltshirei*, aportando información valiosa para la identificación de especies y la comprensión de sus relaciones evolutivas.

Palabras clave: Lepidoptera, Erebidae, *Leucoma*, identificación genética, ADNmt, ADNn, plaga del roble, análisis filogenético, incertidumbres taxonómicas, bosques de Zagros, Irán.

Introduction

Insect pests can indeed pose significant challenges to oak forests, and their interactions with trees are a complex aspect of forest ecosystems (Ferrenberg, 2016). While insects are indeed integral to ecosystems and play various roles (Haack & Byler, 1993), certain pest species can negatively impact forest biological balance due to climate-triggered insect defoliators as mentioned in Abdi (2019) and the abundance of natural enemies (Nealis, 1991). Exactly, caterpillars and other leaf-feeding insects can pose a significant threat to oak trees (Evans, 1987). Zagros forests of Iran are classified into two distinct parts located in northern and southern Zagros. In the latter, *Quercus brantii* Lindl. dominates the forest ecosystem (Sagheb-Talebi et al. 2014). The defoliation caused by Lepidoptera pests can have significant implications for the overall health and vitality of the oak ecosystems (Kulman, 1971). Indeed, *Leucoma wiltshirei* Collenette, 1938 is recognized as a key pest that can cause substantial damage to oak trees in the Zagros forests (Sadeghi et al. 2009). The historical description of *L. wiltshirei* based on a holotype collected by the pioneer lepidopterologist Edward Parr Wiltshire in 1935 from Rawandiz in the Kurdistan region of Iraq, is significant. This early documentation is a key reference in the systematics, distribution, bionomy and population dynamics as well as of control measures of *L. wiltshirei,* a destructive pest in Iranian oak stands (Abai, 1980; Abai, 1981). Despite this degree of importance of the pest, there is a need for accurate and early detection. Recording the identity DNA sequences of the pest, brings several advantages for both forest pest control managers and researchers involved in systematic study and taxonomy. Identifying pests using genetic sequences is a valuable and increasingly common approach in modern biological research (Hebert et al. 2003). Genetic data such as DNA sequencing can provide a more precise and comprehensive understanding of the pests' taxonomy and their evolutionary relationships (Hosseini-Chegeni & Tavakoli, 2023; Karthika et al. 2016). This study focusing on the molecular identification of *L. wiltshirei* and the phylogenetic analysis using mitochondrial and nuclear DNA gene sequences. The study's focus is praised as a commendable and comprehensive approach to address the challenges posed by *L. wiltshirei* in Iranian oak stands.

Methods

Sample collection and identification

Leucoma adults were collected in northern Khuzestan province, located in the zone of southern Zagros. These samples captured during the outbreak occurred during the spring and summer of 2022 in the region. Dead specimens were transferred to the laboratory for morphological identification, which included examining wing venation and genitalia, in accordance with traditional methods used in lepidopteran taxonomy (Abai, 1980), and followed by molecular assays.

Table 1. Primer details and PCR conditions used in this study.

Gene	Primer sequence (5´→3´)	Product size* (bp)	Touchdown temperature profile
D-18S rRNA	F: GAG GGA GCC TGA GAA ACG G R: ACC TTG TTA CGA CTT TTA CTT CCT CTA	1465-8	95 °C—4 min; 94 °C—1 min, 60–50 °C—30 s (annealing at 60 °C with 1°C decrease per cycle until 50 °C), 72 °C—90 s [× 10]; 94 °C—1 min, 50 °C—30 s, 72 °C—90 s [× 30]; 72 °C—10 min
U-18S rRNA	F: GAG GGA GCC TGA GAA ACG G R: ACC TTG TTA CGA CTT TTA CTT CCT CTA	1465-8	
Ef1α	F: CCC GTT TCG AGG AAA TCA A R: GCA GCA TCA CCA GAT TTG AT	706	
12S rRNA	F: TTA ATA ACT AAT TTT GTG CCA GC R: GAC GGG CAA TAT GTA CAT	560, 594	
Cytb	F: CAT ATT GGR CGA RGA ATT TAT TAT G R: GCA ATW ACT CCY CCT AAT TTA TTA G	590	
COI	C1-J-1718**: GGA GGA TTT GGA AAT TGA TTA G C1-N-2776***: GGA TAA TCA GAA TAT CGT CGA G	1106	

* Product sizes were calculated according to sequences of different *Leucoma* species deposited in GenBank,
** Simon et al. (1994), *** Hedin & Maddison (2001)

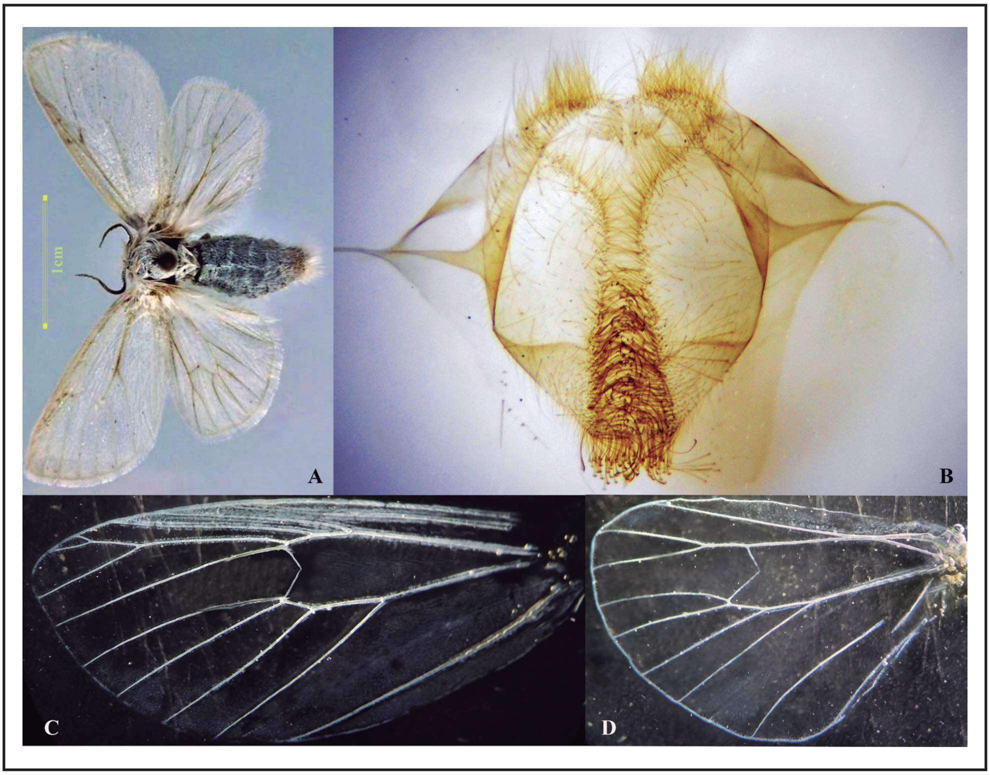
DNA extraction, amplification and sequencing

Genomic DNA (gDNA) of a representative whole female was extracted using the ionic detergent cetyltrimethylammonium bromide (CTAB; Merck, Darmstadt, Germany) and a chloroform-isoamyl alcohol mixture according to Doyle & Doyle (1987). DNA sample was tested to amplify six partial gene fragments of the moth specimen by polymerase chain reaction (PCR) using the primers (Table 1) designated for the first time in this study except primer *COI* gene. For designing of the primers, GenBank sequences of different *Leucoma* species were aligned using GeneDoc® v. 2.7 (Nicholas et al. 1997) and the desired conserved loci were selected by visual observation. Selected fragments were analyzed using Oligoanalyzer v. 3.1 (www.eu.idtdna.com/analyzer/applications/oligoanalyzer) (Integrated DNA Technologies, Iowa, USA). The specificity of the candidate primers for our PCR was tested in NCBI primer BLAST database (www.ncbi.nlm.nih.gov/tools/primer-blast) in order to finding oligos specific to our PCR template. The various target genes consist of mitochondrial genomic: cytochrome oxidase subunit I (*COI*), cytochrome b (*CytB*), small subunit (SSU) ribosomal RNA (rRNA) of the mitochondrial ribosome (12S rRNA) and nuclear genomic: upward (U-18S rRNA) and downward (D-18S rRNA) small subunit ribosomal RNA, elongation factor 1-alpha (*Ef1α*). Finally, the oligonucleotide primers were synthesized by the SinaClon company (Tehran, Iran). PCR reactions were performed in 30 µl mixture consisting of 10.5 µl double-distilled water, 15.5 µl Master Mix RED® (Ampliqon, Odense, Denmark), 1 µl from each 10 pM primers, 2 µl gDNA template (50–100 ng/µl) in a thermocycler, BioRad MyCycler® (Applied Biosystems, Waltham, MA, USA). PCR products were visualized by electrophoresis on 1% agarose gel stained with SYBR® safe DNA gel stain (Invitrogen, Burlington, USA), and finally submitted to a third-party service provider for Sanger sequencing. Sequencing was done on Applied bioSyestems-ABI, 3130XL in the Codon Genetic Group®-Iran, using the same primers as in PCR as two directional. The ABI output sequences were edited manually using FinchTV® (Qt Company, Espoo, Finland). All sequences were submitted to GenBank via BankIt® and accession numbers were assigned.

Phylogenetic analysis

The nucleotide sequences were compared to taxa available in GenBank using BLASTn analyses (https://blast.ncbi.nlm.nih.gov/Blast.cgi) to identify the correct species or homologous. We employed a focused approach by limiting BLASTn analysis to *Leucoma* genus, to obtain more specific and relevant results. Subsequently, all sequences were submitted to GenBank via BankIt® and accession numbers were assigned. Sequences were aligned using SeaView v. 5.0.4 (PRABI-Doua, Lyon, France) (Gouy et al. 2010), and genetic differences (distance matrix) among the *Leucoma* sequences were calculated using Maximum Composite Likelihood in the MEGA11 software (Tamura et al. 2021). A merged alignment sheet created that includes sequences from different genes 18S rRNA (upward and downward regions), *Ef1α*, 12S rRNA, *Cytb* and *COI* sequences belonging to lepidopteran taxa. The taxa include six genera and seven species of superfamily Noctuoidea, with *L. wiltshirei* (this study) and other species like *L. salicis* (Linnaeus, 1758), *Lymantria dispar* (Linnaeus,1758), *Euproctis similis* (Fuessly, 1775), *Catocala fraxini* (Linnaeus, 1758) (Erebidae) as in-group, and *Spodoptera exigua* (Hübner, [1808]) and *Lithophane socia* (Hufnagel, 1766) (Noctuidae) as outgroup. Finally, sequences from the present study and the GenBank nucleotide data were analyzed to construct a combined phylogenetic tree by MEGA11. Before that, a Partition Homogeneity Test (PHT) or Incongruence Length Difference (ILD) with heuristic search was performed under one thousand replicates between 18S rRNA (upward and downward), *Ef1α*, 12S rRNA, *Cytb* and *COI* sequences by PAUP v. 4.0 (Swofford, 2002). Phylogenetic relationships between taxa were inferred using the Neighbor Joining (NJ) method including in- and out-group taxa. The clades were arranged and labelled based on bootstrap support value, the genetic distance computed among the taxa and comparison to the outgroups. Moreover, for the clade *Leucoma* different support values containing 50% majority rule consensus, Clade Credibility and Posterior Probability were calculated using PAUP, MrBayes v. 3.2.7a (Huelsenbeck and Ronquist, 2001), BEAST v. 2.5 (Bouckaert et al., 2019) software, respectively. Jalview v. 2.11.3.2 software (Waterhouse et al. 2009) was used to determine the variable and conserved sites of six partial gene sequences of *Leucoma* and related taxa. The conserved, variable sites (parsim-informative sites and singletons) among the sequences in this study were determined using MEGA11.

Figure 1. *Leucoma wiltshirei*. **A.** female dorsal view. **B.** her genitalia. **C.** forewing D. hindwing (mounted on microscopic slide).



Results

Morphological identification: In total, 10 moth samples of the study were identified as female *Leucoma wiltshirei* based on the wing venation and genitalia characteristics (Figure 1). All these samples were collected from *Quercus brantii*, which is noted as the sole host of this particular pest in southern Zagros.

Two directional sanger sequencing: After sequence editing, the number of nucleotides for different genes in the study are as follows: D-18S rRNA: 488 bp, U-18S rRNA: 455 bp, *Ef1α*: 693 bp, 12S rRNA: 561 bp, *Cytb*: 572 bp, *COI*: 914 bp. Distance matrix (differences) show genetic similarity to *L. salicis* between one to 16% and among different *Leucoma* sequences available in GenBank (Table 2). Accession numbers for the sequences are including OQ596329.1 (*Ef1a*), OQ596330.1 (*Cytb*), OQ599898.1 (12S rRNA), OQ586447.1 (D-18S rRNA), OQ586442.1 (U-18S rRNA), OP221142.1 (*COI*).Phylogenetic analysis of the combined data set: A Partition Homogeneity Test (PHT) generated a *p* value of 0.47. Considering the incongruence threshold of $p = 0.05$ (Cunningham, 1997), suggesting that the datasets for D-18S rRNA, U-18S rRNA, *Ef1α*, 12S rRNA, *Cytb*, and *COI* were not substantially incongruent and could be combined for analysis. The combined phylogenetic tree is typically built based on genetic data, and the process involves comparing genetic sequences to estimate the evolutionary distances between different species (Figure 2). The combined phylogenetic tree showed evolutionary distances between *Leucoma wiltshirei* and nearest taxa, with 11% similarity to *Lymantria dispar* and 14% to *Euproctis similis*. The phylogenetic tree revealed distinct clades, with the family Noctuidae (*Spodoptera exigua* and *Lithophane socia*) forming a more distinct evolutionary lineage. The phylogeny of the various Lepidoptera genera is rooted in clades of selected out-group genera. Visual analysis using Jalview software indicated that the 12S gene region exhibited the greatest diversity among the studied taxon sequences (Figure 3), making it suitable for identifying *Leucoma* species. Other gene fragments, such as *COI*, *Cytb*, and *Ef1α*, followed in terms of diversity. D-18S rRNA and U-18S rRNA genetic regions showed the lowest diversity, suggesting their conservation across studied species but may not be suitable for species-specific diagnosis. A total of 2877 conserved sites, 819 variable sites, and 426 parsimony-informative sites were identified using MEGA11. These sites provided insights into functional regions, genetic diversity, and evolutionary relationships in the studied sequence alignment or dataset.

Figure 2. NJ bootstrap consensus combined tree (MEGA11) of Superfam.: Noctuoidea inferred from the molecular data set (3734 bp + gaps) including six partial gene sequences of *Leucoma* and related taxa as in-group (Fam.: Erebidae): 1: 488-bp D-18S rRNA, 2: 455 bp U-18S rRNA, 3: 693-bp Ef1α, 4: 561-bp 12S rRNA, 5: 572-bp Cytb, 6: 914-bp COI. Bootstrap values of *Leucoma* clade are in bold included NJ (MEGA11), NJ 50% majority rule consensus tree (PAUP), MP 50% majority rule consensus tree (PAUP), BI clade 10 credibility value (MrBayes), BI posterior probability value (BEAST), respectively. The taxon sequenced in the present study is highlighted in bold. Spodoptera exigua and 12 Lithophane socia (Fam.: Noctuidae) are included as out-group. BI: Bayesian Inference, D: 13 Downstream, MP: Maximum Parsimony, NJ: Neighbor-Joining, U: Upstream).

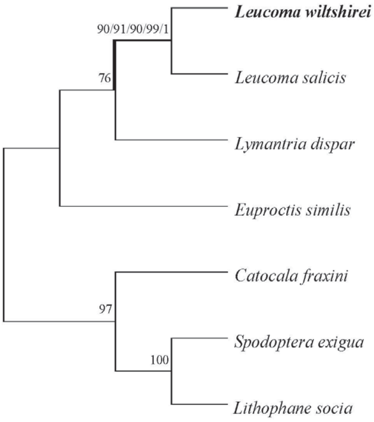


Figure 3. Variable and conserved sites of six partial gene sequences of *Leucoma* and related taxa mentioned in figure 2. Tiny color rods embedded in the dark part representing genetic variability.

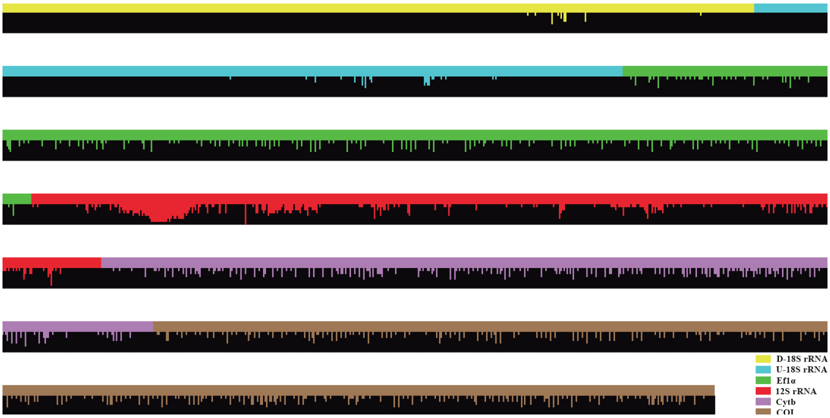


Table 2. Genetic distance between *Leucoma wiltshirei* and different *Leucoma* sequences available in GenBank based on Maximum Composite Likelihood (MCL) calculated by MEGA11.

Gene	*L. candida*	*L. chrysoscela*	*L. luteipes*	*L. melanoscela*	*L. nyingchiensis*	*L. parallela*	*L. salicis*	*L. sartus*	*L. sericea*
D-18S rRNA							1		
U-18S rRNA							2		
Ef1α		7					10		10
12S rRNA		7					8		
Cytb		15					15		
COI*	17	18	15	18	13	18	16	22	19

*Due to the limitations in the available COI sequence data, only 425 base pairs were calculated for comparison with the species (except *L. salicis*).

Discussion

This study confirms the identity of *Leucoma wiltshirei* through genetic analysis of mitochondrial and nuclear DNA. The 12S rRNA mitochondrial gene region exhibits the greatest diversity, making it suitable for identification. Other gene fragments, such as *COI*, *CytB*, and *Ef1α*, also show diversity. D-18S rRNA and U-18S rRNA genetic regions are more conserved and less suitable for species-specific diagnosis. Our study was devised and executed to resolve taxonomic uncertainties surrounding the identity, employing a multi-gene molecular analysis. Mitochondrial and nuclear ribosomal RNA genes have been more widely used to deduce relationships among various Lepidoptera taxa (Elameen et al. 2024; Ma et al. 2020; Wiemers et al. 2010; Zhao et al. 2019). Wahlberg et al. (2009) discovered a significant and well-supported discrepancy between the results obtained from mitochondrial DNA and those from nuclear DNA when estimating the species relationships within the genus *Polygonia* (Lepidoptera: Nymphalidae). Bertrand et al. (2014) demonstrate congruent patterns of nuclear and mitochondrial lineages for the *Urbanus* Hübner, [1807] complex (Lepidoptera: Hesperiidae), based on Bayesian phylogenetic trees constructed from *COI*, *Cytb*, and *Ef1α* sequences. Pazhenkova & Lukhtanov (2019) emphasized the importance of simultaneously analyzing nuclear and mitochondrial genes in *Brenthis* Hübner, [1819] (Lepidoptera: Nymphalidae) to assess their compatibility with morphological species. The key finding is that the specific nuclear genome is more specific in determining the borders of morphological species compared to the specific mitochondrial genome alone or the combination of mitochondrial and nuclear genes. DNA sequence data have provided new insights into the origins of the hawkmoth genus *Hyles* Hübner, [1819] (Lepidoptera: Sphingidae). The authors utilized a combination of mitochondrial sequences (e.g., *COI*) and nuclear sequences such as *Ef1α* (Hundsdoerfer et al. 2009). Zahiri et al. (2012) unveils the most robust phylogenetic hypothesis to date for the higher taxa within Erebidae, leveraging novel molecular data from eight independent gene regions including mitochondrial gene (*COI*) and seven nuclear genes (such as *EF-1α*). Mitochondrial and nuclear sequences were utilized to differentiate closely related species of the genera *Plebejus* (Vodolazhsky & Stradomsky, 2010) and *Polyommatus* Latreille, 1804 (Vodolazhsky et al. 2011) (Lepidoptera: Lycaenidae).

In our study, the phylogenetic tree analysis of superfamily Noctuoidea revealed that *Leucoma wiltshirei* shares a common ancestor with *L. salicis*. These two species, along with *Lymantria dispar* and *Euproctis similis*, form a cohesive clade within the Erebidae family, totaling four species. Interestingly, *Catocala fraxini*, another member of the Erebidae family, is positioned outside this clade and instead clusters with species from the out-group of the Noctuidae family, specifically *Spodoptera exigua* and *Lithophane socia*. This discovery indicates the presence of paraphyly within the Erebidae family, which is also mentioned in Zahiri et al. (2012) about the genus *Rivula* Guenée, [1845] and the Phaegopterina subtribe within the Erebidae Lepidoptera, discussing some paraphyletic taxa. However, it's claimed that the relationships among the four families within the Noctuoidea, such as Noctuidae and Erebidae, are not clear (Zahiri et al. 2023). The superfamily Noctuoidea is indeed a large taxonomic group within the order Lepidoptera. It comprises several families, one of which is the family Erebidae. As of last update, it included approximately 1,760 genera and 24,569 species, making it one of the largest families within the superfamily Noctuoidea (van Nieukerken et al. 2011).

In our multi-gene analysis, we employed five methods, namely Neighbor-Joining (NJ), NJ with 50% majority rule consensus, 50% majority rule consensus using Maximum Parsimony (MP), clade credibility value from Bayesian Inference (BI), and posterior probability value from BI, to evaluate the accuracy of the *Leucoma* clade. Various phylogenetic software tools were utilized for this assessment. The accuracy of this clade, which comprises two species, *L. wiltshirei* and *L. salicis*, ranged from 90% to 100%. Dai et al. (2012) utilized five distinct analysis methods-Maximum Likelihood (ML), Neighbor-Joining (NJ), "best close match" (BCM), Minimum Distance (MD), and a BP-based method-across both single-gene and multiple-gene analyses to support the monophyly of the moth genus *Dendrolimus* Germar, 1812 (Lepidoptera: Lasiocampidae). As well as the simultaneous use of mitochondrial and nuclear genomes for phylogenetic analysis has been employed to study butterflies of this genus. The results indicate that the interpretation of nuclear and mitochondrial data can differ, leading to varying conclusions about species differentiation (Kononov et al. 2016).

Our examination revealed 2877 conserved sites, 819 variable sites, and 426 parsimony-informative sites. These findings offer vital genetic insights necessary for evaluating the distribution and population dynamics of this significant pest species with global implications. Similar investigations aiming for polymorphism, genetic diversity, and genetic structure assessment have been conducted on various moth species worldwide, such as the study by Chen et al. (2013) analyzing *Lymantria dispar* (Lepidoptera: Erebidae) in China. Our analysis revealed genetic characteristics and diversity within the *Leucoma wiltshirei* gene fragments, contributing valuable information for species identification and understanding their evolutionary relationships.

Conclusion

This study confirms the identity of *Leucoma wiltshirei* through multi-gene molecular analysis, highlighting the 12S rRNA mitochondrial gene as the most diverse and suitable for identification. The phylogenetic analysis shows that *L. wiltshirei* and *L. salicis* form a cohesive clade within the Erebidae family, with significant paraphyly observed in the family. The findings provide essential genetic insights for species identification and understanding evolutionary relationships, with implications for managing this pest species globally.

Acknowledgments

That's great to acknowledge Ms. Fatemeh Ehteshami for her contribution to the collection of moth specimens. This research was financially supported by Lorestan University (project No. 1401-6-01-24-53-1403).

Conflit of Interest

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

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(Recibido para publicación / *Received for publication* 6-VII-2024)
(Revisado y aceptado / *Revised and accepted* 15-XII-2024)
(Publicado / *Published* 30-IX-2025)

SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 543-550 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1086 https://shilap.org
https://zoobank.org/ABBD5D6E-7938-40DB-875A-6D8ECAADF256

Molecular identification of *Trichogramma* Westwood, 1833 species as egg parasitoids of *Ostrinia nubilalis* (Hübner, 1796) in corn production areas of Sakarya province in Türkiye (Insecta: Lepidoptera, Hymenoptera)

Fahriye Sümer Ercan & Sevcan Öztemiz

Abstract

The study focuses on using ITS2 sequences from rDNA for systematic studies of *Trichogramma* Westwood, 1833 species. ITS2 sequences have shown to be reliable in distinguishing *Trichogramma* species. Accurate identification of natural enemies is essential for biological control programs. The aim of the study is to compare rDNA-ITS2 sequences from *Trichogramma* samples with sequences in GenBank. By utilizing ITS2 as a barcode, the study aims to achieve dependable species identification and evaluate genetic diversity within *Trichogramma* species. ITS2 sequence was used to differentiate two *Trichogramma* species, *Trichogramma euproctidis* (Girault, 1911) and *Trichogramma brassicae* Bezdenko, 1968 collected from Sakarya province of Türkiye. The ITS2 sequences of the two *Trichogramma* species were aligned using Clustal W, and genetic distances as well as a phylogenetic tree were calculated using MEGA V7.0. In the study, rDNA-ITS2 sequences of fifty four *Trichogramma* specimens were confirmed in GenBank. Additionally Mfold web server was used to predict secondary structures of ITS2 sequences. The construction of all secondary structures was carried out at 37ºC using RNA version 2.3 default parameters. The study identified a new species that expands the Trichogramma fauna of Sakarya Province in northwestern Türkiye, where only one species had previously been detected through rDNA-ITS2 sequence analysis. This shows the importance of molecular markers in species identification and biological control strategies.

Keywords: Insecta, Lepidoptera, Hymenoptera, ITS2, *Trichogramma*, *Ostrinia*, biological control, molecular systematics, Türkiye.

Identificación molecular de especies de *Trichogramma* Westwood, 1833 como parasitoides de huevos de *Ostrinia nubilalis* (Hübner, 1796) en zonas de producción de maíz de la provincia de Sakarya en Turquía (Insecta: Lepidoptera, Hymenoptera)

Resumen

El estudio se centra en la utilización de las secuencias ITS2 del ADNr para estudios sistemáticos de las especies de *Trichogramma* Westwood, 1833. Las secuencias ITS2 han demostrado ser fiables para distinguir las especies de Trichogramma. La identificación precisa de los enemigos naturales es esencial para los programas de control biológico. El objetivo de este estudio es comparar secuencias de ADNr-ITS2 de muestras de Trichogramma con secuencias del GenBank. Utilizando ITS2 como código de barras, el estudio pretende lograr una identificación fiable de las especies y evaluar la diversidad genética dentro de las especies de *Trichogramma*. Se utilizó la secuencia ITS2 para diferenciar dos especies de *Trichogramma*, *Trichogramma euproctidis* (Girault, 1911) y *Trichogramma brassicae* Bezdenko, 1968, recogidas en la provincia turca de Sakarya. Las secuencias ITS2 de las dos especies de *Trichogramma* se alinearon utilizando Clustal W, y las distancias genéticas, así como un árbol filogenético, se calcularon utilizando MEGA V7.0. En el estudio se confirmaron en GenBank las secuencias de ADNr-ITS2 de cincuenta y cuatro especímenes de *Trichogramma*. Además, se utilizó el servidor web Mfold para predecir las estructuras secundarias de las secuencias ITS2. La construcción de todas las estructuras secundarias se llevó a cabo a 37ºC utilizando los parámetros por defecto de la versión 2.3 de RNA. El estudio identificó una nueva especie que amplía la fauna de *Trichogramma* de la provincia de Sakarya, en el noroeste de Turquía, donde anteriormente sólo se había detectado una especie mediante el análisis de secuencias de ADNr-ITS2, lo que demuestra la importancia de los marcadores moleculares en la identificación de especies y las estrategias de control biológico.

Palabras clave: Insecta, Lepidoptera, Hymenoptera, ITS2, *Trichogramma*, *Ostrinia*, control biológico, sistemática molecular, Turquía.

Introduction

Biological control is based on the reduction of harmful insect populations by using their natural enemies. Natural enemies of harmful insects are also defined as biological control agents, and one of the most important among them is parasitoids. The selection of the natural enemy is the most critical step for the biological control to reach the target. Accordingly, the natural enemy in the application area can be protected, increased or brought from a different region to the application area (Wiedenmann, 2000).

Among the egg parasitoids, the species belonging to the genus *Trichogramma* Westwood, 1833 are the most used group. These microscopic wasps parasitize over 400 pest species and especially economically important pest species belonging to the order Lepidoptera. Although it can successfully parasitize the eggs of pests belonging to the order Lepidoptera, it can also parasitize the eggs of species belonging to the orders Coleoptera, Diptera, Hemiptera, Hymenoptera and Neuroptera (Li, 1994; Smith, 1996; Pinto, 1999).

The key to the success of biological control programs lies in the accurate selection of the appropriate species or strains of natural enemies. In biological control programs in which *Trichogramma* species are used, it is important to select the most suitable and effective *Trichogramma* species for successful mass production and control of the target pest. The identification of species belonging to this genus is problematic due to their small size. For the identification of these parasitoids, which are approximately 0.5 mm long, the morphological characters of the male genitalia were used as a basis (Nagarkatti & Nagaraja, 1971). However, many important species have very similar genitalia (Pinto & Stouthamer, 1994). Their very small size makes it difficult to identify visible and reliable features that enable them to be distinguished among themselves and from other insects. However, the most important limitation is that female individuals cannot be identified based on morphological characters (Stouthamer et al. 1990).

The reasons such as the unreliable morphological features and the absence of male individuals have directed researchers to different methods that are more reliable and stable for diagnosis. As a result, various biochemical and molecular techniques have been created to differentiate closely related taxa. A technique based on the sequence analysis of the ITS2 locus of rDNA was developed and started to be used effectively in the diagnosis of *Trichogramma* (Stouthamer et al. 1999). Thus, the problem of species identification, which is limited to morphological diagnosis depending on the characteristics of male individuals, has been solved, and at the same time, an alternative and more useful method to biochemical analysis has been developed.

It can be said that most of the *Trichogramma* species names used in the literature of previous years are misidentified or suspicious. Because species included in published information are rarely preserved. Therefore, it has become impossible to review the original diagnoses or to make a decision by comparing new and correct nomenclature based on current information. As a result, a small amount of literature can be used by researchers. For this reason, it is absolutely necessary for researchers to protect the species they have determined as a result of their studies (Rosen, 1986). There are many *Trichogramma* species and they vary greatly in their adaptability to different environmental conditions and the different insects that controlled by them (Silva 1999). Molecular identification of *Trichogramma* species, which are distributed in different regions of Türkiye, has been carried out with our previous studies (Sümer et al. 2009; Sümer et al. 2010; Ercan et al. 2011; Ercan et al. 2013; Ercan et al. 2022).

This study aims to identify the *Trichogramma* species collected from the Sakarya region of Türkiye using molecular techniques. Although there are many studies on the cultivation of *Trichogramma* and its use in biological control in our country, studies on the use of molecular methods in the identification of this important biological control agent have gained importance in recent years. With this study, *Trichogramma* species found in corn fields in Sakarya province were detected using molecular methods and contributed to future biological control studies.

Materials and methods

Collection of *Trichogramma* Specimens

Trichogramma samples were collected from corn fields in Sakarya province between July and September 2022. During the field study, sampling was made on 100 plants from each field from randomly selected corn fields in the Sakarya region in May-September. All the leaves and leaf undersides of the selected maize were carefully examined, and the maize leaves with parasitized (blackened) and non-parasitized egg packs of *Ostrinia nubilalis* (Hübner, 1796). Were cut without damaging the egg pack, taken into plastic culture containers and brought to the laboratory in an ice container. Each of the egg packages was placed in separate glass test tubes and followed in a long-day illuminated air-conditioning cabinet adjusted to 25±1ºC temperature and 70±5% proportional humidity. As a result of the field study, parasitoid hatching was detected from pest eggs obtained from 3 different localities (N 40º 68’78.86”’/E 30º 39’69.33”’, N 40º 69’56.53”’/E 30º 39’07.25” and N 40º 75’58.75”’/E 30º 41’53.56”’). *Trichogramma* adults emerging from egg packages collected from the field were transferred into 70% alcohol to be used in DNA isolation and labeled. (Ercan et al. 2011)

Molecular Studies

DNA extraction from *Trichogramma* samples was performed from individual wasp of each sample. Firstly, 60 µl 5% Chelex-100 and 2 µl Proteinase K (20 mg/ml) were used to grind the samples. Then ground samples incubated at 1 h at 55º C, followed by 10 min at 96º C. The rDNA-ITS2 amplification was performed to reveal the phylogenetic relationship between the samples, ITS2 froward and reverse primers were used (5′-TGT GAA CTG CAG GAC ACATG-3′ and 5′-GTC TTG CCT GCT CTGAG-3′, respectively) in PCR reaction (Stouthamer et al. 1999). After electrophoresis cloning was veri as described in Ercan et al. (2011). PCR products were visualized by electrophoresis after cloning and sent for automatic sequencing in a sequencing facility (BM Laboratory, Türkiye).

Structural characterization of ITS2

The mFOLD web server is used for predicting RNA secondary structures and calculating the Gibbs free energy (ΔG) of these structures. This prediction was veri at 37 °C using RNA version 2.3 with the default parameters provided by the program (http://unafold.rna.albany.edu/?q=mfold/RNA-Folding-Form2.3) (Santa Lucia, 1998; Zuker, 2003).

Phylogenetic Studies

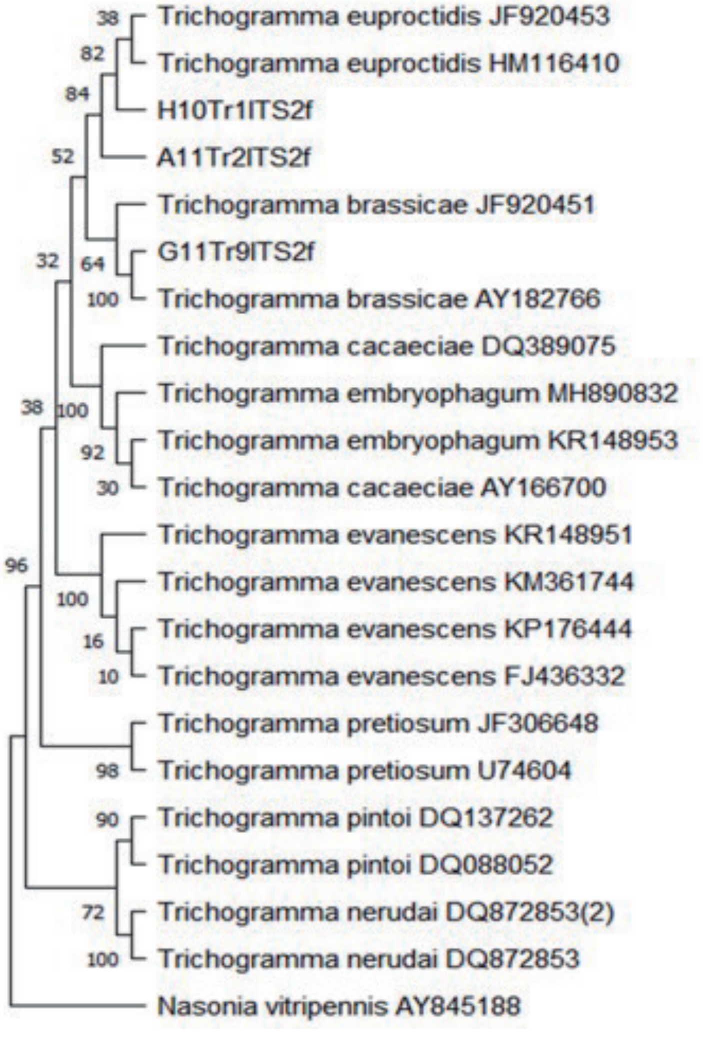
Mega 7 yazılım was used to determine inter- and intra-species nucleotide differences. Kimura 2-Parameter (K2P) distance model is a widely used method to examine the evolutionary similarities of DNA sequences (Kimura, 1980). Kimura’s model calculates the genetic distance between species by taking into account the nucleotide change rates (Kumar et al. 2016). In the study, the probability of the best phylogenetic tree was determined according to the polymorphism in the nucleotide sequences. For this purpose, Maximum Likelihood (ML) analysis was used. In ML analyses, jModelTest v.0.1.1 program was used to determine the most appropriate model for sequence variation and the model with the lowest AIC (Akaike Information Criteria) value was selected to determine the phylogenetic tree. In addition, the reliability of the created model phylogenetic trees was checked with 1000 replication Bootstrap test.

Results and Discussion

Trichogramma samples were collected from *Ostrinia nubilalis* eggs in Sakarya province of Türkiye. Fifty four individuals were emerged from the collected host eggs.

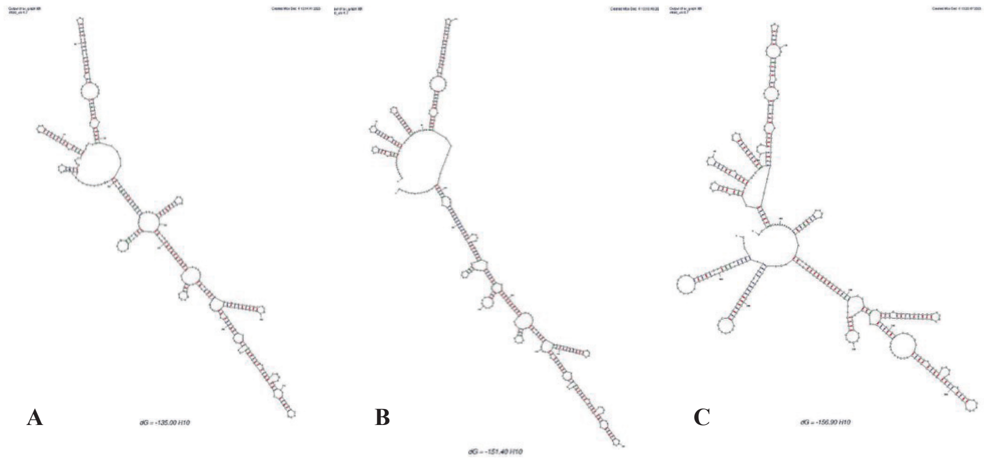
RDNA-ITS2 sequences specimens were searched in GenBank database of National Center for Biotechnology Information. We compared them with all obtained homologous sequences of other *Trichogramma* species in GenBank. From the samples collected 41 out of 54 specimens were identified as *Trichogramma euproctidis* (Girault, 1911) and other 13 individuals as *Trichogramma brassicae* Bezdenko, 1968. The ITS2 sequences of *Trichogramma euproctidis* samples varied in length between 415 and 424 bp while the ITS2 sequence length of all of the samples from *T. brassicae* was determined as 435 bp. Sequence results were used to construct a phylogenetic tree. GenBank provides a large database of genetic sequences, allowing researchers to study the genetic material of a variety of organisms. Genetic analysis of parasitoid insects such as *Trichogramma* species is a common method of constructing dendrograms using the sequences obtained. (Figure 1). *T. euproctidis* A11 coded, *T. euproctidis* H10 coded and *T. brassicae* G11 coded samples were selected randomly.

Figure 1. Phylogenetic tree based on the ITS2 gene region of *Trichogramma* samples (except for the samples coded A11, H10 and G11, the samples in the tree were taken from NCBI. *Nasonia vitripennis* is included in the tree as an outgroup.



ITS2 secondary structures of *T. euproctidis* and *T. brassicae* were generated using the Mfold web server (Figure 2). Analysis of predicted secondary structures using the Mfold web server can reveal genetic and morphological differences among species. Branching structures were found to be remarkable in *T. brassicae*, which led to the emphasis of structural differences between species. In the constructed phylogenetic tree, similarities and differences are reflected by helices and angles over the ITS2 sequence. This provides an important element in understanding the evolutionary relationships of species. The calculated ΔG values as- 135.00 kcal/mol for *T. euproctidis* and-156.90 kcal/mol for *T. brassicae* reveal the thermodynamic differences between the species. Since the lower ΔG value means a more stable structure, it provides additional information about the secondary structure of these species. The secondary structure of the ITS2 region can be interpreted as a clear observation of the nucleotide sequences and can be evaluated as morphological characteristics of the species.

Figure 2. Secondary structure predictions and ΔG (Gibbs) free energy values (bottom) of T. euproctidis (A: A11, B: H10) and T. brassicae (C: G11) http://www.unafold. Calculated and analyzed on the mFOLD web server org/mfold/applications. /rna-fold-form-v2.php).



Trichogramma are a priority group for molecular identificaiton due to their importance in biological control against especially lepidopteran pests. Their relatively small size and morphological similarity lead to inability to accurately identify species and to understand the effects of these parasitoids on pest populations. PCR of intraspecies conserved regions is very important for molecular identification of *Trichogramma* and reliable results were obtained by selecting the rDNA-ITS2 region as the target region for analysis. *Trichogramma* is a genus of parasitic insects that are important in agricultural pest control. DNA sequence analysis plays a vital role in correctly identifying these species and distinguishing similar species. Identifying species with the genetic data and analysis results obtained allows the development of more effective and sustainable methods in agricultural practices.

Although there are many studies on the cultivation of *Trichogramma* and its use in biological control in our country, studies on the use of molecular techniques in the diagnosis of this important biological control agent have gained importance in recent years. Sakarya region, which was sampled in our study, ranks first in its region in corn cultivation and is economically important. Therefore, it is important to detect and identify the natural biological control agents of the region for the development of alternative control methods against European cornborer, *Ostrinia nubilalis*, which is one of the main pests that cause product loss in corn production. In this study, the local *Trichogramma* species(s) of the region were identified molecularly for the first time.

The secondary structure of the ITS2 sequence reveals notable branched formations in *T. brassicae* when compared to *T. euproctidis*. Furthermore, the similarities and differences evident in the phylogenetic tree are also reflected in the helices and secondary structural composition of ITS2 among the species. Consequently, thermodynamic calculations for T. euproctidis and T. brassicae, along with the computation of ΔG (Gibbs) free energy values using mFold program parameters based on helices and angles in the secondary structure, varied by species. The calculated values were -135.00 kcal/mol for the *T. euproctidis* A11 coded sample, -151.40 kcal/mol for the *T. euproctidis* H10 coded sample, and -156.90 kcal/mol for the *T. brassicae* G11 coded sample. Therefore, the secondary structural formation of the ITS2 region has also been utilized as a morphological characteristic of the species due to the clear visualization of the nucleotide sequences (Figure 2).

Molecular markers that are rapidly evolving and located in highly conserved gene regions can be effectively utilized to differentiate closely related taxa. The ITS2 region is a significant molecular marker that enables comparison of closely related species, sub-species, and populations. Zhu & Williams (2002) cloned and sequenced the ITS2 region of Mymarid parasitoids and their hosts using rDNA sequence primers. This molecular technique demonstrates potential for the accurate and sensitive identification of both single and multiple species of egg parasitoids in agricultural and natural environments.Various biochemical and molecular methods have been developed to discern differences between closely related taxa, such as allozyme electrophoresis, random amplified polymorphic DNA variability (RAPD), Restriction Enzyme Fragment Length Diversity (RFLP), mitochondrial cytochrome oxidase subunit I (COI), and microsatellite markers (Miura et al. 1990; Pintureau, 1993; Vanlerberghe-Masutti, 1994; Sappal et al. 1995; Chang et al. 2001; Al-Barrak et al. 2004; Monti et al. 2005; Pizzol et al. 2005).

Thomson et al. (2003) used ITS2 sequence analyzes to identify *Trichogramma* species from southeastern Australia. They found that ITS2 length differs for each species. Chang et al. (2001) found that the ITS1 regions of *T. ostriniae* Pang & Chen, 1974 and *T. chilonis* Ishaii, 1941, two egg parasitoids of *Ostrinia furnacalis* (Guenée, 1854) (Lepidoptera: Pyralidae) found in Taiwan, were 86.1% identical. They determined that the length of ITS1 is different in these two species, 458 bp and 322 bp, respectively. In our study, *T. euproctidis* and *T. brassicae* species were identified according to the ITS2 sequence, and the sequence lengths of the ITS2 region were determined as 415 and 424 bp for *T. euproctidis* (A11 and H10, respectively) and 435 bp for *T. brassicae*. Ciociola et al. (2001) used five adult individuals for DNA extraction. With the system we used in our study, sufficient DNA extract could be obtained from only one adult parasitoid for successful PCR and subsequent sequencing of the ITS2 region of the rDNA.

Today, it can be said that most of the *Trichogramma* species names used in the literature of the past years are incorrect or at least doubtful. Because species included in published information are rarely protected. Therefore, it has become impossible to review the original diagnoses or to make decisions by comparing new and correct nomenclature based on current information. As a result, a small number of literature can be used by researchers. It is estimated that only 10-30% of parasitic Hymenoptera have been identified so far. The species identified as a result of our study will be protected. This is especially important for entomophagous insects, due to their small body size, morphological homogeneity, and taxonomic status, which is much less known than many other groups. Thus, it will be possible to molecularly compare the *Trichogramma* obtained in subsequent studies. By identifying natural populations collected from the field, misdiagnoses will be corrected and a contribution to the literature will be made.

With this study, a new species was added to the *Trichogramma* fauna of Sakarya Province, North western of Türkiye where a single species was previously detected. The importance and necessity of molecular diagnostic studies for biological control studies to be carried out in the corn fields of Sakarya province in the future have been revealed with this study. The possibilities of using this species in biological control should be studied in corn fields of Sakarya province where corn planting is high. Economical production can be achieved through biological control applications, and ecological benefits can be achieved by preserving the natural balance and biodiversity. Producers will use less chemical input and social awareness will be raised. It is very important to have an accurate molecular diagnosis of biological control agents that can be used commercially in the future. This provided basic data for new research projects.

Acknowledgements

The authors are grateful to Kırşehir Ahi Evran University Research Fund (Project No: ZRT.A4.23.003).

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.

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(Recibido para publicación / *Received for publication* 1-XI-2024)
(Revisado y aceptado / *Revised and accepted* 20-I-2025)
(Publicado / *Published* 30-IX-2025)

SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 551-556 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1087 https://shilap.org
https://zoobank.org/B1D49C2A-12A0-4A6F-AB21-A39A52E7B78F

Acronicta strigosa ([Denis & Schiffermüller], 1775) - a new observation in Piedmont region confirms the presence of the species in Italy (Lepidoptera: Noctuidae)

Denise Trombin, Giuseppe Rijllo, Simona Bonelli &
Stefano Scalercio

Abstract

The present study confirms the presence of *Acronicta strigosa* ([Denis & Schiffermüller], 1775) in Italy a century after the last record.

Keywords: Lepidoptera, Noctuidae, *Acronicta strigosa*, new record, Piedmont, Italy.

Acronicta strigosa ([Denis & Schiffermüller], 1775) - una nueva observación en la región de Piemonte confirma la presencia de la especie en Italia (Lepidoptera: Noctuidae)

Resumen

El presente estudio confirma la presencia de *Acronicta strigosa* ([Denis & Schiffermüller], 1775) en Italia un siglo después del último registro.

Palabras clave: Lepidoptera, Noctuidae, *Acronicta strigosa*, nuevo registro, Piamonte, Italia.

Acronicta strigosa ([Denis & Schiffermüller], 1775) - una nuova osservazione in Piemonte conferma la presenza della specie in Italia (Lepidoptera: Noctuidae)

Riassunto

Questo studio conferma la presenza di *Acronicta strigosa* ([Denis & Schiffermüller], 1775) in Italia un secolo dopo l'ultima registrazione.

Parole chiave: Lepidoptera, Noctuidae, *Acronicta strigosa*, nuovo record, Piemonte, Italia.

Introduction

The genus *Acronicta* Ochsenheimer, 1816 includes 12 species in Italy (Parenzan & Porcelli (2006), among which the rarest one seems to be *Acronicta (Hyboma) strigosa* ([Denis & Schiffermüller], 1775) (Noctuidae, Acronictinae). This is the only species of the subgenus *Hyboma* Hübner, [1820] occurring in Europe (Fibiger et al. 2009). It is not recorded from most of southern Europe, and extinct in the British Isles since 1933, but outside Europe ranges from Transcaucasia, Caucasus, through south Siberia to Russian Far East, Korea, Japan and China (Fibiger et al. 2009). In Italy, *A. strigosa* was only rarely found in the Alps where it was recorded in Piedmont, Alto Adige, and Veneto regions (Parenzan & Porcelli, 2006). In detail, it was found only once in Piedmont region, in Venaria near Turin, in May (Rocci, 1912), once in Alto-Adige, in Lana near Bolzano with two individuals in May and June (Dannhel, 1926), and twice in Venice (Sormani Moretti, 1881) and in Vicenza (Disconzi, 1865) provinces in Veneto region. However, all these data are very old and the presence of this species in Italy deserved confirmation.

According to Fibiger et al. (2009) the usual habitat of the species is woodland, with an abundance of *Crataegus*. In South Europe it seems to prefer wet woodlands in hilly areas (Hellmann & Parenzan, 2010). The species flies from late May to August, in northern or mountainous areas in July, and in southern areas it is bivoltine with two overlapping generations.

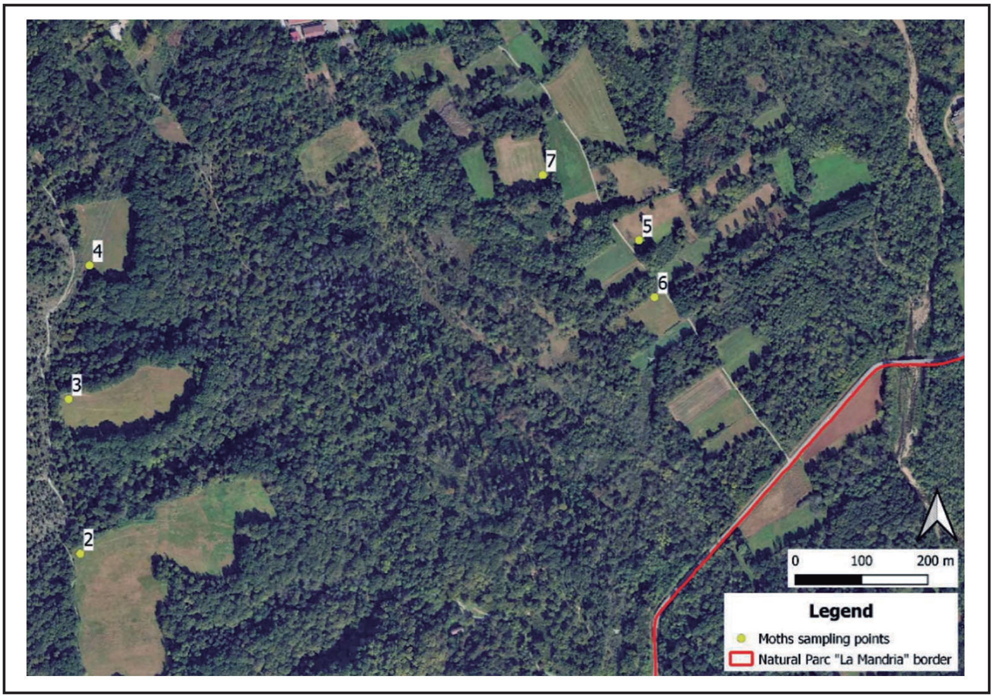
The larva is polyphagous, preferring *Crataegus*, and several Rosaceae such as *Prunus* spp., including *P. cerasus* L. and *P. domestica* L., *Sorbus*, *Pyrus* and *Malus*; the larva feeds also on various other trees of different families like *Betula*, *Ligustrum*, or *Rhamnus* (Fibiger et al. 2009).

One individual belonging to this species was surprisingly found in Piedmont during a survey aimed to evaluate the impact of anthropogenic noise on moth communities, confirming its presence in Italy after more than one century from the last observation.

Material and Methods

A Heterocera assemblage sampling was carried out in the Municipality of Varisella (383219 E, 5007126 N), in the Province of Città Metropolitana Torino, very close to the Protected Area “La Mandria” (IT1110079), in a natural area in the Piedmont region (Italy).

Figure 1. Map of the study area and sampling points..



The study area is located at 368 m a.s.l. and it is principally occupied by agriculture, with significant areas of natural vegetation according to the Corine Land Cover (Copernicus Land Monitoring Service, 2018). Natural vegetation, particularly woodlands were characterised by deciduous oaks. The traps were placed in an ecotone habitat between the woodlands and open spaces occupied by pastures. Moth assemblage was sampled using light traps (Compact Skinner Moth Trap, actinic lamp 20 W) activated from sunset to sunrise. Six different sampling points (Figure 1) were investigated over two consecutive nights. Two replicates were carried out in July for a total of four sampling nights per point. During the survey the mean relative humidity and the minimum, maximum, and mean temperatures were recorded at each sampling point.

The specimen was photographed by Giuseppe Rijllo (Figure 2) and preserved in the Lepidoptera collection of the Wildlife Management and Forest Biodiversity Laboratory of the Research Centre for Forestry and Wood (CREA-FL), Rende, Italy.

Using GBIF.org we created a distribution map of *A. strigosa* with the aim of identifying the areas of presence for the species (occurrence download https://doi.org/10.15468/dl.gguzbe for *A. strigosa* and https://doi.org/10.15468/dl.a75hk7 for *Hyboma strigosa*, accessed via GBIF.org on 2024-09-11). The research considered the data present in the European continent, without placing any time limit, and considering only the data reporting geographical coordinates integrated with historical data for which we provided approximate coordinates. Subsequently, we divided the observations based on the time scale to highlight the differences between past and current knowledge. However, these data should be used carefully, because they are mostly based on photographs for which species identifications are sometimes very difficult.

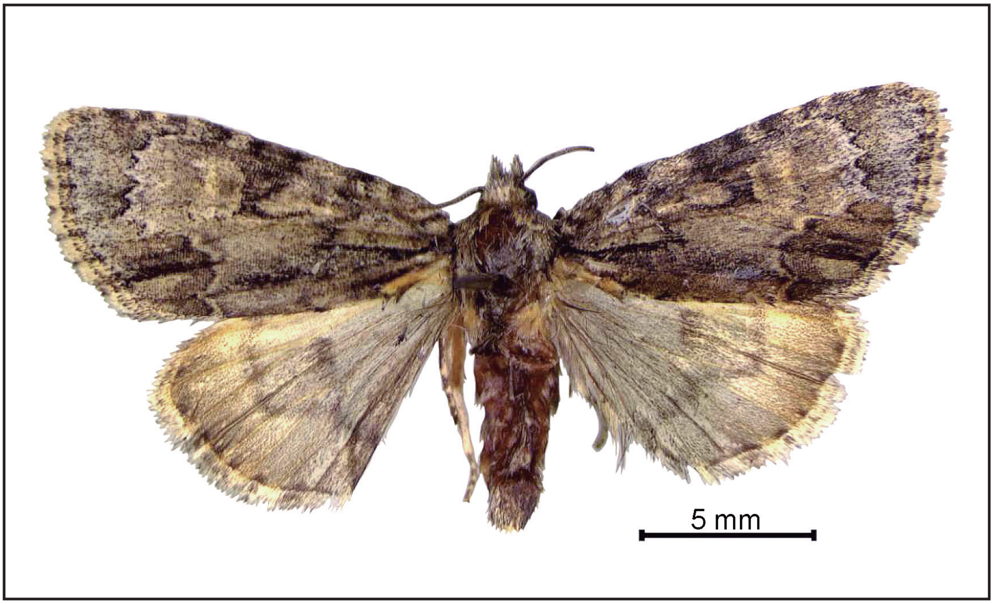
Results

Acronicta strigosa ([Denis & Schiffermüller], 1775) (Figure 2)

Material examined: 1 ♂, 22-VII-2023, Municipality of Varisella, Città Metropolitana di Torino, Italy, 367 m a.s.l., 383219 E 5007126 N (Figure 3).

Description: the specimen seems to be freshly emerged, with a wingspan of 27 mm. The pattern of wings is characteristic of this unmistakable species, which is why the integrity of the specimen was preserved and genitalia undissected.

Figure 2. *Acronicta strigosa* ♂, Varisella, 22-VII-2023. Wingspan 27 mm. Photo: Giuseppe Rijllo.

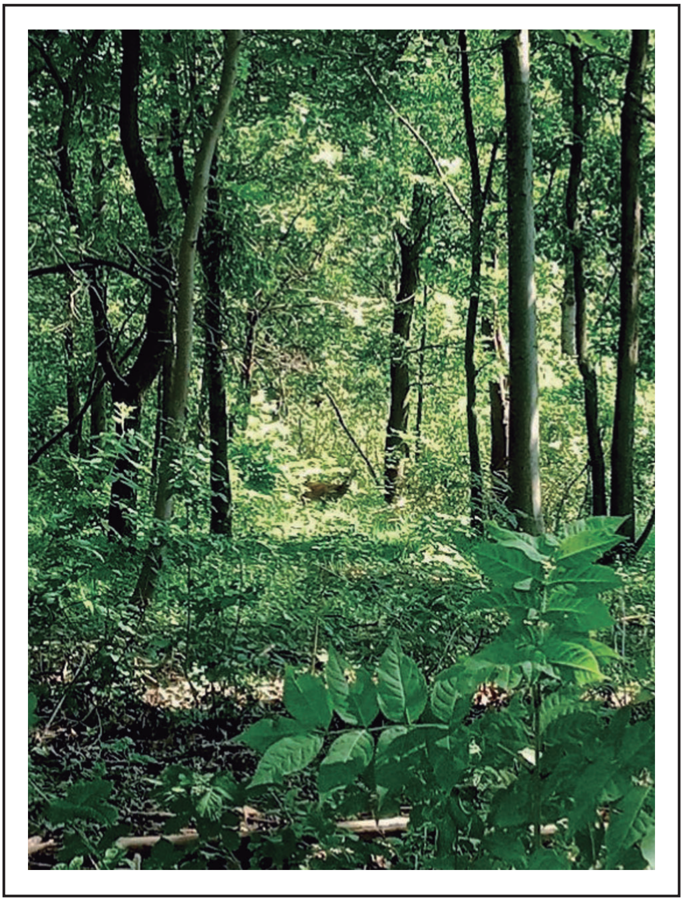


The mean relative humidity recorded during the night, when the moth was captured, was 99.92 %. The minimum temperature was 17.51ºC, the maximum was 22.02ºC, and the average throughout the night was 19.19ºC. Moreover, the night was characterised by a crescent moon (20 %).

Discussion and Conclusions

Acronicta strigosa was found in only one of the six investigated sampling sites (point code: P6) (Figure 1). The point shows different microhabitats especially in term of humidity degree. In fact, this was the only sampling point located in a humid environment (Figure 3). During spring and early summer, there are small pools of stagnant water in the ecotone zone and under the canopy. Consequently, the habitat results wetter than the other sampling points confirming the available past observations that indicate humid woodlands as the preferred habitat for this species in South Europe.

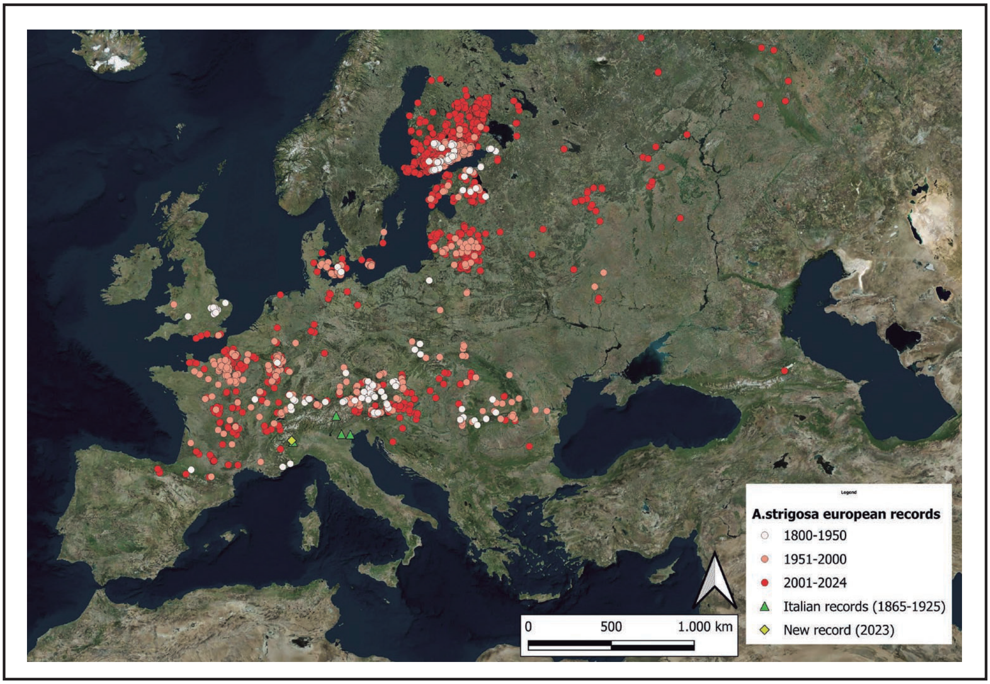
Figure 3. Sampling site of *Acronicta strigosa* in Piedmont, Varisella.



This research allowed us to report the presence of the species in this area of Piedmont (Figure 4), despite having been found in only one individual throughout the study.

The distribution of *A. strigosa* results concentrated in central and northern Europe with few records in the Mediterranean area. The knowledge of the species is still limited, particularly regarding its distribution in Italy, where the observations date back to the period 1865-1925. The distribution map shows a strong increase in the number of observations since 2000 (Figure 4), probably due to the increase in scientific research regarding nocturnal Lepidoptera and the availability of citizen science web platforms on which records should be double-checked for misidentifications.

Figure 4. European distribution of species. Map designed using QGis (vers. 3.34.11- Prizren), base layer from http://ecn.t3.tiles.virtualearth.net/tiles/a{q}.jpeg?g=1



Subsequent research in the northern part of Italy could result in newer records and could help better define the distribution and the ecology of this rare species in Italy.

Conflict of Interest

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

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(Recibido para publicación / *Received for publication* 24-IX-2024)
(Revisado y aceptado / *Revised and accepted* 19-XII-2024)
(Publicado / *Published* 30-IX-2025)

SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 557-565 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1088 https://shilap.org
https://zoobank.org/ADC4612F-615B-4D35-9627-20DC1DFFBDD2

A preliminary list of Heterocera in high altitude Gulmarg, Kashmir, India (Insecta: Lepidoptera)

Yasir Irfan Yattoo & Yashashree Gadhikar

Abstract

Field investigations were made to record the diversity of Heterocera from the world-famous high-altitude tourist spot Gulmarg in Kashmir Valley. The present study has been carried out to elucidate the fauna which has not been explored before. The study is carried out from June 2022 to September 2023 including meadows and forests, in order to eventually contribute to biodiversity conservation as well as to management of forest ecosystem of this area. A total of 33 species belonging to 10 families were recorded from this site. The Erebidae family was found to be dominant with the highest number of eight species followed by Family Crambidae with a record of seven species.
Keywords: Insecta, Lepidoptera, diversity, high altitude, conservation, Gulmarg, India.

Una lista preliminar de Heterocera en la altitud de Gulmarg, Cachemira, India (Insecta: Lepidoptera)

Resumen

Se realizaron investigaciones de campo para registrar la diversidad de Heterocera del mundialmente famoso lugar turístico de gran altitud Gulmarg, en el valle de Cachemira. El presente estudio se ha llevado a cabo para dilucidar la fauna que no ha sido explorada antes. El estudio se lleva a cabo desde junio de 2022 hasta septiembre de 2023, incluyendo praderas y bosques, con el fin de contribuir eventualmente a la conservación de la biodiversidad, así como a la gestión del ecosistema forestal de esta zona. En este lugar se registraron un total de 33 especies pertenecientes a 10 familias. La familia Erebidae resultó ser la dominante con el mayor número de ocho especies, seguida de la familia Crambidae con un registro de siete especies.
Palabras clave: Insecta, Lepidoptera, diversidad, gran altitud, conservación, Gulmarg, India.

Introduction

The importance of biological diversity has been widely recognized because it affects not only the global economy and human welfare, but also human survival. Biological diversity can provide an essential ecological service through enhancing the resilience of the ecosystem (Elmqvist et al. 2003). The order Lepidoptera, comprising butterflies and moths are taxonomically well known and critical to the functioning of many ecosystems, with the species having functional roles as selective herbivores, pollinators and prey for birds and small mammals (Schowalter et al. 1986). Much less attention has been given to the less conspicuous species, even though they are known to comprise more than 90% of the known lepidopteran species and are distributed globally throughout a wide range of habitats (Janzen 1988). Heterocera are responsible for a great variety of ecological processes and ecosystem functions as pollinators, selective herbivores, and prey for migratory passerines (Summerville and Crist 2004). There have been substantial population declines in many species, including two-thirds of analyzed common Heterocera species in the UK (Conrad et al. 2006). The main drivers of decline are expected to include climate change, agricultural intensification and deforestation (Fox et al. 2013).

Gulmarg is a hill station situated in the Pirpanjal range in the Western Himalayas. Gul means flower and Marg means meadow, thus Gulmarg means meadow of flowers. Gulmarg lies in Baramulla District of the state Jammu and Kashmir, India. It has world famous beauty and attracts tourists all over the world. It is popular and appealing in all seasons of the year. Even though Gulmarg is considered to have a high biological diversity because of the well-balanced preservation and management programs put in place, still no research has been undertaken to investigate the moths in this area. Thus, the present survey is a must and utmost to highlight the diversity of species.

Materials and Methods

Study site

Gulmarg is a mountainous area extending between 74º 28’ to 74º 31’ East and 34º 03’ to 33º 58’ North (Singh et al. 1987). Situated at an altitude of 2730 m (meters above sea level) covering an area of 180 sq. km. Besides being a wildlife Sanctuary, it is known for its unparallel beauty and is rated as one of the matchless tourist spots of the world.

Sampling method and period

Light traps were set using a solar powered lantern or gas petromex in front of a white 10’ x 6’ cloth sheet hung between two vertical poles in such a way that whole sheet was brightly illuminated for moth attraction and photography of moths was done. When Heterocera were unidentified or difficult to identify by visual observation, they were captured with the help of insect net carefully, transferred to air-free plastic transparent box and then identified with references.

Identification was made by comparison with the available literature by Kendrick (2002) and by iNaturalist guides to Heterocera species. The photographs have been taken in their most likely natural resting positions. None of these species were killed, frozen or stuck just for the sake of obtaining a perfect picture. The moth species recorded in this study have been determined to a specific level with a good level of certainty by external examination, on the basis of their size, shape, wing pattern, antennae and colored markings on wings, and wingspan.

Results

Table 1. List of moth species recorded during present study.

Family	Species	Author
Drepanidae	*Oreta vatama*	Moore, [1866]
Geometridae	*Ligdia adustata*	([Denis & Schiffermüller],1775)
	Abraxas sylvata	(Scopoli, 1763)
	Agathia carissima	Butler, 1878
	Orthonama obstipata	(Fabricius, 1794)
	Prasinocyma semicrocea	(Walker, 1861)
	Chiasmia cymatodes	Wehrli, 1932
Noctuidae	*Trachea atriplicis*	(Linnaeus, 1758)
	Acontia lucida	(Hufnagel, 1766)
	Polymixis flavicincta	([Denis & Schiffermuller], 1775)
	Arcte coerula	(Guenée, 1852)

	Dysgonia algira	(Linnaeus, 1767)
Erebidae	*Cyana peregrina*	(Walker, 1854)
	Syntomoides imaon	(Cramer, 1780)
	Utetheisa pulchelloides	Hampson, 1907
	Euproctis lutea	(Fabricius, 1775)
	Lymantria concolor	Walker, 1855
	Cyana hamata	Walker, 1854
	Spilosoma obliqua	Walker, 1855
	Somena scintillans	Walker, 1856
Crambidae	*Nomophila nearctica*	Munroe, 1973
	Leucinodes orbonalis	Guenée, 1854
	Nausinoe gueyraudi	Guillermet, 2003
	Anania verbascalis	([Denis & Schiffermüller], 1775)
	Glyphodes bicolor	(Swainson, 1821)
	Glyphodes pyloalis	Walker, 1859
	Omphisa anastomosalis	(Guenée, 1854)
Nolidae	*Earias cupreoviridis*	(Walker, 1862)
	Nola confusalis	(Herrich-Schäffer, 1847)
Tineidae	*Monopis monachella*	(Hübner, 1796)
Tortricidae	*Gypsonoma aceriana*	(Duponchel, 1843)
Lasiocampidae	*Euthrix laeta*	(Walker, 1855)
Zygaenidae	*Praezygaena cashmirensis*	(Kollar, [1844])

Acknowledgments

We are highly thankful to the Gulmarg development authority who allowed us to carry out this research work in Gulmarg region of District Baramulla State Jammu and Kashmir.

Conflict of interest

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

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(Recibido para publicación / *Received for publication* 21-III-2024)
(Revisado y aceptado / *Revised and accepted* 3-X-2024)
(Publicado */ Published* 30-IX-2025)

Figures 1-4. 1. Location of study site Gulmarg**. 2-4. 2.** Vegetation type of study area. **3.** *Abraxas sylvata*. **4.** *Acontia lucida*.

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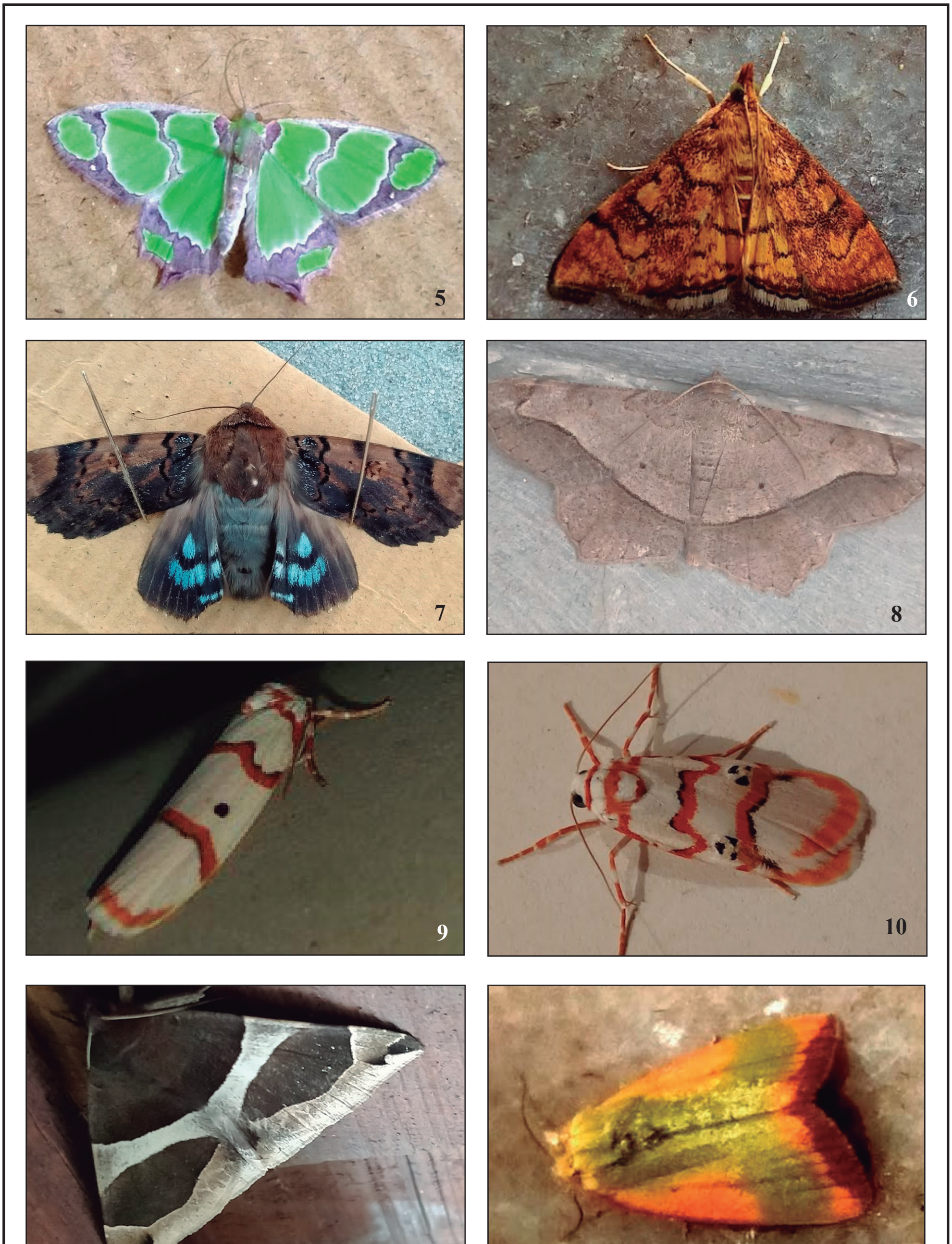
Figures 5-12. 5. *Agathia carissima*. **6.** *Anania verbascalis*. **7.** *Arcte coerula*. **8.** *Chiasmia cymatodes*. **9.** *Cyana hamata*. **10.** *Cyana peregrina*. **11.** *Dysgonia algira*. **12.** *Earias cupreoviridis*.



Figures 13-19. 13. *Euproctis lutea*. **14.** *Euthrix laeta*. **15.** *Glyphodes pyoalis*. **16.** *Gypsonoma aceriana*. **17.** *Nomophila neartica*. **18.** *Leucinodes orbonalis*. **19.** *Lygdia adustata*.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Figures 20-27. 20. *Lymantria concolor*. **21.** *Monopis monachella*. **22.** *Nausinoe gueyraudi*. **23.** *Nola confusalis*. **24.** *Somena scintillans*. **25.** *Omphisa anastomosalis*. **26.** *Oreta vatama*. **27.** *Orthonama obstipata*.


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Figures 28-34. 28. *Polymixis flevicincta*. **29.** *Praezygaena cashmirensis*. **30.** *Prasinocyma semicrocea*. **31.** *Spilosoma obliqua*. **32.** *Syntomoides imaon*. **33.** *Utetheisa pulchelloides*. **34.** *Tracea atriplicis*.


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SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 566 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1095 https://shilap.org

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SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 567-572 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1089 https://shilap.org
https://zoobank.org/3F9E3F1C-A6FE-4B59-830B-1B8C15738BC5

Metzneria riadella Englert, 1974, a new record for the Türkiye Fauna (Lepidoptera: Gelechiidae)

Hanife Uçak & Muhabbet Kemal

Abstract

In this study, *Metzneria riadella* Englert, 1974 is presented as a new record for the Türkiye fauna. Morphological and ecological data on the Türkiye populations of the taxon are also included. The female external genital organ, the abdominal skin of male and female individuals is presented visually for the first time in this study. Additionally, some ecological data regarding the habitat of the species are also mentioned.
Keywords: Lepidoptera, Gelechiidae, *Metzneria riadella*, new record, Türkiye.

Metzneria riadella Englert, 1974, un nuevo registro para la fauna de Turquía (Lepidoptera: Gelechiidae)

Resumen

En este estudio se presenta *Metzneria riadella* Englert, 1974 como un nuevo registro para la fauna de Turquía. También se incluyen datos morfológicos y ecológicos sobre las poblaciones de Turquía del taxón. El órgano genital externo de la hembra, la piel abdominal de los individuos machos y hembras se presenta visualmente por primera vez en este estudio. Además, se mencionan algunos datos ecológicos relativos al hábitat de la especie.
Palabras clave: Lepidoptera, Gelechiidae, *Metzneria riadella*, nuevo registro, Turquía.

Introduction

The genus *Metzneria* Zeller, 1839, also lists 48 species in the world catalogue according to provisional data (Hobern et al. 2024). This genus is known by 24 species in Europe (Huemer & Karsholt, 2020) and 12 species in Türkiye (Koçak & Kemal, 2018). *Metzneria varennei* Nel, 1997, which is on the list of Koçak & Kemal (2018) and has only a Kahramanmaraş record in Türkiye, was synonymized with *Metzneria campicolelle* (Mann, 1857) (Nel & Varenne, 2017) and was later temporarily presented under the genus *Metzneria* in the European Gelechiide checklist (Huemer & Karsholt, 2020). The species, whose type locality is Fiume (Italia), was also presented under the genus *Metzneria* by Leraut (2023), in accordance with the above-mentioned source. Finally, Nel et al. (2022) transferred *M. campicolella* to the newly established genus *Huemeria* Nel, Varenne & Bassi, 2022 and the new name combination became *Huemeria campicolelle* (Mann, 1857). The species, whose original combination was *Gelechia campicolelle* Mann, 1857, was listed with the name combination *Ptocheuusa campicolella* (Mann, 1857) in the studies of Koçak & Kemal (2006, 2009, 2012, 2018), who took Karsholt & Razowski (1996) as a reference. For the above reasons, it is more appropriate that the genus *Metzneria* in Türkiye is represented by 11 species according to current data.

In the genus *Metzneria*, new species have been described in recent years, such as *M. transbaikalica*

Bidzilya, 2018; *M. fulva* Labonne, Huemer, Thibault & Nel, 2019; *M. freidbergi* Bidzilya, Karsholt, Kravchenko & Šumpich, 2019; *M. neli* Huemer, 2021 and *M. leae* Gastón & Huemer, 2022. Özaslan et al. (2016) added *Metzneria subflavella* Englert, 1974 to the Türkiye fauna together with its new larval food plant. The Türkiye fauna is also a group with high potential for the detection of new taxa in terms of *Metzneria* species. Some taxa in the Cesa collection, which are planned to be studied, are important in this respect.

While the Lepidoptera research initiated by Cesa in the Mediterranean region of Türkiye and the Taurus Mountains continues, *M. riadella* Englert, 1974 was recorded for the first time for the Türkiye fauna in the field studies in 2022 and 2024. Apart from the study by Englert (1974) in which the species was described, no other study containing morphological data for this species was found. This study includes morphological data on Türkiye populations of the taxon in question in the collection area.

Material and methods

The materials examined were collected from Anamur district of İçel (Mersin) (Türkiye) by night light trap in April, 2022 and 2024. The collected samples were prepared as required and Robinson (1976) was followed for permanent genital preparations for definitive identification. The specimens were photographed with a Canon EOS 60D, and the genitals were photographed with a stereomicroscope connected to a computer at a resolution of Leica S8APO, DFC290. The examined materials are preserved in the Cesa collection.

Results

Metzneria riadella Englert, 1974
Metzneria riadella Englert,1974, *Z. angew. Ent., 75*, 398, fig.
LT: [SAUDI] ARABIA, Riad, 700 m (LNK).

Material Examined: 2 ♂, 2 ♀, 07-IV-2022, 40 m; 2 ♂, 3 ♀, 06-IV-2024, 2 ♂, 4 ♀, 09-IV-2024, 40 m. Türkiye İçel Prov., Anamur district, Anemurium (33Al), M. Kemal & H. Uçak leg. (Cesa-coll.).

Biology: Unknown.

Distribution: Saudi Arabia (Englert, 1974), Cyprus (Gozmany, 2012), Girit (Gozmany, 2012; Karsholt & Huemer, 2017), Iran (Rajaei et al. 2023), Spain (Vives Moreno, 2014; Labonne et al. 2019; Gastón & Huemer, 2022). **New for Türkiye**.

Morphological features in Anamur population

External morphology (Figures 2-3a-b): The wingspan of individuals varies between 10-14 mm. Forewing covered with greyish-brown scales on a light cream ground colour. It has a distinct yellow line extending from the forewing base to the discal region parallel to the dorsum. A second similar line extends from the discal region to the apex, but does not reach the apex. There are brownish dot-like spots on the forewing. Similar spots are irregular, their number varies from three to five in individuals. Hindwing light cream (Figure 2b, Figures 3a-b). The head, palpi and thorax are covered with cream and brown scales. Palpus base segment cream-scaled, second and third segments usually have more brown scales. Antenna has predominant brown scales, first segment is thicker.

Male genitalia (Figure 4a, b1): The free end of the valve is oval, the anal part is spiny like a beak downwards. The valve is covered with dense and long hairs. Sacculus thumb-shaped, setae shorter than the hairs on the valve and relatively sparse. Sacculus V-shaped. Aedeagus cylindrical, caecum is slightly puffed and open. There is a distinct break in approximately 1/3 of the length. The number of triangular spines inside the aedeagus is 15 and above.

Abdomen skin (Figure 4b2): The sclerites that connect the sternum (S2) and tergum (T1) to the thorax have a strong chitinous structure. The ends of the sclerites connecting the tergum (T1) to the thorax are bent at 90 degrees to each other and have a strong chitinous. The last segment of the abdominal skin (T8) is rectangular stool-shaped.

Female genitalia (Figure 5): Anal papilla weakly sclerotized. Anterior and posterior apophysis are almost the same length. The posterior apophysis base is wider and more sclerotized than the anterior apophysis base. Bursa copulatrix oval, very small, very weak and without signum. The length of the antrum is twice the width. Abdomen skin: The sclerites connecting the sternum (S2) and tergum (T1) to the thorax lie parallel to each other and have a strong chitinous.

Discussion

Except for some faunistic records, no detailed study has been found on the external morphological characteristics and genital structures of the species since its description. In terms of wing color and patterns and the structure of the phallus in the male genital organ, it is very similar to *Metzneria littorella* (Douglas, 1850), the most important distinguishing feature being the shape of the valve. Of the two male individuals collected from the same habitat on the same day, the other (GP3518) differs in that the aedeagus is relatively long and the caecum is slightly lobed. Additionally, the forewing coloration and spots of the other individual (GP3519) are darker and more contrasting. In the female external genital organ, the antrum is twice as long as it is wide. Englert (1974) stated that the antrum is three times as long as it is wide. This differences may be attributed to individual or geographical variation. The materials examined in this study are largely consistent with the structure of the male genitalia, as mentioned in Englert (1974). The female reproductive organ and the abdominal skin of male and female individuals are included in this study for the first time.

No information is known on the biology and larval foodplant of *Metzneria riadella*. However, data on the biology of the closest species, *M. littorella*, and on the larval foodplant *Plantago coronopus* L., were presented by Walsingham (1900) and Bankes (1901). The habitat where the examined samples were collected is a rocky area at an altitude of 40 meters above sea level, dominated by Mediterranean maquis vegetation (Figure1). According to the floristic study conducted here, *Plantago atrata* Hoppe., *P. afra* L., *P. cretica* L., and *P. lanceolata* L. species were identified from the stony and rocky area between 20-50 meters (Yıldıztugay & Küçüködük, 2010). The collection data for these four species are compatible with the period when vegetation was developing and *Metzneria riadella* adults were flying. Future research on the biology of the species will focus on this subject by following the information provided by Walsingham (1900) and Bankes (1901).

Conflict of Interest

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

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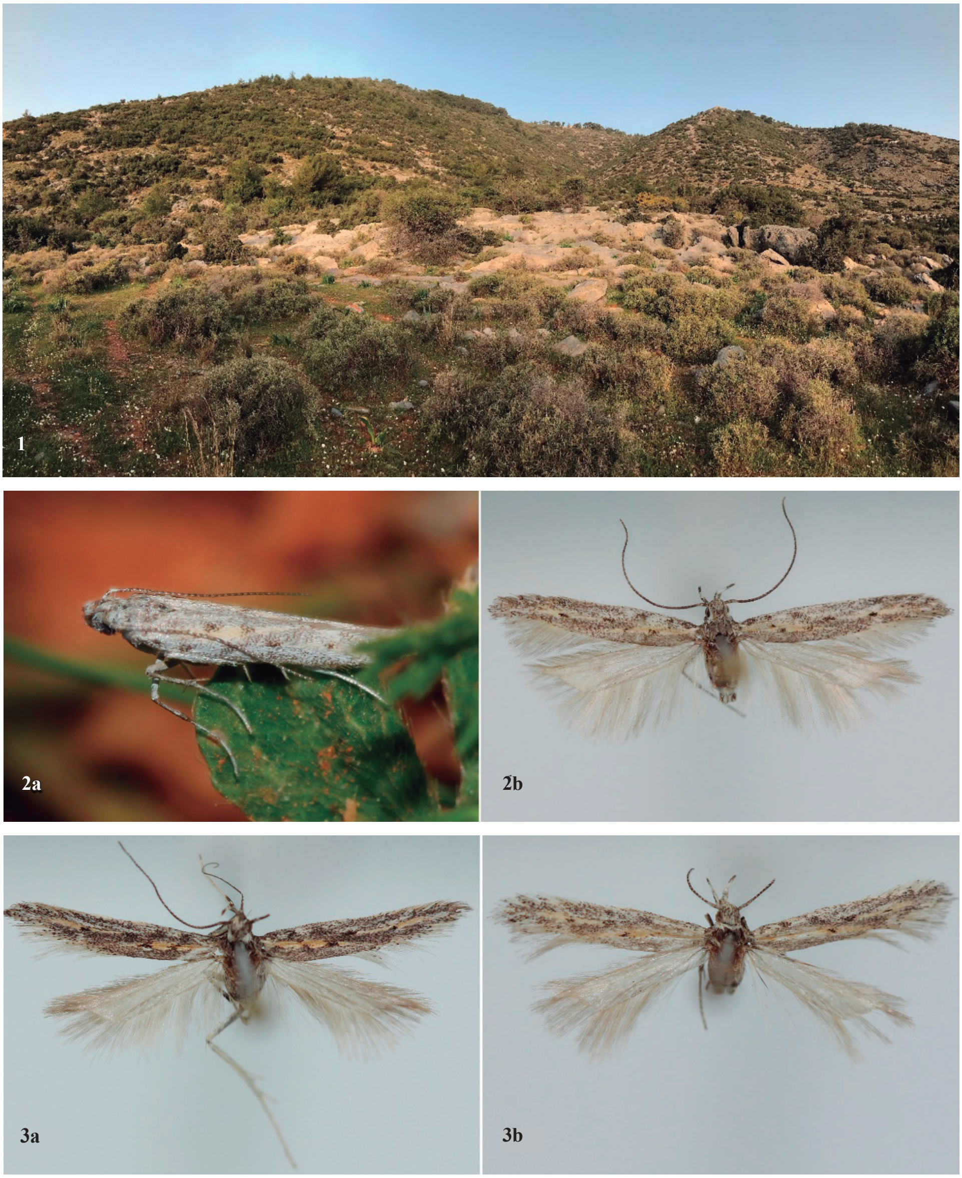
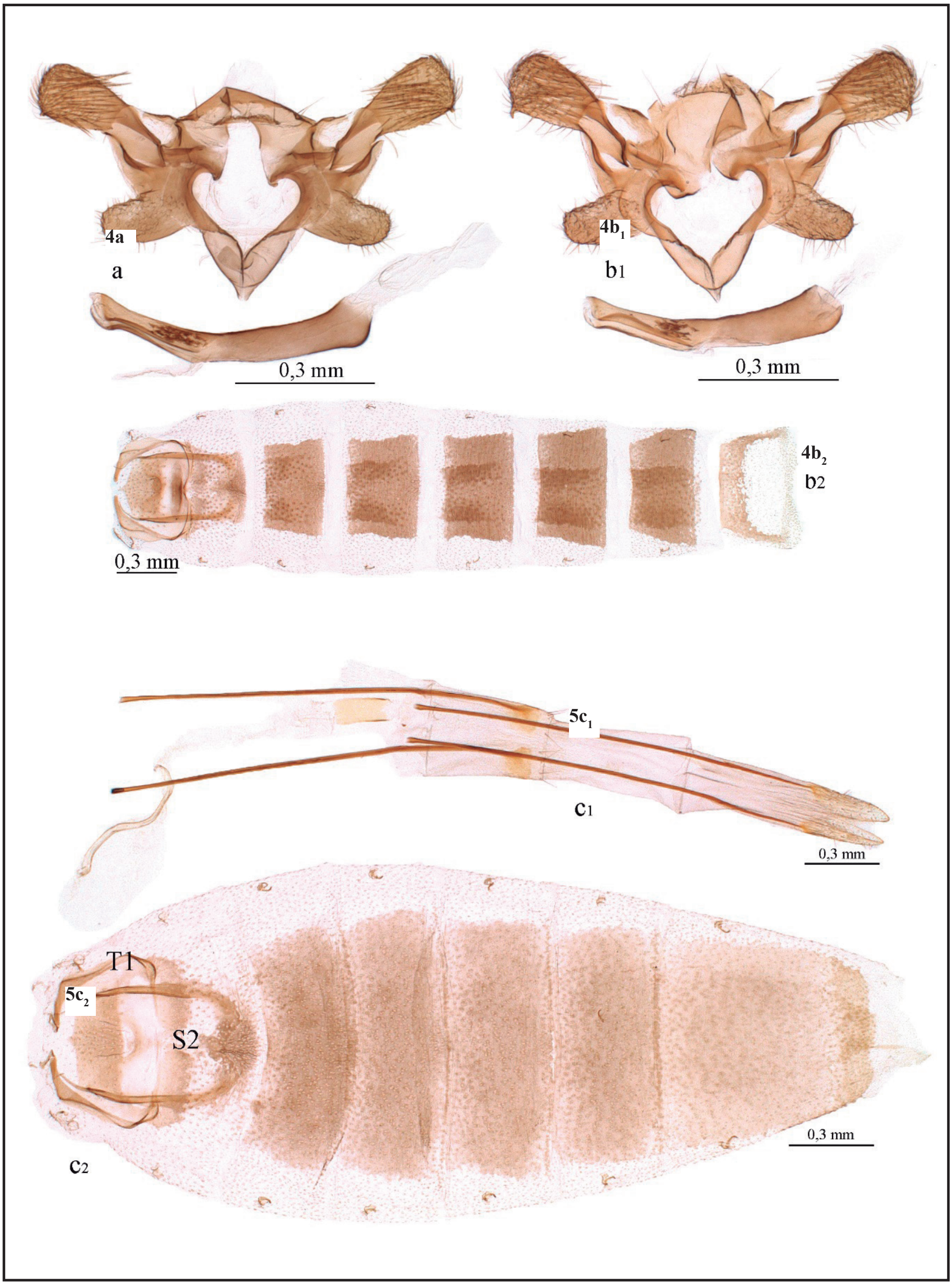
(Recibido para publicación / *Received for publication* 23-XII-2024)
(Revisado y aceptado / *Revised and accepted* 10-II-2025)
(Publicado / *Published* 30-IX-2025)

Figure 1-3. 1. Habitat the *Metzneria riadella*. Türkiye, İçel Prov., Anamur Dist. Anemurium Antique City (33Al) (Photos: M. Kemal). **2**. *Metzneria riadella*. **a**. In its habitat (near the Ex PAIT, early morning). **b**. the same male individual (GP3518). Türkiye, İçel Prov., Anamur Dist. Anemurium Antique City (33Al) (Photos: M. Kemal). **3. a**. Adult male (GP3519). b. Adult female (GP3520). Türkiye, İçel Prov., Anamur Dist. Anemurium Antique City (33Al) (Photos: M. Kemal).



Figures 4-5. **4. a**. Male genitalia with aedeagus (GP3518). b. Male genitalia with aedeagus (GP3519). Türkiye, İçel Prov., Anamur Dist. Anemurium Antique City (33Al) (Photos: M. Kemal). **5**. Female genitalia with abdominal skin (GP3520). Türkiye, İçel Prov., Anamur Dist. Anemurium Antique City (33Al) (Photos: M. Kemal).



SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 573-592 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1090 https://shilap.org
https://zoobank.org/43DE98DB-D5F3-4E74-839A-10A581A4F1AC

Diversidad de Papilionoidea en la subcuenca del río Páez, Cartago, Costa Rica: un acercamiento al uso de los Lepidoptera diurnos como indicadoras de integridad biológica (Insecta: Lepidoptera)

Rubén I. Sánchez-Alvarado & Ana Victoria Wo Ching-Wong

Resumen

Se propuso un acercamiento a la comprensión de la integridad biológica de la subcuenca del río Páez en Cartago, Costa Rica, mediante el monitoreo de la diversidad de Lepidoptera diurnos, con el objetivo de analizar la relación entre la cobertura forestal y el uso potencial de hábitat de estos organismos. Se estudió la subcuenca considerando un sistema de categorías basado en los rasgos espaciales de los fragmentos de bosque en la variable altitudinal del territorio. Mediante el monitoreo de individuos en transectos durante 48 días totales de muestreo se describieron las características de uso de hábitat de las especies en seis sitios de la subcuenca. Se registraron un total de 5503 individuos pertenecientes a 107 especies de Lepidoptera diurnos, para los cuales se aplicaron índices de diversidad con el fin de estimar las características en el interior del bosque (IB), su borde (BB) y la matriz adyacente (MA). En IB, BB y MA el índice de diversidad de Shannon mostró valores de 2.64, 2.05 y 2.22, respectivamente. La evaluación de los organismos, a través de análisis de complementariedad Jaccard, permitió asociar 50 especies al interior de bosque, 26 al borde del bosque y 31 a la matriz adyacente. Los Papilionoidea pueden ser utilizadas como indicadores de la integridad biológica en la subcuenca, y su variedad, riqueza y abundancia están directamente relacionadas con las condiciones físicas del hábitat. Se establece que la evaluación de los Lepidoptera diurnos proporciona un acercamiento para estimar la cobertura forestal presente en una matriz de paisaje, y se evidencia que el potencial de estos insectos como indicadores de la integridad biológica se basa en su categorización como una comunidad, más que como especies individualizadas.

Palabras clave: Insecta, Lepidoptera, Papilionoidea, integridad biológica, biodiversidad, bioindicadores, Costa Rica.

Diversity of Papilionoidea in the Paez River sub-basin, Cartago, Costa Rica: an approach to the use of diurnal Lepidoptera as indicators of biological integrity (Insecta: Lepidoptera)

Abstract

An approach to understanding the biological integrity in the Páez River sub-basin in Cartago, Costa Rica, was proposed through monitoring the diversity of diurnal Lepidoptera, aiming to analyze the relationship between forest coverage and the potential habitat use of these organisms. The sub-basin was studied considering a category system based on the spatial characteristics of forest fragments and the altitudinal variable of the territory. By monitoring individuals along transects over 48 days of sampling, habitat use characteristics of the species were described at six sites in the sub-basin. A total of 5503 individuals belonging to 107 species of diurnal Lepidoptera were recorded, for which diversity indexes were applied to estimate characteristics in forest fragments (IB), their edges (BB), and the adjacent matrix (MA). Shannon's diversity values were as follows: H 2.64 in IB; H 2.05 in BB, and H 2.22 in MA. The assessment of organisms, through Jaccard complementarity analysis, revealed 50 species associated with forest interior (IB), 26 with forest edges (BB) and 31 with the adjacent matrix (MA). Diurnal butterflies can be used as indicators of biological integrity in the sub-basin, and their variety, richness, and abundance are directly related to the physical habitat conditions. It is established that the evaluation of diurnal lepidopterans provides an approach to estimate forest coverage in a landscape matrix, and it is evident that the potential of these insects as indicators of biological integrity is based on their categorization as a community rather than individualized species.

Keywords: Insecta, Lepidoptera, Papilionoidea, biological integrity, biodiversity, bioindicators, Costa Rica.

Introducción

La integridad biológica, como enfoque metodológico propuesto por Torres-Olvera et al. (2018), fusiona elementos estructurales y funcionales de los ecosistemas para evaluar su salud y diversidad ecológica. Este concepto se centra en la capacidad del medio ambiente para mantener una comunidad equilibrada y adaptada de organismos, con una composición, diversidad y organización funcional específicas.

En el contexto de los desafíos ambientales actuales que amenazan la biodiversidad, el uso de organismos bioindicadores se vuelve esencial. Estos organismos no solo reflejan procesos ecológicos e históricos, sino que también influyen en el ciclo vital de otros taxones en el ecosistema. Dentro del amplio espectro de Lepidoptera, pertenecientes a la superfamilia Papilionoidea, emergen como indicadores cruciales del estado de conservación y diversidad. Su relevancia radica en su capacidad para reflejar procesos biológicos a escalas locales, lo que las convierte en candidatas ideales para la evaluación ambiental y la conservación (González et al. 2020).

La evaluación de la integridad biológica surge como una estrategia científica con un gran potencial para analizar múltiples sitios de estudio, proporcionando resultados rápidos y accesibles. Este enfoque es fundamental para el seguimiento de evaluaciones de riesgo ambiental y la comprensión de condiciones regionales, particularmente en unidades como cuencas hidrográficas. Los paisajes fragmentados y complejos pueden exhibir una mayor riqueza y diversidad de especies debido a las diferencias estructurales y propiedades de hábitat que generan cambios en la composición de especies. En este sentido, la abundancia y la riqueza de organismos como los Papilionoidea están intrínsecamente ligadas al contexto del paisaje local (Ospina et al. 2015).

Considerando la importancia de los Papilionoidea, como indicadores, surge la pregunta de investigación: ¿Cómo la relación entre la diversidad y el uso potencial del hábitat de los Lepidoptera diurnos permite la evaluación de la integridad biológica del paisaje productivo en la subcuenca del río Páez? Esta pregunta se plantea con el objetivo de comprender mejor la relación entre la estructura del paisaje y la biodiversidad en entornos específicos. En este contexto, se propone el estado de las comunidades silvestres, con un enfoque particular en los Papiolonoidea, como indicador del uso potencial del hábitat.

Metodología

Área de estudio

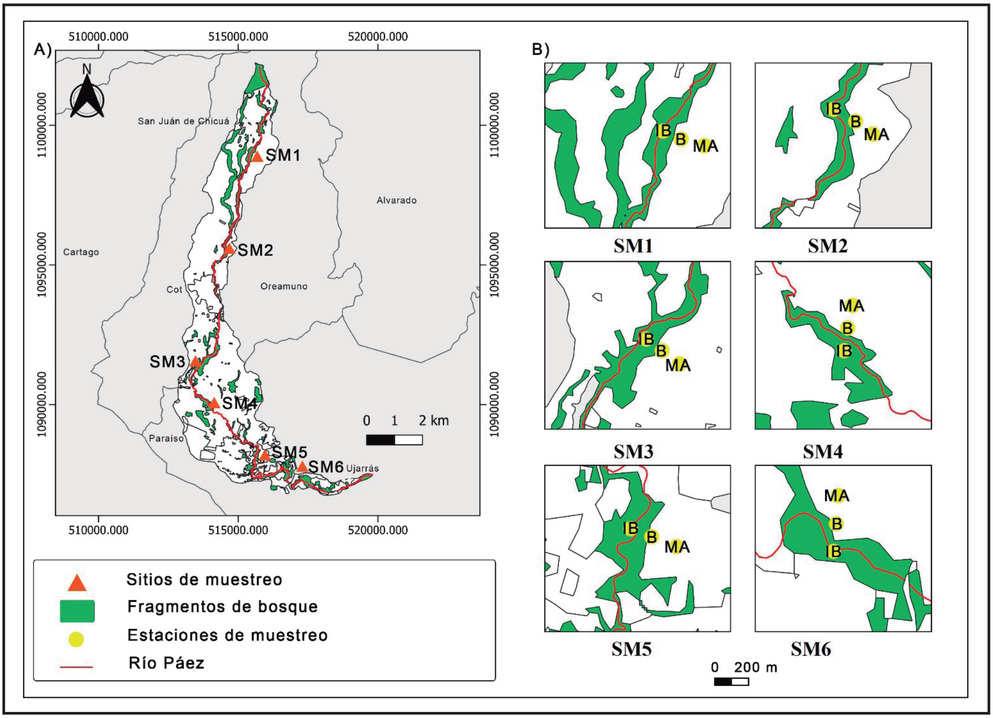
El área de estudio comprende el paisaje productivo de la subcuenca del río Páez, ubicado en la vertiente sureste del volcán Irazú en la provincia de Cartago, Costa Rica. La subcuenca, con un área de 55 km^2, abarca los cantones de Oreamuno y Paraíso. El río Páez es una fuente crucial de agua en la zona y su caudal también es utilizado para la producción de energía hidroeléctrica y turismo. Además, contribuye significativamente en el desarrollo de las actividades agrícolas, pecuarias e industriales de las comunidades aledañas (Álvarez-Jiménez et al. 2021).

El paisaje productivo de la subcuenca está inmerso en un mosaico agropecuario, compuesto principalmente por fragmentos de bosque secundario en diferentes etapas sucesionales, plantaciones, tierras agrícolas de uso intensivo y pastos para el ganado lechero (Aguilar-Torres, 2021). La subcuenca del río Páez comprende un rango altitudinal entre los 1.003 m s. n. m. en el embalse de Cachí y los 3.330 m s. n. m. en la cumbre del volcán Irazú. Presenta una precipitación media anual de 2.200 mm y temperatura promedio anual de 20 ºC. Según la clasificación de Zonas de Vida de Holdridge (Holdridge, 1967), el sitio de estudio comprende las zonas de vida bosque muy húmedo montano (bmh-M), bosque húmedo montano (bh-M) y bosque húmedo premontano (bh-P).

Trabajo de campo

Para obtener una muestra representativa de la diversidad de hábitats y especies en la subcuenca del río Páez, se seleccionaron seis sitios de muestreo (SM) considerando la disposición de los componentes estructurales de la vegetación, la extensión de la subcuenca y su variación altitudinal. Estos sitios se distribuyeron en tres niveles de la cuenca: dos en la cuenca alta, dos en la cuenca media y dos en la cuenca baja. En cada uno de estos sitios, se establecieron tres estaciones de recolección de datos, sumando un total de 18 estaciones para la recolección de datos (figura 1).

Figura 1. Subcuenca del río Páez mostrando los escasos fragmentos de bosque y los seis sitios de muestreo. A) Localización de los sitios de muestreo a lo largo de la variación altitudinal de la subcuenca. B) Detalle de las estaciones establecidas en cada sitio de muestreo, señalando en los recuadros donde se establecieron los transectos y la colocación de trampas Van Someren-Rydon. IB: Interior de bosque. BB: Borde de bosque. MA: Matriz adjacente.



Cada estación de muestreo se ubicó en tres puntos distintos: en el interior del bosque (IB), en el borde del bosque (BB) y en la matriz adyacente al borde (MA). Esta disposición permitió categorizar el uso de hábitat de las especies en los diferentes componentes de la vegetación agrupados bajo las mismas características estructurales. Se utilizó una combinación de dos técnicas de recolección para los Lepidoptera diurnos: captura directa con una red entomológica y trampas de fruta Van Someren-Rydon.

El muestreo se realizó durante siete meses, desde julio de 2021 hasta enero de 2022, con visitas mensuales a cada una de las 18 estaciones establecidas. En total, se acumularon 48 días de muestreo en los que se colocaron trampas Van Someren-Rydon, con cinco trampas colocadas simultáneamente a lo largo de 300 metros en cada estación, a diferentes alturas para abarcar el dosel y el sotobosque. En cada estación se colocaron seis trampas separadas entre sí por al menos 50 metros; el cebo consistió en bananos fermentados con diferentes tiempos de fermentación, para considerar las preferencias alimenticias de las especies frugívoras.

Durante las visitas a las estaciones, se definieron los mejores sitios para colocar las trampas, evitando espacios abiertos y áreas no adecuadas como tacotales. Las trampas se revisaron cada tres horas, desde las 9:00 a.m. hasta las 3:00 p.m., para garantizar su correcto funcionamiento y posición. Además, se utilizó la captura de individuos por medio de red de golpe, siguiendo transectos establecidos de 150 metros en cada tipo de hábitat en las estaciones: interior de bosque, borde de bosque y matriz adyacente.

En cada día de muestreo se recolectaron los Papilionoidea en las 18 estaciones, y se contabilizaron e identificaron los Lepidoptera a cinco metros a cada lado del transecto, en dos períodos de tres horas cada día. Las especies recolectadas se identificaron en el campo y se registraron los detalles de la colecta y fotografías. En total, se invirtieron 329 horas efectivas en el trabajo de campo.

Análisis de datos

Se empleó una base de datos para procesar los datos recolectados que incluía el número de individuos muestreados y la diversidad de especies halladas, con cada especie identificada y su nombre científico registrado. Además, se consignaron la ubicación y fecha del muestreo. La identificación de gran parte de los especímenes se realizó en el campo, utilizando guías como las de Chacón & Montero (2007), Garwood & Lehman (2011), Janzen & Hallwachs (2009) y Murillo-Hiller et al. (2019).

Para calcular los índices de diversidad de los Papilionoidea, se emplearon los programas EstimateS (Colwell, 2007), Past4 (Hammer et al. 2001). La riqueza y la abundancia de especies por sitio se describieron mediante el índice de Simpson, el cual requiere datos de cantidad y número de individuos por especie. Los datos y los índices estadísticos de equidad se procesaron mediante el programa EstimateS (Colwell, 2007) para generar curvas de acumulación de especies. Se utilizaron datos de especies observadas (Sobs), especies representadas por un solo individuo (“singletons”) y valores esperados de riqueza utilizando estimadores como ACE, Chao 1 y MMMean.

La complementariedad y el recambio de especies entre sitios se representaron con el índice de Jaccard (Ij), procesado con Past (Hammer et al. 2001), que varía de cero (0) cuando no hay especies compartidas a uno (1) cuando los sitios comparten todas las especies, evaluando diferencias en presencia o ausencia de especies.

Se identificaron atributos ecológicos de las comunidades de Lepidoptera esperados para cambiar a través de asociaciones vegetales en el paisaje. Estos atributos incluyeron el hábitat de ocurrencia (interior de bosque, borde de bosque, matriz adyacente), el estrato de forrajeo (sotobosque, estrato medio, dosel) y el gremio de forrajeo (acimófagas, nectarívoras, hidrófilas). Los Lepidoptera frugívoros se categorizaron en dos grupos según su hábitat en dosel o sotobosque, y se recopiló información sobre endemismo y estado de amenaza para determinar su conservación. Se desarrolló un modelo para evaluar el uso del hábitat por cada especie, utilizando las métricas y valores de especies en cada estación de muestreo (Martínez-Noble et al. 2015).

Finalmente, se analizaron los datos de diversidad mediante comparaciones de los índices de similitud de especies de Jaccard para evaluar el grado de complementariedad de las métricas utilizadas. Estos índices se utilizaron para comparar la composición específica entre lugares, generando valores de similitud basados únicamente en datos de presencia-ausencia. En cada estación se realizaron tres ensambles para cada métrica, comparando la riqueza total y el índice de diversidad de Shannon como variables dependientes en bosques, bordes y áreas no boscosas.

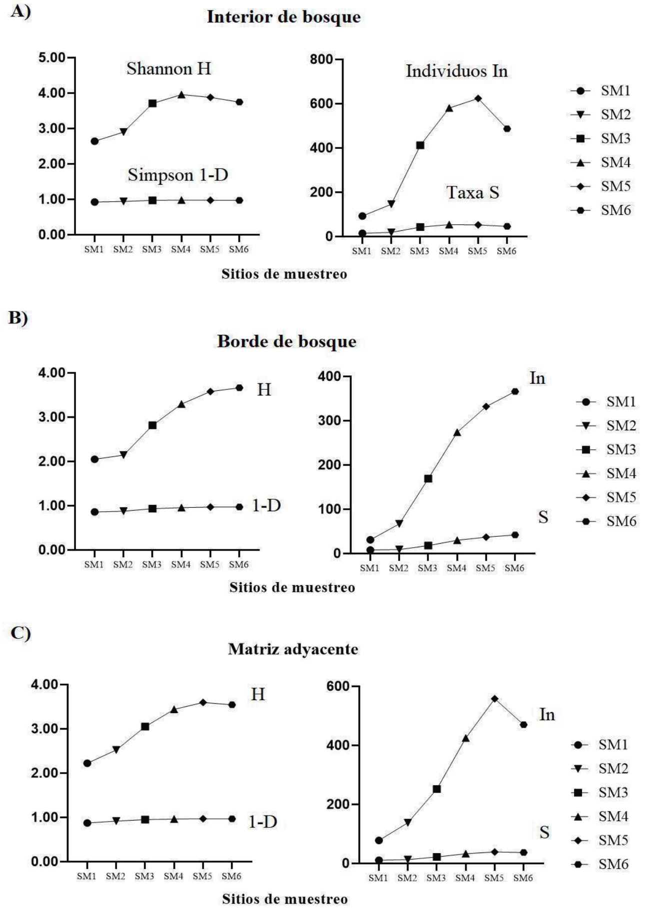
Resultados

Se registraron 5.503 individuos pertenecientes a 107 especies presentes en tres hábitats: interior de bosque, borde de bosque y matriz adyacente. Estas especies pertenecen a seis familias de la superfamilia Papilionoidea: Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae, Pieridae y Riodinidae. Algunas de las especies más comunes fueron *Emesis tenedia* (Felder & Felder, 1861), *Catasticta hegemon* (Godman & Salvin, 1889), *Catasticta nimbice bryson* (Godman & Salvin, 1889), *Abaeis xanthochlora* (Kollar, 1850), *Yphthimoides renata* (Stoll, 1780), *Pedaliodes dejecta* (H. Bates, 1865), *Anartia fatima fatima* (Fabricius, 1793), *Dione moneta poeyii* (A. Butler, 1873), *Altinote ozomene nox* (H. Bates, 1864), *Eutresis dilucida*

(Staudinger, 1885), *Dircenna klugii* (Geyer, 1837), *Danaus plexippus* (Linnaeus, 1785), *Consul electra* (Westwood, 1850), *Leptotes cassius cassidula* (Boisduval, 1870), *Poanes zabulon* (Boisduval & Le Conte, 1837) *y Heliconius melpomene* (Boisduval, 1870). Los valores resultantes del índice de Shannon fueron: H 2.64 en IB; H 2.05 en BB, y H 2.22, en MA.

La evaluación de los organismos, a través de análisis de complementariedad Jaccard determinó que 50 especies estaban asociadas al interior de bosque (IB), 26 al borde del bosque (BB) y 31 a la matriz adyacente (MA). De las especies evaluadas, 60 dependían únicamente de un solo uso del hábitat, entre ellas: *Ithomeis eulema imitatrix* (Godman & Salvin, 1878), *Heliconius clysonimus montanus* (Salvin, 1871), y *Catasticta hegemon* (Godman & Salvin, 1889) sólo se encontraron en diferentes estratos del interior del bosque. En el borde del bosque, las siguientes fueron únicas de este hábitat: *Heliconius melpomene* (Boisduval, 1870), *Anthanasa otanes* (Hewitson, 1864) *y Autochton vectilucis* (Butler, 1872). Además, en la matriz adyacente, Lepidoptera diurnos como *Abaies xanthoclora* (Kollar, 1850), *Siproeta epaphus* (Latreille, [1813]) y *Remella rita* (Evans, 1955) estuvieron limitadas a esta composición del paisaje.

Figura 2. Índices de diversidad de lepidópteros diurnos calculados para cada uno de los sitios de muestreo. Se presentan los valores del índice de Simpson 1-D, índice de Shannon H, número de individuos y número de especies para cada uno de los sitios de muestreo.



En el interior de bosque (IB) se identificó una riqueza (S) de 62 especies y 2.343 individuos, donde predominaron *Dircenna klugii* (Geyer, 1837) con 79 individuos; *Eutresis dilucida* (Staudinger, 1885), con 75 y *Consul electra* (Westwood, 1850) y *Catasticta hegemon* (Godman & Salvin, 1889), con 94 individuos. En el borde de bosque (BB) se contabilizó una riqueza (S) de 48 especies, con un total de 1.239 individuos, y las especies que estuvieron representadas en mayor número fueron *Yphthimoides renata* (Stoll, 1780), con 75 individuos; *Heliconius melpomene* (Boisduval, 1870), con 57 individuos y *Autochton vectilucis* (Butler, 1872)*,* con 50 individuos. En contraste, la matriz adyacente (MA) registró una riqueza total (S) de 41 especies y 1.921 individuos, destacando la presencia de cuatro especies: *Poanes zabulon* (Boisduval & Le Conte, 1837), con 96 individuos; *Leptotes cassius cassidula* (Boisduval, 1870), con 105 individuos; *Anartia fatima* (Fabricius, 1793), con 100 individuos e *Yphthimoides renata* (Stoll, 1780), con 81 individuos.

Durante el estudio, se encontró una variación significativa en los índices de diversidad de Lepidoptera diurnos entre los sitios de muestreo (SM) y los diferentes hábitats dentro de cada sitio (figura 2). Se observó que los índices de diversidad eran más altos en el interior de los bosques, más bajos en la matriz adyacente y de nivel intermedio en el borde.

Además, se encontró una relación entre los índices de diversidad y la altitud de los sitios de muestreo. Los sitios de muestreo ubicados en altitudes más bajas, como el SM6 en la cuenca baja, presentaron índices de diversidad más altos que los SM localizados en elevaciones más altas, como el SM1 en la cuenca alta. Estos resultados sugieren que la altitud puede ser un factor importante que influye en la diversidad de lepidópteros diurnos en la zona de estudio.

En el interior del bosque, el índice de Simpson 1-D tuvo una variación de 0.92 (SM1) a 0.97 (SM6). Los valores de borde de bosque reflejaron una variación de 0.86 (SM1) a 0.97 (SM6), mientras que los de matriz adyacente presentaron valores de 0.87 (SM1) a 0.96 (SM6).

Por otra parte, el índice de diversidad de Shannon H corrobora la tendencia en el aumento de los valores de diversidad en respuesta a la altitud y la ubicación de las estaciones de muestreo, siendo bosque la dominante: la diversidad H aumenta de 2.64 (SM1) a 3.74 (SM6), el valor más alto registrado de este índice. En el borde del bosque, los valores de H fueron de 2.05 (SM1) a 3.66 (SM6). La matriz adyacente muestra los valores más bajos, de 2.22 (SM1) a 3.54 (SM6).

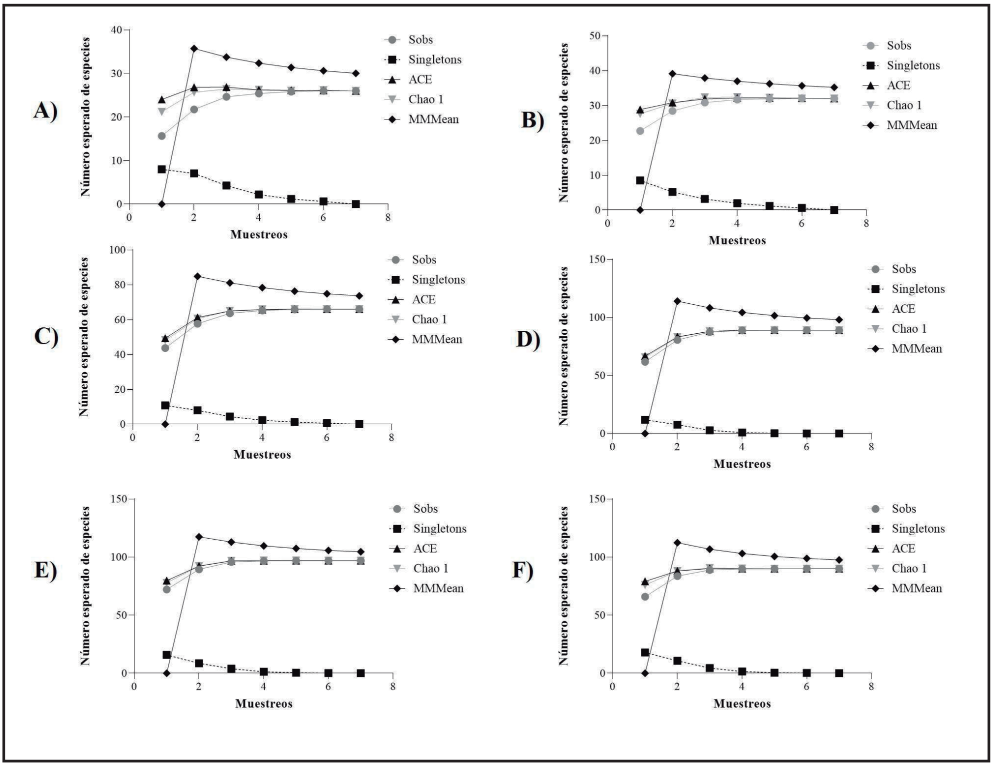
Siguiendo el patrón de los índices de diversidad, la riqueza y la abundancia también aumentaron a medida que la variable altitudinal disminuyó, siendo el bosque como estación de muestreo la que más especies aportó. Los sitios SM5/SM6 presentaron un promedio de riqueza de 49 especies (555 individuos en la cuenca baja); mientras que en los sitios SM1/SM2, en la cuenca alta, los taxones no superaron las 17 especies (93 individuos). En la cuenca media SM3 y SM4, la riqueza promedio es de 48 especies (490 individuos).

En el borde de bosque los valores promedios registrados en SM6/SM5, cuenca baja, fueron de 39 especies (349 individuos). En contraste en los sitios SM1/SM2, (cuenca alta) se observaron 13 especies (49 individuos). Los sitios SM3/SM4, (cuenca media), generaron un promedio de 24 especies (118 individuos). Por su parte, la matriz adyacente registró valores promedio en SM6/SM5 (cuenca baja) de 38 especies (514 individuos); SM1/SM2 (cuenca alta), 12 especies (108 individuos), y en los sitios SM3/SM4 (cuenca media), 27 especies (195 individuos).

Con respecto a los índices de diversidad, considerando la totalidad de datos obtenidos por estaciones de muestreo, en el interior de bosque (IB) Simpson y Shannon mostraron los valores más altos del análisis: 1-D: 0.98 y H: 4.01. Esto indica que la diversidad de Papilionoidea fue muy alta en este hábitat. En contraste, en la matriz adyacente (MA) 1-D: 0.97 y H: 3.62, los más bajos de las tres composiciones de hábitats, pero, aun así, estas cifras indican una riqueza alta en el lugar. El borde de bosque (BB) presentó valores de 1-D: 0.97 y H: 3.69.

Al cotejar visualmente las curvas de abundancia-diversidad contemplando la totalidad de los datos de riqueza y abundancia (figura 3) de los seis sitios de muestreo, se puede constatar que se presenta un patrón de distribución similar. El lugar donde fue más alto el número de especies y la totalidad de la riqueza evaluada (Sobs) fue el SM5, con 72 el primer día y 97 el último; mientras que en el SM1 fue de 15 el primer día y 26 en el último. Por su parte, el SM3, con una abundancia media de diversidad, presenta 43 en el primer día y 66 en el último.

Figura 3. Curvas de acumulación de especies de lepidópteros diurnos determinadas en los seis sitios donde se establecieron cada una de las estaciones de muestreo. *Nota*. A y B denotan los sitios de muestreo en la cuenca alta. C y D denotan los sitios de muestreo en la cuenca media. E y F denotan los sitios de muestreo en la cuenca baja. Se representa el número de especies observadas de acuerdo con el muestreo (Sobs), el número de especies con un solo individuo (singletons) y los valores esperados de la riqueza de los estimadores (ACE, Chao 1 y MMMean).



El número de especies representadas por un solo individuo por día de muestreo (singletons) fue mayor en el SM5 con 15.85 de las especies observadas en el primer día. En el SM1, siendo el más alto en diversidad, sin embargo, no muestra una cantidad muy alejada de la anterior, pues presentó 7.99 singletons el primer día, en contraste con el SM3 donde se observó un valor de 10.81.

Las curvas de acumulación de Papilionoidea observadas, tomando como referencia el número de especies en cada uno de los sitios, reflejó la estabilización de la curva (asíntota), validando con ello que el esfuerzo del muestreo fue adecuado para encontrar las especies existentes en cada área. Esto significa que esta cantidad no aumentaría, o se incrementaría de manera poco significativa, aunque se incorporen más muestreos al estudio.

Durante el análisis, se utilizaron tres estimadores (ACE, Chao 1 y MMmean) para calcular los valores esperados de la riqueza de lepidópteros en diferentes sitios de muestreo. Los resultados mostraron una estabilidad en la curva, lo que sugiere que se alcanzó una buena cobertura en la recolección de especies. En el sitio de muestreo SM5, que obtuvo la mayor valoración, los valores esperados fueron de 79.79 para ACE, 77.90 para Chao 1 y 117.46 para MMmean. Mientras tanto, en el SM1, que obtuvo la menor valoración, los valores esperados fueron de 24.02 para ACE, 21.21 para Chao 1 y 35.73 para MMmean. En el SM3, que tuvo una valoración intermedia, los valores esperados fueron de 49.35 para ACE, 48.23 para Chao 1 y 84.91 para MMmean. Lo anterior sugiere que la diversidad de Lepidoptera varía significativamente entre los diferentes sitios de muestreo y que la utilización de múltiples estimadores puede proporcionar una mejor comprensión de la diversidad de la comunidad.

Con respecto al análisis de similitud, el índice de Jaccard mostró que, de manera similar a como sucedió con los índices de diversidad, los sitios de muestreo fueron similares de acuerdo con la altitud: en la cuenca alta SM1/SM2 se presentó un índice de similitud de 0.90 en interior de bosque y el borde de bosque, excepto en la matriz adyacente, donde adquiere un valor de 0.80.

En la cuenca media SM3/SM4 y baja SM5/SM6, el índice de Jaccard presentó valores inferiores a 0.3; en tanto en la cuenca media y baja adquirió valores de 0.88 en el bosque, 0.90 en el borde de bosque y 0.70 en la matriz adyacente.

Después de describir los índices de riqueza y abundancia de especies, se evaluó la complementariedad de los datos obtenidos. Teniendo en cuenta las características particulares de la diversidad, se compararon las tres estaciones de muestreo para determinar en qué medida se complementan entre sí, considerando tanto la exclusividad de las especies como la totalidad de estas en el caso de que dos estaciones se unieran

El índice de Jaccard para el número de especies en común (i.e. compartidas) entre el borde de bosque (BB) y la matriz adyacente (MA) tiene un valor de 0.50; mientras que entre ambas anteriores (BB y MA) con respecto al interior de bosque (IB), el índice señala una semejanza de 0.09. Estos números indican que la composición de comunidades es más similar entre el BB y la MA, que entre cualquiera de estas dos y el IB, y se genera así un recambio de especies; por otra parte, la comparación de IB con cualquiera de los componentes BB-MA no mostraría cambios.

Las tres composiciones estructurales de paisaje (interior de bosque, borde de bosque y matriz adyacente) o estaciones de muestreo de los seis sitios fueron sometidas a comprobación de similitud a través de los valores de diversidad y riqueza para validar la significancia de la complementariedad (figuras 4-6).

Con los resultados obtenidos se clasificaron las métricas de hábitat de ocurrencia, estrato forrajero, gremio alimentario y endemismo.

1) Hábitat de ocurrencia: interior de bosque (IB) 50 especies, borde de bosque (BB) 26 especies, y matriz adyacente (MA) 31 especies (también podría indicarse como fuera de bosque FB). De lo anterior, 37 especies fueron únicamente encontradas en IB, 4 únicas de BB y 19 especies solamente en MA.
2) Estrato de forrajeo: Las especies se clasificaron en:
    - Sotobosque (S): 43 especies
    - Sotobosque-Estrato medio (SM): 18 especies
    - Estrato medio-dosel (MD): 15 especies
    - Fuera de bosque (FB): 31 especies
3) Gremio de forrajeo. Las preferencias alimentarias: Acimófagas (ACI) 10 especies, nectarívoras (NEC) 69 especies, Además, se consideran:
    - ACI-HID: 6 especies
    - NEC-ACI: 4 especies
    - NEC-HID: 8 especies
    - NEC-ACI-HID: 3 especies
4) Grupos indicadores potenciales (especies endémicas regionales, Nicaragua, Costa Rica, Panamá): 10 especies.

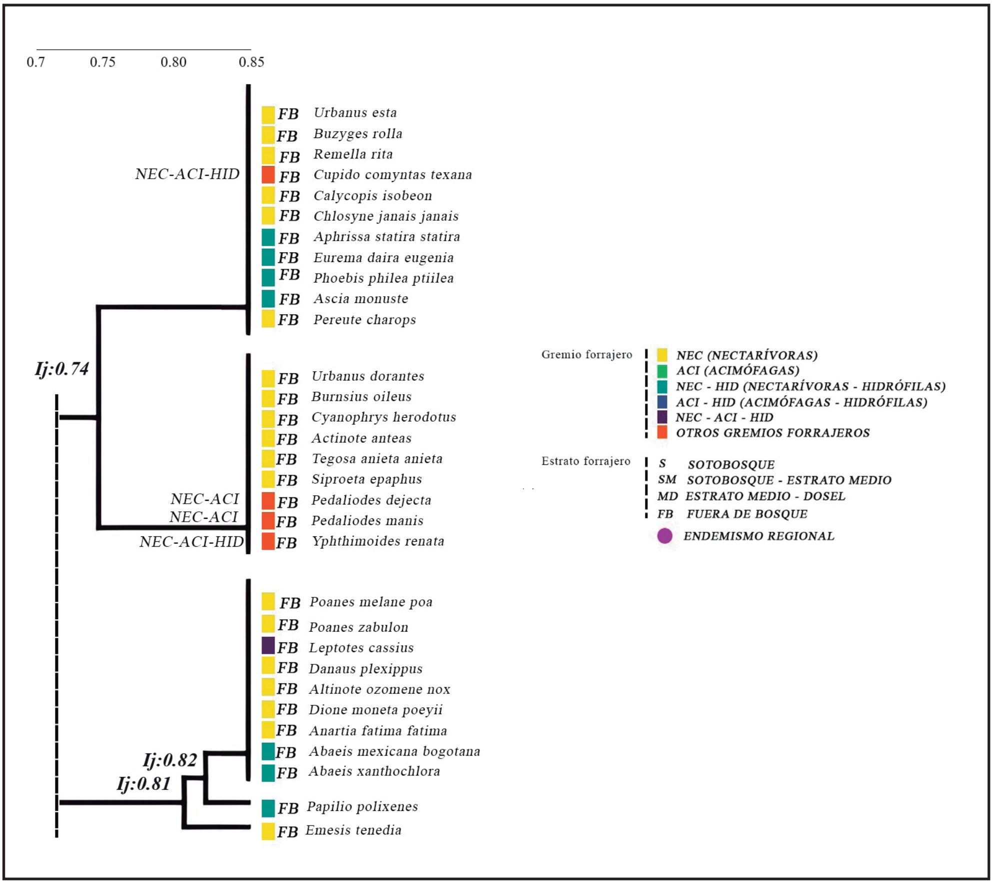
Discusión

El estudio de los Lepidoptera diurnos en la subcuenca del río Páez indica que el paisaje agroproductivo presenta diferentes arreglos de hábitats en los que se puede mantener un número significativo de especies. No obstante, las características del uso de suelo y la zonificación se relacionan con una lepidoterofauna severamente empobrecida, característica de hábitats perturbados. Es posible concluir lo anterior, al contrastar con los resultados de Hernández & Barrantes (2016); estos autores examinaron la influencia del paisaje en la diversidad de Papilionoidea y mostraron que la fragmentación del paisaje y la intensificación del uso del suelo, como el evidenciado en la subcuenca, tienen un impacto negativo en la riqueza y la diversidad de especies de Papilionoidea si se evidencia una variación de las especies a través de la gradiente de perturbación: transición de hábitats más cerrados (IB) a hábitats abiertos (MA).

El hecho de que en la subcuenca del río Páez se observe una mayor riqueza o diversidad de Lepidoptera en el interior del bosque, en contraste con el borde o con la matriz adyacente, concuerda con lo expuesto por

Beck & Khen (2007), quienes determinaron que estos organismos son indicadores sumamente sensibles al cambio de uso del suelo. La alteración del hábitat parece ser un factor clave para explicar la estructura de sus comunidades de Lepidoptera.

Figura 4. Papilionoidea asociados al hábitat de matriz adyacente (MA) en el clúster de los valores de complementariedad del índice de Jaccard, determinados por la riqueza y la abundancia de especies representadas en la totalidad de las estaciones de muestreo.

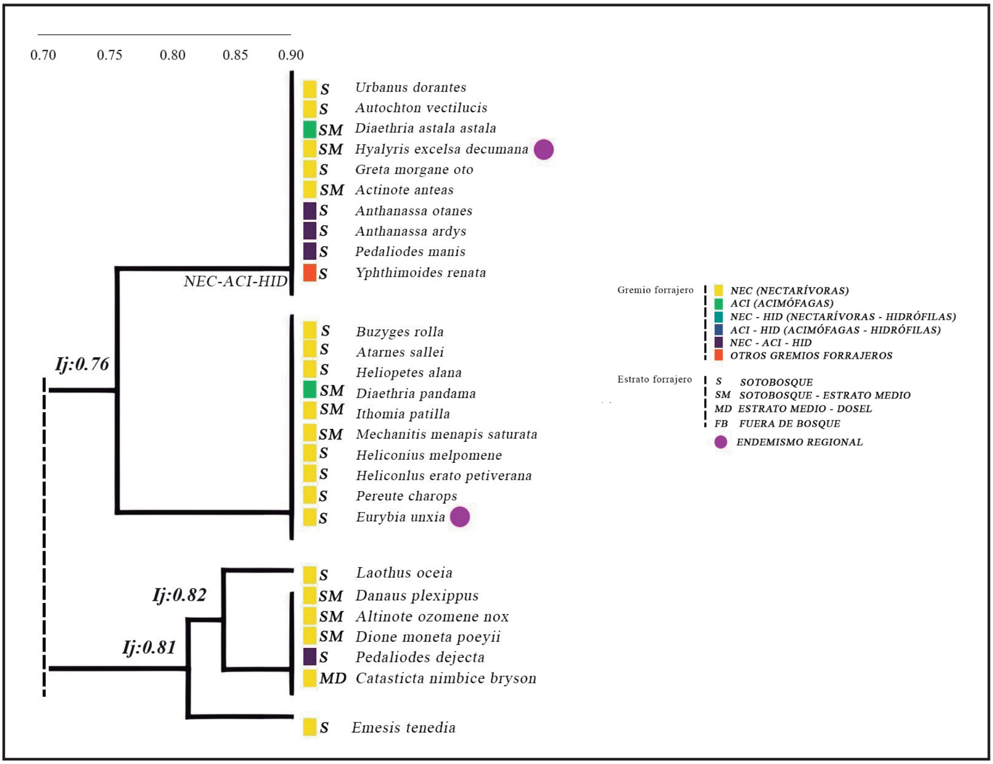


Este patrón también concuerda con lo expuesto por Häuser et al. (2007) en cuanto a la sensibilidad a los cambios ambientales demostrada por los lepidópteros de los bosques tropicales. Más aun, estos autores concluyen que estos organismos son los indicadores más adecuados para alertar sobre perturbaciones que ocurren en los hábitats terrestres. En este sentido, haciendo referencia a la escala espacial del presente estudio, a pesar de las cortas distancias entre las unidades del paisaje en los sitios de muestreo, se logró cuantificar la manera en que los Papilionoidea hacían uso del hábitat, y se obtuvo el mismo patrón que en estudios similares. Es decir, este tipo de evaluaciones rápidas puede tener aplicaciones para evaluar la condición del paisaje en distintas cuencas del país. En este estudio se logró determinar patrones de diversidad de lepidópteros diurnos en distintos entornos naturales por medio de la obtención de índices de diversidad, y es algo que se puede replicar en el mismo sitio (e.g. monitoreo a largo plazo) o en distintos lugares del país.

Las investigaciones sobre comunidades de Lepidoptera se han centrado, con frecuencia, en la comparación realizada entre sistemas agrícolas homogéneos y remanentes de bosque. Las diferencias observadas aquí en la variedad de especies en una gradiente de perturbación se comparan con lo hallado por

Ricketts et al. (2001) en una comparación más extrema (ambientes homogéneos de cultivo versus remanentes de bosque). Estos autores afirman que este tipo de estudios generalmente evidencian disimilitudes en los parámetros de abundancia, diversidad y composición general de las poblaciones de Lepidoptera.

Figura 5. Papilionoidea asociados al hábitat de borde de bosque (BB) en el clúster de los valores de complementariedad del índice de Jaccard, determinados por la riqueza y la abundancia de especies representadas en la totalidad de las estaciones de muestreo.

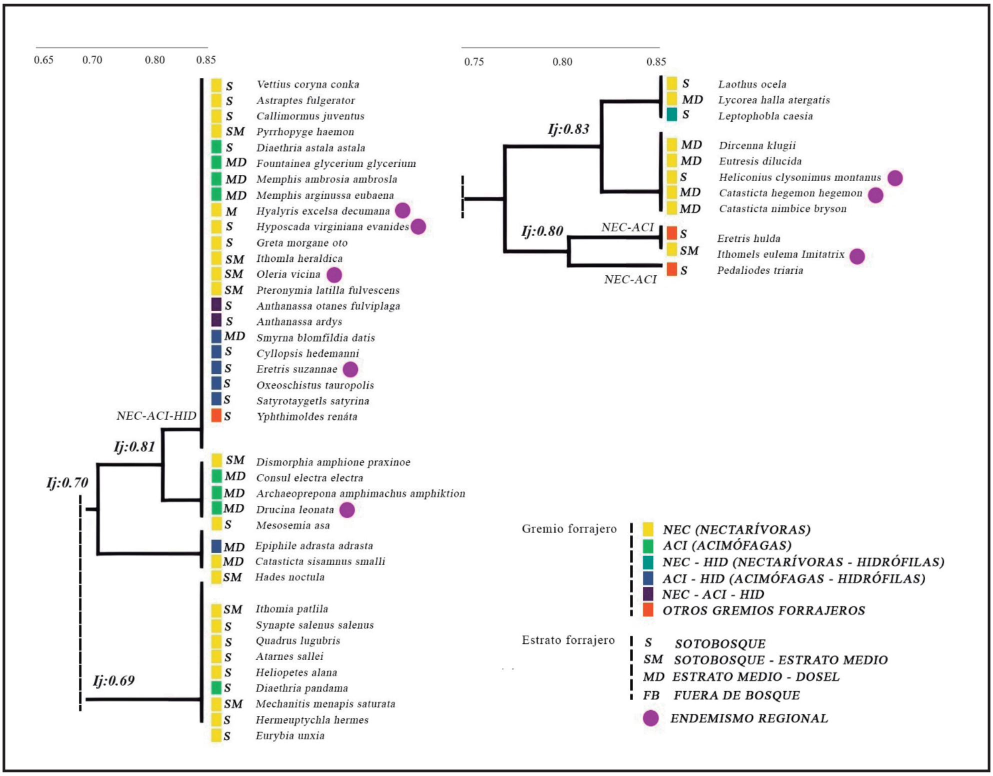


Aunque los grupos de Lepidoptera de la subcuenca del río Páez mostraron patrones similares en su respuesta a la perturbación del hábitat, se encontró que ciertas especies son más dependientes de los fragmentos de bosque. Sin embargo, se evidenció que algunas de estas especies también se mueven fuera del bosque, lo que sugiere que su supervivencia podría estar amenazada por la degradación de hábitats más allá de los bosques. De hecho, se observó que existe un recambio de especies entre el interior del bosque y la matriz adyacente, lo que indica que la conservación de estos bosques es importante para la supervivencia de especies más generalistas. Muchas, incluso, son características de ambientes en transición (bordes) y pueden fungir potencialmente como bioindicadores de integridad biológica y alteración. Debido a que los valores de los índices de diversidad en el bosque fueron los más sobresalientes, se sugiere que es el bosque la formación con mayor integridad biológica. Asimismo, se espera que, a mayor distancia de los fragmentos boscosos, se observará menos diversidad y por ende menor integridad biológica. Por esta razón, es importante no solo mantener parches boscosos grandes, sino tenerlos distribuidos a lo largo de la matriz agrícola (Arroyo-Rodríguez et al. 2020).

La composición de los Papilionoidea fue diferente en las comunidades de bosque, ya que las especies frugívoras (acimófagas) y nectívoras de dosel fueron abundantes en estas unidades; mientras que en pastizales y demás áreas abiertas dominaron los Lepidoptera generalistas hidrófilas y las que se alimentan de néctar. De todas las especies evaluadas, 60 de ellas dependían únicamente de un solo hábitat, lo que significa que no se evidenció actividad de estas especies a través de la gradiente de perturbación. Especies como

Ithomeis eulema imitatrix (Godman & Salvin, 1878)*, Consul electra* (Westwood, 1850)*, Dircenna klugii* (Geyer, 1837)*, Epiphile adrasta* (Hewitson, 1861)*, Heliconius clysonimus montanus* (Salvin, 1871)*, Memphis arginussa eubaena* (Boisduval, 1870)*, Fountanea glycerium* (Doubleday, 1849) y *Catasticta hegemon* () solo se encontraron en diferentes estratos del interior del bosque (IB). En el borde del bosque (BB), cuatro especies dependían de este hábitat: *Heliconius melpomene* (Boisduval, 1870)*, Heliconius charithonia vazquezae* (W. Comstock & F. Brown, 1950)*, Anthanasa otanes* (Hewitson, 1864) y *Autochton vectilucis* (Butler, 1872). Por otro lado, en la matriz adyacente (MA), Lepidoptera diurnos como: *Papilio polixenes* (Rothschild & Jordan, 1906)*, Abaies xanthoclora* (Kollar, 1850)*, Siproeta epaphus* (Latreille, [1813])*, Urbanus esta* (Evans, 1952)*, Remella rita* (Evans, 1955) y *Phoebis philea* (Linnaeus, 1763) fueron únicas en esta composición del paisaje.

Figura 6. Papilionoidea asociadas al hábitat de interior de bosque (IB) en el clúster de los valores de complementariedad del índice de Jaccard, determinados por la riqueza y la abundancia de especies representadas en la totalidad de las estaciones de muestreo.



La principal razón por la que estos Lepidoptera prefieren estos ambientes es que allí encuentran una gran cantidad de alimento en forma de néctar y frutos. En el dosel forestal, las flores de muchas plantas, como los árboles, crecen en la parte superior y se ubican en zonas iluminadas por el sol, lo que permite que los néctares estén disponibles en grandes cantidades. Además, la altura de los árboles protege a estos Papilionoidea de los depredadores terrestres, reduciendo la tasa de mortalidad. En contraste, las áreas abiertas, como los campos y los bordes de los bosques, suelen tener menos flores y, por lo tanto, menos néctar disponible, lo que dificulta la supervivencia de estos Papilionoidea. Otra razón por la que los Papilionoidea frugívoras y nectarívoras de dosel prefieren estos ambientes es que están mejor adaptadas a vivir en estos entornos. La forma de sus alas y su comportamiento de vuelo les permite maniobrar entre las ramas de los árboles y acceder a los recursos que necesitan para sobrevivir. Por lo tanto, estos Papilionoidea están mejor adaptadas a vivir en ambientes boscosos y pueden tener dificultades para sobrevivir en áreas abiertas.

A diferencia de las conclusiones presentadas por DeVries (2012), para las especies de áreas cerradas, es probable que exista una correlación significativa con el porcentaje de bosques circundantes en épocas del año diferentes. Esto se debe a que muchas de estas especies tienen movimientos locales que responden a cambios climáticos específicos en diferentes partes de las zonas montañosas, y a menudo frecuentan los bordes y áreas abiertas en busca de alimento. Por lo tanto, aunque los Papilionoidea de áreas cerradas pueden ser menos dependientes del bosque durante ciertas épocas del año, aún requieren la presencia de bosques circundantes para mantener su supervivencia a largo plazo. Así, se generan patrones distintos de la composición de las comunidades dentro de una escala temporal en un espacio determinado, lo que explica la similitud en las unidades del paisaje comparadas en términos de riqueza.

Aunque se sabe que las especies pueden variar en su presencia y abundancia a lo largo del tiempo, se logró demostrar que también existe variación de especies en los diferentes hábitats analizados. La observación de Papilionoidea en cada uno de los sitios de muestreo permitió identificar aquellas especies que prefieren los ambientes más cerrados, las que se encuentran en zonas abiertas o las que se mueven entre ambos tipos de hábitats. De esta manera, se pudo determinar la diversidad de Papilionoidea que habitan cada tipo de ambiente y las características que las hacen únicas.

El muestreo simultáneo en todos los sitios permitió comparar de manera precisa la presencia y la abundancia de las especies en cada uno de los hábitats analizados. Esta metodología asegura que los resultados obtenidos fueran lo más exactos y confiables posibles. Además, el análisis de la variación de especies en los diferentes hábitats proporciona información valiosa para entender la relación entre la diversidad biológica y los factores ambientales.

La escogencia de una serie de sitios de muestreo a lo largo de una gradiente altitudinal en los fragmentos de bosque, su borde y la matriz adyacente permitió conocer una vez más la variabilidad de especies desde el punto de vista ecológico de uso de hábitat. De esta manera, la metodología utilizada para determinar la diversidad de especies diurnas en un paisaje productivo contribuye a establecer, de manera cuantitativa, el papel de los fragmentos de bosque remanentes, al catalogar y describir métricas derivadas de análisis de historia natural de estos organismos en entornos suburbanos.

Se concuerda con Ricketts et al. (2001) en cuanto a que la estructura y composición de la comunidad está estrechamente relacionada con la complejidad de su ambiente (propiciada esta última por la riqueza y diversidad de especies vegetales, la densidad de la vegetación, la densidad del dosel, el sotobosque y la complejidad vertical). La falta de diversidad de lepidópteros en los potreros y sitios de cultivo, a diferencia de lo que ocurre en los bosques secundarios y los hábitats de borde, puede deberse a la homogeneidad estructural de estos últimos, los cuales no proveen una variedad de nichos y recursos para la fauna. De esta manera, los reductos como estos en paisajes productivos mantienen características de integridad, a pesar de la degradación a la que han sido sometidos sus alrededores.

Haciendo referencia a lo anterior, es posible afirmar que la abundancia y la riqueza de las especies de Papilionoidea pueden verse favorecidas directamente por las condiciones físicas del hábitat, a las cuales los organismos ya están adaptados. En este sentido, Dovčiak (2014) encontró que estos factores, en particular los componentes florísticos del paisaje también pueden provocar cambios en las interacciones ecológicas como la depredación y la competencia entre especies por recursos. Así, por ejemplo, en los sitios de la subcuenca con mayor abundancia de lepidópteros se esperaría también encontrar una mayor presencia de animales que se alimentan de Lepidoptera como anfibios, reptiles, aves, artrópodos depredadores y parasitoides como Diptera e Hymenoptera.

Los bosques en un paisaje productivo como la subcuenca Páez, donde el entorno natural está fragmentado, pueden presentar pequeños reservorios de diversidad donde converjan características climáticas y ecológicas que conduzcan a una estabilidad de las poblaciones. La amplia cobertura vegetal observada en el tacotal y bosque secundario analizado permite cumplir con la relación de diversidad-estabilidad propuesta por Carvalheiro et al. (2013). Según estos autores, la variedad de plantas permite que los polinizadores se mantengan estables incluso en periodos sin floraciones masivas. En consecuencia, la alta riqueza vegetal de la zona favorece la estabilidad en la producción de recursos para los Lepidoptera y contribuye a mantener poblaciones estables de otros insectos polinizadores en la región de Cartago.

La diversidad de Lepidoptera varió significativamente entre los sitios de muestreo de la subcuenca del río Páez, lo que indica cuantitativamente la importancia de los parches de bosques remanentes en áreas urbanas y suburbanas. Estos parches son figuras ecosistémicas cruciales para mantener comunidades bióticas estables, así como para generar múltiples servicios ambientales, como la conectividad biológica. Se debe destacar la cuantificación de varias especies de lepidópteros diurnos en el borde del bosque y la matriz adyacente. Es posible que esta diversidad de especies se deba a la interacción del bosque con estos hábitats circundantes, que pueden actuar como corredores ecológicos y facilitar el movimiento de los Lepidoptera entre estas diferentes áreas. Lo anterior refuerza lo que establece Alfaro-Jiménez (2018), quien hizo hincapié en la capacidad de estas áreas de ofrecer múltiples servicios ambientales, al ejemplificar en su estudio cómo los espacios que componen la matriz adyacente pueden llegar a contener una diversidad propia significativa que interactúa con los fragmentos.

De esta manera, así como logró concluir Molina-Guerra et al. (2013), las interacciones entre los elementos del paisaje pueden incidir en la diversidad y la abundancia, lo que influye en el movimiento de los organismos tanto a través del mosaico de los parches, como a lo largo de otras áreas en regeneración. Esto se reflejó en el presente estudio en el hecho de que a pesar de que se contabilizaron diversos tipos de lepidópteros diurnos, el estudio comparativo por medio de Jaccard demostró que no todos presentan similitudes en cuanto a preferencia de hábitat o movilidad entre los componentes boscosos y su colindancia. En otras palabras, a pesar de que se identificaron muchas especies de Papilionoidea, no todas fueron determinantes para la evaluación, pues 82 de un total de 107 estaban asociadas al componente paisajístico (bosque, borde de bosque, matriz adyacente).

Es de resaltar cómo la variación altitudinal incide en la riqueza: los índices de diversidad disminuyen conforme aumenta la altitud de los sitios, por lo cual se observó que la abundancia de individuos y la riqueza de especies aumentaba a medida que se descendía a la subcuenca baja. Lo anterior encuentra apoyo en los resultados de McCain & Grytnes (2010), quienes destacan varios factores que cambian de forma previsible con el aumento de la elevación; el más evidente es el descenso, generalmente lineal, de la temperatura. Otros factores climáticos y abióticos varían a lo largo de las gradientes montañosas, pero tienen una relación más compleja con la altitud. El mejor ejemplo, y probablemente el más importante, es la precipitación, ya que aunada a otros factores abióticos, esta influye fuertemente en la distribución de las especies florales y, por tanto, en los cambios en las comunidades vegetales dominantes y en los hábitats que se observan a medida que se gana altitud.

Las similitudes entre los componentes del paisaje sujetos a muestreo según las métricas de hábitat de ocurrencia, estrato forrajero, gremio alimentario y endemismo fueron comprobadas y constataron que las estaciones de muestreo presentan diferencias significativas en cuanto a la distribución de las especies. Este resultado es relevante porque plantea que es necesario considerar diversos hábitats a fin de conocer la composición específica de las comunidades en la zona de estudio. Además, Sánchez-Alvarado (2023) evidenció una tendencia hacia una mayor riqueza y diversidad de especies en la cuenca media, en comparación con las cuencas alta y baja. Esto puede deberse a diversos factores, como la mayor heterogeneidad del hábitat en la cuenca media, la presencia de microhábitats más diversos o la influencia de factores ambientales específicos.

Es fundamental tener en cuenta que los resultados obtenidos en esta investigación son específicos de la muestra estudiada y no necesariamente pueden extrapolarse a otras regiones o ecosistemas, pero sí la metodología aplicada y el alto potencial de seleccionar una comunidad de especies que represente el estado de la integridad biológica. Es necesario seguir profundizando en el estudio de la ecología y la biología de las especies de lepidópteros diurnos para comprender mejor su distribución y factores que influyen en ella.

La fragmentación del entorno apunta a ser el factor clave para explicar la estructura de sus comunidades de Lepidoptera. Por lo tanto, con la afirmación sustentada de que el bosque es la formación con mayor integridad biológica, es imprescindible no solo mantener parches boscosos grandes, sino tenerlos distribuidos a lo largo de la matriz agrícola.

Conclusiones

Se evidencia una gradiente cuantificable en los valores de diversidad de Papilionoidea en los diferentes componentes del paisaje. Entre estos, los fragmentos de cobertura boscosa albergan una mayor cantidad de especies e individuos de Papilionoidea. Esto se fundamenta en que los bosques proporcionan un hábitat adecuado para muchas especies de Lepidoptera, al ofrecer refugio, alimento y recursos para su reproducción. Además, los bosques suelen estar menos alterados que otros tipos de cobertura, lo que les permite mantener una mayor biodiversidad.

Los valores de diversidad de Lepidoptera diurnos disminuyen a medida que aumenta la distancia de los parches de bosque. La presencia de bosques en una unidad del paisaje puede tener un efecto positivo en la diversidad de Lepidoptera diurnos en la región, incluso en áreas donde la mayor parte no está cubierta por bosques. Esto destaca la importancia de estos ecosistemas en la subcuenca del río Páez, ya que actúan como refugios para la biodiversidad en paisajes fragmentados. La altitud en la subcuenca es un factor que determina la riqueza y abundancia de la lepidopterofauna. Las condiciones climáticas en la subcuenca pueden influir en la diversidad de los Lepidoptera diurnos y en que las especies puedan adaptarse a diferentes altitudes y hábitats. Por lo tanto, es importante considerar la altitud al planificar actividades de conservación y restauración en la región, pues este factor puede tener un impacto significativo en la biodiversidad.

Los índices de diversidad de los Papilionoidea cambian en un solo sitio de muestreo si se delimitan estaciones en diferentes componentes del paisaje y sus hábitats (interior de bosque, borde de bosque y matriz adyacente). Esto puede deberse a que la elección de los lugares influye en los resultados de la evaluación de la diversidad de Papilionoidea. Por lo tanto, es importante considerar la selección de los sitios de muestreo cuidadosamente, teniendo en cuenta diferentes componentes del paisaje y hábitats, para obtener una imagen más precisa de la biodiversidad en la subcuenca del río Páez. La selección de métricas basadas en la historia natural de los Lepidoptera diurnos permite determinar su disposición en la estructura de las unidades del paisaje. Su funcionalidad radica en entender cómo las características del hábitat influyen en la presencia y diversidad de estas especies, lo que a su vez ayuda a entender la salud del ecosistema.

La coexistencia de especies que comparten el mismo hábitat, así como aquellas que tienen preferencias únicas para cada tipo de ambiente, puede tener implicaciones significativas en la conservación de la biodiversidad en la subcuenca del río Páez. Por ejemplo, si un hábitat se degrada o se pierde, las especies que tienen preferencias únicas por ese entorno pueden sufrir un impacto mayor en términos de pérdida de poblaciones o extinción local. Por lo tanto, identificar estas especies y sus preferencias de hábitat puede ayudar a orientar los esfuerzos de conservación hacia la protección de los sitios más críticos para estas especies.

El uso de datos de diversidad para identificar especies indicadoras en una región y cómo estas están ligadas al uso del hábitat justifica cómo los cambios en el uso del suelo pueden afectar la biodiversidad. Esto permite identificar especies clave y áreas críticas para la conservación y gestión del hábitat. La generación de índices de similitud permite identificar especies complementarias en una unidad de paisaje, ya que este tipo de análisis ayuda a la comprensión de la relación entre diferentes especies y cómo la presencia de una especie puede influir en la de otra.

Con la premisa de que la integridad biológica disminuye en el paisaje productivo de la subcuenca a medida que los componentes de la matriz del paisaje se alejan del bosque, la capacidad de los lepidópteros diurnos como indicadores de la integridad biológica en una región se basa en el conocimiento y la categorización de ellos como una comunidad, más que como especies individualizadas.

Agradecimientos

Este trabajo fue posible gracias al programa de becas CeNAT-CONARE y la colaboración personal del laboratorio de Gestión Ambiental y PRIAS del Centro Nacional de Alta Tecnología.

Conflicto de interés

Los autores declaran que no existe ningún interés financiero conocido ni relaciones personales, que pudieran haber influido en el trabajo que se presenta en este artículo.

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(Recibido para publicación / *Received for publication* 30-IV-2024)
(Revisado y aceptado */ Revised and accepted* 30-VII-2024)
(Publicado / *Published* 30-IX-2025)

Anexo. Lista total de la abundancia de especies de lepidópteros diurnos de la subcuenca del río Páez. IB-Interior de bosque, BB-Borde de bosque, MA-Matriz adyacente, RG-Red de golpe, - VSR-Trampa Van Someren-Rydon

FAMILIA	ESPECIE	SM1	SM2	SM3	SM4	SM5	SM6	Hábitat	Método de captura	Mes
Hesperiidae	*Astraptes anaphus annetta*		**14**	**19**	**22**			MA	RG	Jul-Dic
	Astraptes fulgerator			**14**	**9**	**11**	**17**	IB	RG	Jul-Ene
	Urbanus esta				**12**	**20**	**9**	MA	RG	Sep-Dic
	Urbanus dorantes			**16**	**8**	**18**	**15**	BB/MA	RG	Jul-Dic
	Synapte salenus				**12**	**18**	**6**	IB	RG	Jul-Dic
	Saliana esperi					**10**	**17**	BBB	RG	Ago-Dic
	Buzyges rolla				**14**	**29**	**21**	BB/MA	RG	Jul-Dic
	Cynea cynea					**22**	**18**	BB/MA	RG	Jul-Ene
	Perichares philetes					**22**	**13**	IB	RG	Jul-Ene
	Poanes melane poa	**7**	**16**	**14**	**9**	**17**	**12**	BB/MA	RG	Jul-Ene
	Poanes zabulon	**12**	**10**	**21**	**20**	**19**	**14**	MA	RG	Jul-Ene
	Callimormus juventus			**6**	**8**	**9**	**8**	IB	RG	Nov-Ene
	Remella rita				**18**	**29**	**11**	BB/MA	RG	Ago-Ene
	Vettius coryna conka			**16**	**14**	**19**	**10**	IB	RG	Jul-Ene
	Dalla pulchra	**19**	**24**	**20**				BB/MA	RG	Ago-Ene
	Achlyodes pallida					**17**	**10**	BB/MA	RG	Jul-Ene
	Quadrus lugubris				**9**	**15**	**8**	IB	RG	Ago-Dic
	Noctuana lactifera	**10**	**8**					IB	RG	Ago-Dic
	Atarnes sallei				**15**	**27**	**20**	IB/BB	RG	Ago-Dic
	Autochton vectilucis			**12**	**13**	**15**	**10**	BB	RG	Jul-Oct
	Burnsius oileus			**7**	**18**	**8**	**15**	MA	RG	Oct-Ene
	Heliopetes alana				**19**	**12**	**12**	IB/BB	RG	Sep-Ene
	Pyrrhopyge haemon			**5**	**4**	**9**	**8**	IB	RG	Nov-Ene
Lycaenidae	*Cupido comyntas texana*				**12**	**23**	**29**	MA	RG	Jul-Ene
	Leptotes cassius cassidula	**19**	**13**	**16**	**11**	**20**	**26**	MA	RG	Jul-Ene
	Arawacus sito					**19**	**23**	BB/ MA	RG	Jul-Nov
	Cyanophrys herodotus			**12**	**14**	**19**	**8**	MA	RG	Jul-Ene

Nymphalidae	*Calycopis isobeon*				**23**	**18**	**32**	MA	RG	Jul-Ene
	Laothus oceia	**8**	**23**	**16**	**20**	**14**		IB/BB	RG	Jul-Ene
	Ostrinotes keila					**9**	**22**	IB/BB	RG	Jul-Sep
	Panthiades bathildis					**14**	**18**	IB/BB	RG	Jul-Nov
	Diaethria astala			**7**	**12**	**18**	**10**	IB/BB	**RG/ VSR**	Jul-Nov
	Diaethria pandama				**12**	**25**	**7**	IB/BB	**RG/ VSR**	Jul-Nov
	Epiphile adrasta			**9**	**15**	**11**	0	IB	**RG/ VSR**	Jul-Nov
	Consul electra		**11**	**15**	**22**	**28**	**21**	IB	**RG/ VSR**	Jul-Dic
	Fountainea glycerium			**10**	**18**	**6**	**12**	IB	**RG/ VSR**	Jul-Nov
	Memphis ambrosia			**7**	**5**	**6**	**13**	IB	**RG/ VSR**	Ago-Nov
	Memphis arginussa eubaena			**6**	**11**	**15**	**4**	IB	**RG/ VSR**	Set-Nov
	Memphis philumena indigotica					**8**	**5**	IB	**RG/ VSR**	Set-Dic
	Archaeoprepona amphimachus amphiktion		2	**6**	**10**	**3**	**7**	IB	**RG/ VSR**	Jul-Nov
	Anetia thirza insignis	**7**	5					BB	RG	Jul-Oct
	Danaus plexippus	**4**	**9**	**12**	**25**	**21**	**17**	IB/MA	RG	Jul-Ene
	Lycorea halia atergatis	**3**	**2**	**11**	**9**	**5**	**14**	IB	RG	Jul-Oct
	Dircenna klugii	**7**	**11**	**14**	**10**	**22**	**15**	IB	RG	Jul-Oct
	Eutresis dilucida	**13**	9	**8**	**14**	**15**	**16**	IB	RG	Jul-Nov
	Hyalyris excelsa decumana			**17**	**20**	**25**	**8**	IB/BB	RG	Jul-Dic
	Hyposcada virginiana evanides			**10**	**13**	**16**	**22**	IB	RG	Jul-Nov
	Greta morgane oto			**8**	**15**	**18**	**10**	IB/BB	RG	Jul-Oct
	Ithomia heraldica			**12**	**8**	**10**	**9**	IB	RG	Jul-Nov
	Ithomia patilla				**18**	**19**	**11**	IB/BB	RG	Jul-Oct
	Mechanitis menapis saturata				**20**	**15**	**9**	IB/BB	RG	Jul-Nov
	Oleria vicina			**7**	**6**	**12**	**11**	IB	RG	Jul-Oct
	Pteronymia latilla fulvescens			**11**	**9**	**15**	**17**	IB	RG	Jul-Nov
	Actinote anteas			**18**	**16**	**23**	**34**	BB/ MA	RG	Jul-Nov
	Altinote ozomene nox	**4**	**7**	**21**	**19**	**11**	**14**	BB/ MA	RG	Oct-Dic
	Dione moneta poeyii	**8**	**24**	**35**	**14**	**17**	**11**	BB/ MA	RG	Jul-Ener
	Dryadula phaetusa					**11**	**15**	MA	RG	Jul-Nov

	Heliconius charithonia vazquezae				**18**	**20**	**16**	BB	RG	Ago-Dic
	Heliconius clysonimus montanus	**5**	**11**	**16**	**7**	**3**	**2**	IB	RG	Jul-Nov
	Heliconius melpomene				**24**	**13**	**20**	BB	RG	Jul-Nov
	Anthanassa otanes fulviplaga			**22**	**29**	**15**	**18**	IB/BB	RG	Jul-Ene
	Anthanassa ardys			**14**	**31**	**7**	**11**	IB/BB	RG	Jul-Ene
	Chlosyne janais				**13**	**18**	**21**	MA	RG	Jul-Ene
	Tegosa anieta			**12**	**19**	**9**	**15**	MA	RG	Jul-Ene
	Smyrna blomfildia datis			**8**	**11**	**16**	**19**	IB	**RG/VSR**	Jul-Nov
	Anartia fatima	**8**	**16**	**18**	**24**	**22**	**12**	MA	RG	Jul-Ene
	Siproeta epaphus			**8**	**18**	**24**	**13**	MA	**RG/VSR**	Jul-Ene
	Caligo telamonius menus			**11**	**9**	**15**	**6**	IB/BB	RG	Jul-Nov
	Opsiphanes tamarindi					**14**	**11**	IB	**RG/VSR**	Jul-Oct
	Cyllopsis hedemanni			**12**	**13**	**20**	**16**	IB	**RG/VSR**	Jul-Nov
	Cyllopsis philodice	**8**	**3**					IB	**RG/VSR**	Jul-Oct
	Drucina leonata		**8**	**9**	**12**	**6**	**7**	IB	RG	Ene-Dic
	Eretris hulda	**3**	**9**	**2**	**8**			IB	**RG/VSR**	Oct-Ene
	Eretris suzannae			**6**	**11**	**13**	**6**	IB	**RG/VSR**	Jul-Nov
	Forsterinaria neonympha			**4**	**10**			IB	**RG/VSR**	Ago-Oct
	Hermeuptychia hermes				**16**	**12**	**18**	IB	**RG/VSR**	Jul-Nov
	Oxeoschistus tauropolis			**10**	**20**	**17**	**21**	IB	**RG/VSR**	Set-Ene
	Pedaliodes dejecta	**6**	**11**	**22**	**18**	**8**	**14**	IB/BB	**RG/VSR**	Ago-Ene
	Pedaliodes manis			**18**	**8**	**20**	**12**	BB/MA	**RG/VSR**	Jul-Ene
	Pedaliodes triaria	**7**	**8**	**3**	**5**	**0**	**15**	IB	**RG/VSR**	Jul- Oct
	Satyrotaygetis satyrina			**7**	**13**	**22**	**18**	IB	**RG/VSR**	Jul-Ene
	Yphthimoides renata			**57**	**62**	**41**	**60**	IB/BB/MA	**RG/VSR**	Jul-Ene
Papilionidae	*Mimoides euryleon clusoculis*			**9**	**7**			IB	RG	Jul-Ene
	Heraclides anchisiades idaeus					**21**	**22**	MA	RG	Jul-Ene
	Heraclides thoas autocles					**18**	**11**	MA	RG	Jul-Nov
	Papilio polyxenes stabilis	**2**	**8**	**11**	**19**	**14**		MA	RG	Oct- Dic

Pieridae	*Abaeis mexicana bogotana*	**6**	**17**	**9**	**7**	**12**	**13**	MA	RG	Oct- Dic
	Abaeis xanthochlora	**9**	**7**	**11**	**16**	**13**	**21**	MA	RG	Ago-Ene
	Aphrissa statira				**13**	**17**	**23**	MA	RG	Jul-Dic
	Eurema daira eugenia				**12**	**7**	**22**	MA	RG	Set-Ene
	Phoebis philea				**8**	**19**	**14**	MA	RG	Jul-Dic
	Dismorphia amphione praxinoe			**12**	**9**	**8**	**13**	IB	RG	Jul-Nov
	Dismorphia eunoe desine				**12**	**7**		IB	RG	Jul-Oct
	Ascia monuste				**11**	**29**	**24**	MA	RG	Jul-Ene
	Catasticta hegemon	**7**	**12**	**20**	**24**	**19**	**12**	IB	RG	Ago-Oct
	Catasticta nimbice bryson	**4**	**6**	**16**	**23**	**17**	**14**	IB/BB	RG	Jul-Sep
	Catasticta sisamnus smalli			**7**	**12**	**10**		IB	RG	Jul-Oct
	Leptophobia aripa elodia				**15**	**16**		MA	RG	Jul-Oct
	Leptophobia caesia tenuicornis	**11**	**8**	**9**	**10**	**14**		IB	RG	Jul-Oct
	Pereute charops				**16**	**21**	**19**	IB/BB	RG	Jul-Ene
Riodinidae	*Hades noctula*			**19**	**13**	**22**		IB	RG	Oct-Ene
	Eurybia unxia				**12**	**9**	**18**	IB - BB	RG	Set-Ene
	Mesosemia asa		**13**	**10**	**7**	**5**	**9**	IB	RG	Ago-Dic
	Ithomeis eulema imitatrix	**5**	**9**	**8**	**6**			IB	RG	Ago-Dic
	Calephelis iris					**6**	**12**	BB	RG	Jul-Oct
	Emesis mandana					**13**	**10**	BB	RG	Jul-Nov
	Emesis tenedia		**19**	**11**	**13**	**9**	**21**	BB/MA	RG	Ago-Nov

SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 593-601 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1091 https://shilap.org
https://zoobank.org/1753BC4E-F5C6-4241-89A9-3B6DB62D2203

Aportaciones a la corología de *Gegenes nostrodamus* (Fabricius, 1793) y *Borbo borbonica zelleri* (Lederer, 1855) en la península ibérica (Lepidoptera: Papilionoidea, Hesperiidae, Hesperiinae, Baorini)

Jesús Gómez-Fernández & Manuel Ortiz-García

Resumen

Las especies *Gegenes nostrodamus* (Fabricius, 1793*)* y *Borbo borbonica* (Boisduval, 1833) están distribuidas en el sur de Europa. En este documento se aportan nuevos registros de ambas especies en la península ibérica y se presentan los primeros registros de *G. nostrodamus* para la provincia de Guadalajara, España, ampliando el conocimiento de su corología y actualizando el mapa de distribución para ambas especies.

Palabras clave: Lepidoptera, Papilionoidea, Hesperiidae, Hesperiinae, Baorini, *Gegenes nostrodamus*, *Borbo borbonica*, España.

Contributions to the chorology of *Gegenes nostrodamus* (Fabricius, 1793) and *Borbo borbonica zelleri* (Lederer, 1855) in the Iberian Peninsula (Lepidoptera: Papilionoidea, Hesperiidae, Hesperiinae, Baorini)

Abstract

The species *Gegenes nostrodamus* (Fabricius, 1793) and *Borbo borbonica* (Boisduval, 1833) are distributed in southern Europe. This document provides new records of both species in the Iberian Peninsula and presents the first records of *G. nostrodamus* for the province of Guadalajara, Spain, expanding the knowledge of its chorology and updating the distribution map for both species.

Keywords: Lepidoptera, Papilionoidea, Hesperiidae, Hesperiinae, Baorini, *Gegenes nostrodamus*, *Borbo borbonica*, Spain.

Introducción

Gegenes nostrodamus (Fabricius, 1793*)*

Esta especie se distribuye por el área mediterránea, desde Oriente Medio hasta la Península Ibérica, borde mediterráneo de África, Mar Caspio, Arabia, Iraq e India (Tshikolovets, 2011; Leraut, 2016), habita en lugares con vegetación de dunas, arenales costeros y matorral halófilo, y también en campos cultivados de alfalfa (Redondo et al. 2015), desde el nivel del mar hasta los 1.900 m. de altitud (Tshikolovets, 2011; Leraut, 2016).

G. nostrodamus es una especie con los ápices de las alas anteriores puntiagudos, cuya envergadura alar oscila entre los 29 y los 36 mm. (Tshikolovets, 2011; Leraut, 2016). El anverso de estas mariposas es de color castaño, no muy oscuro, en ambos pares de alas y sin dibujos ni máculas. El reverso es también castaño, pero mucho más pálido (sobre todo hacia el margen), con tonos grisáceos y oliváceos (lo que la diferencia de *Gegenes pumilio* (Hoffmansegg, 1804)*,* especie con la que se suele confundir (Leraut, 2016)), además de dos o tres manchitas discales poco marcadas. Las hembras son semejantes a los machos, pero presentan una serie de máculas y puntos discales claros, más pequeños hacia la costa, en el anverso de las alas anteriores. Los imagos tienen un vuelo rápido, rectilíneo y a ras de suelo.

Los huevos tienen forma semiesférica, con la base plana por la que se adhieren a las hojas. Son de color blanquecino con algunas manchas rojizas e irregulares salteadas por su superficie. Las hembras depositan los huevos de uno en uno en su planta nutricia.

Las larvas al nacer son de color hueso, mate, con una abultada y gran cabeza de color negro brillante, y con una mancha negra en la nuca (1^{e} segmento torácico); el extremo anal está deprimido, y de él emergen tres largas cerdas características. Las larvas, en su edad madura, son alargadas y tienen un color verde azulado; el vientre es de un verde más oscuro y destaca una línea blanca por debajo del nivel de los espiráculos. Se alimentan de cardillo (*Scolymus hispanicus*) y otras plantas nutricias que de momento no se han podido comprobar. Están citadas sobre gramíneas como *Imperata cilíndrica* (L.) Beauv., *Dichantium ischaemun* (L.) Roberty, *Oryza sativa* L., *Aeluropus sp*., *Panicum sp*. (Tshikolovets, 2011; Leraut, 2016); Liliaceae como *Allium cepa* L. y Boraginacea como *Heliotropium europaeum* L.

Las crisálidas tienen un aspecto muy alargado, con una prominencia anterior muy afilada en forma de pico cónico; son de color verde con finas líneas dorso-abdominales de color blanco. Las crisálidas se mantienen sujetas a los tallos y hojas de gramíneas cabeza arriba, tanto por el cremáster como por un cinturón de seda situado entre el tórax y el abdomen. Se la considera una especie multivoltina (Tshikolovets, 2011), dependiendo de la altitud y la localidad.

Las hembras de *G. nostrodamus* y *G. pumilio*, que son las que más se prestan a confusión en su identificación, genitalmente son diferenciables claramente, según Coutsis (2012).

Borbo borbonica (Boisduval, 1833)

Sistemáticamente, el género *Borbo* Evans, 1949 se incluye dentro de la subfamilia Hesperiinae Latreille, 1809 y comprende 22 especies descritas, de las que 18 habitan en buena parte del continente africano. La especie *Borbo borbonica* (Boisduval, 1833) es la especie tipo de este género y originalmente fue descrita como *Hesperia borbonica* con ejemplares colectados de las Islas Mauricio y de La Reunión. La subespecie *B. borbonica zelleri* (Lederer, 1855) fue descrita originalmente como *Hesperia* Fabricius, 1793, a partir de ejemplares colectados de Siria. Todo el material ibérico se refiere a esta subespecie, aplicable a las poblaciones mediterráneas al norte del Sáhara (es decir, las ibéricas, marroquíes y argelinas al igual que las del mediterráneo oriental) (Tshikolovets, 2011; García-Barros et al. 2013), aunque según Leraut (2016) es una mera sinonimia. Esta subespecie está muy localizada en dunas y rieras próximas al litoral (Redondo et al. 2015), desde el nivel del mar hasta los 100 m. de altitud (Tshikolovets, 2011; Leraut, 2016).

Su envergadura alar oscila entre los 28 y los 30 mm. (Tshikolovets, 2011; Leraut, 2016; Blázquez et al. 2019).

El huevo es hemisférico, muy parecido al de *G. nostrodamus,* pero algo más achatado en el área micropilar, donde presenta una ligera depresión, siendo su diámetro de 0,8 mm y 0,5 mm, de altura (Muñoz, 2013).

Las larvas, que pasan el invierno en este estadio, viven sobre plantas gramíneas herbáceas como *Leersia hexandra* Swartz y *Sorghum halepense* (L.) Pers. (Tshikolovets, 2011; Leraut, 2016), incluyendo *Oryza sativa* (Gómez & Fernández, 1974). *Polypogon viridis* (Gouan) Breistr. es la única especie de gramínea sobre la que se han encontrados huevos de *B. borbonica zelleri* en Algeciras (Muñoz, 2013). No entran en diapausa invernal y aunque reducen su actividad, siguen alimentándose durante el invierno (Fernández et al. 2020).

La morfología de la pupa de esta especie es similar a la de muchos Hesperiidae de la Tribu Hesperiini, esto es, de forma alargada y ahusada. De aspecto céreo y color verde claro (Muñoz, 2013).

La morfología de la genitalia del andropigio de *B. borbonica zelleri* presenta valvas estrechas y alargadas, cucullus digitiforme, con su margen dorsal profundamente dentado y rematado en su parte inferior por una pieza esclerotizada en forma de medialuna, uncus corto, claramente bifurcado y, adosadas a él, las dos brachias alargadas y estrechas que constituyen el gnathos. Su saccus es largo y estrecho y el aedeagus carece de cornuti (Blázquez et al. 2019). El ginopigio presenta papilas genitales cuadrangulares, más anchas que altas, placa genital bastante grande, esclerotizada y que ocupa gran parte del área postvaginal. Su forma casi triangular es característica de esta especie, el último esternito tiene forma de flecha, el ductus bursae es ancho y relativamente corto y la bursa copulatrix es redondeada (Blázquez et al. 2019).

Tiene dos generaciones en la Península Ibérica, una en junio-julio y otra en septiembre-octubre (Gómez-Bustillo & Fernández-Rubio, 1974; Tshikolovets, 2011), siendo especialmente abundante en los meses otoñales, cuando algunos individuos se dispersan desde sus áreas de reproducción (Fernández et al. 2020), siendo su patrón migratorio el más grande en Europa dentro de la familia Hesperiidae (Obregón et al. 2016). Se haya incluida en el "*Libro Rojo de Los Invertebrados de Andalucía*" (Barea-Azcón et al. 2008) y en el "*Libro Rojo de los Invertebrados de España*" (Verdú et al. 2006) bajo la categoría de amenaza en peligro.

Material y métodos

Este trabajo se basa en una recopilación de datos inéditos de *G. nostrodamus* y *B. borbonica zelleri*, obtenidos de ejemplares del Museo de Ciencias Naturales de Madrid (MNCN), del Departamento de Biología de la Universidad Autónoma de Madrid (UAM), del Centro Entomológico Manuel Ortego de Madrid, del Departamento de Zoología y Antropología Física de la Universidad de Murcia y de diferentes colecciones científicas particulares. Para la determinación y clasificación, se ha seguido en la nomenclatura a Vives Moreno (2014). En la correcta identificación de los ejemplares examinados nos hemos basado en el examen comparativo de los caracteres morfológicos externos, reconocibles fácilmente de visu, no habiendo sido necesaria la realización de genitalia. Las fotografías de los ejemplares montados se han realizado con una cámara Canon EOS 1300D con objetivo Canon EFS 18-135 mm, lente de 4 aumentos, tiempo de exposición 1/250s, velocidad ISO-100 y una resolución de 5184 X 3456 píxeles.

Abreviaturas utilizadas (en orden alfabético)

CCAC:	Colección científica particular de Antonio Correas Marín, Teruel, España
CCTL:	Colección científica particular de Tomás Latasa Asso, La Rioja, España
CEDB:	Colección de Entomología, Departamento de Biología, Universidad Autónoma de Madrid, Madrid, España
CEMO:	Centro Entomológico Manuel Ortego, Madrid, España
CFAA:	Colección científica particular de Aquilino Albadalejo García, Murcia, España
CFGA:	Colección Científica particular de José Antonio García Alamá, Valencia, España
CFJG:	Colección científica particular de Jesús Gómez Fernández, Guadalajara, España
CFJJ:	Colección científica particular de José Juan Luna Rodríguez, Madrid, España
CFJM:	Colección científica particular de Juan Manuel Mateo Fernández, Madrid, España
CFME:	Colección científica particular de Miguel Engra Parra, Castellón, España
CFMO:	Colección científica particular de Manuel Ortiz García, Guadalajara, España
CFSM:	Colección científica particular de Sergio Montagud Alario, Valencia, España
CFTM:	Colección científica particular de José Luis Torres Méndez, Cádiz, España
DZUM:	Departamento de Zoología y Antropología Física, Universidad de Murcia, Murcia, España
JGF:	Jesús Gómez Fernández, Guadalajara, España
MNCN:	Museo Nacional de Ciencias Naturales, Madrid, España
MOG:	Manuel Ortiz García, Guadalajara, España
SEACAM:	Sociedad Entomológica Ambiental de Castilla-La Mancha, Toledo, España
SHILAP:	Sociedad Hispano-Luso-Americana de Lepidopterología, Madrid, España
UAM:	Universidad Autónoma de Madrid, Madrid, España

Resultados y discusión

Se aportan los siguientes registros de *G. nostrodamus* basándonos en los ejemplares depositados en nuestras colecciones científicas (ordenados por fecha de captura) que son los primeros para la provincia de Guadalajara y que amplían su corología en la Península Ibérica con dos nuevas cuadrículas UTM 10 x 10 km., 30TVK89 y 30TVK79: Guadalajara, Guadalajara, Cabanillas del Campo, a 655 m. altitud, UTM 30TVK89, 1 ♂, 21-VIII-2000, 3 ♂, 22-VIII-2000, 1 ♀, 23-VIII-2000, 2 ♂, 24-VIII-2000, 1 ♀, 2-IX-2000 y 2 ♂, 17-VIII-2017, M. Ortiz García leg. y det., CFMO. Azuqueca de Henares, Camino de la Barca, a 614 m. altitud, 40º 33’56,73” N 3º 14’25,46” W, UTM 30TVK79, 1 ♀, 5-VII-2018, J. Gómez-Fernández leg. y det., CFJG. Alovera, Urbanización Parque Vallejo, a 640 m. altitud, 40º 34’53,31” N 3º 15’15,86” W, UTM 30TVK79, 3 ♂, 17-VII-2022, J. Gómez-Fernández leg. y det., CFJG.

Figuras 1-2. *Gegenes nostrodamus* (F.), nueva para Guadalajara. **1.** Macho. **2.** Hembra.

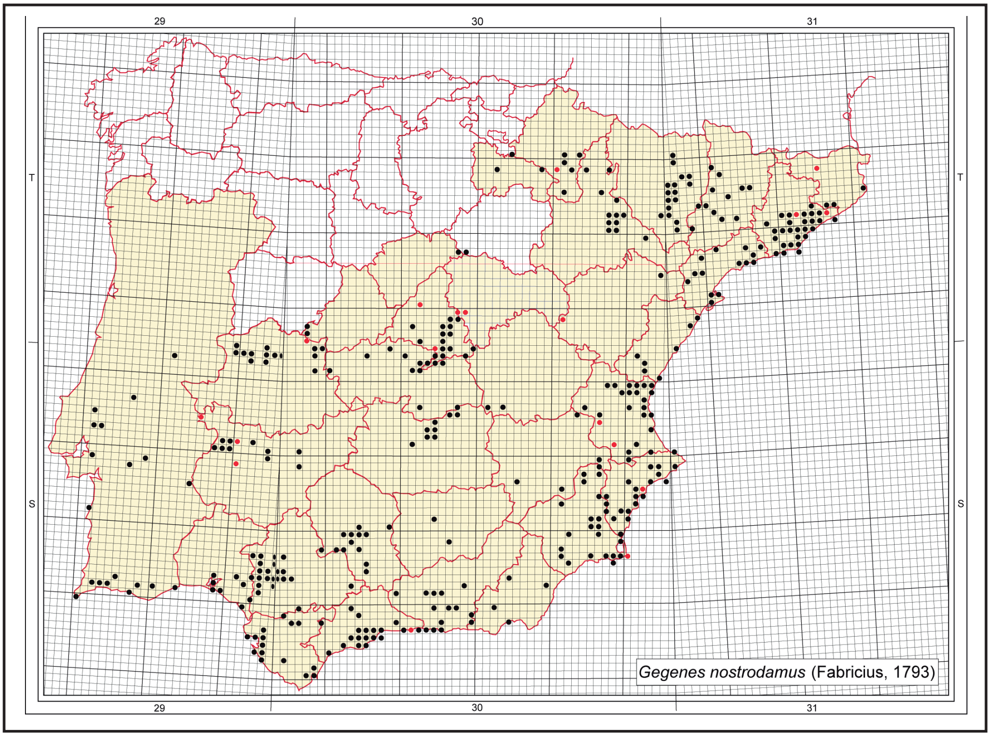
Muy probablemente esta especie esté presente a lo largo de las riberas del Río Henares en la provincia de Guadalajara (España), así como en sus afluentes, ya que observamos que va penetrando al interior a través de valles fluviales con hábitats favorables para la especie.

El día 8 de octubre de 2019 se determinan y catalogan (asignándoles número de catálogo y pasando a formar parte de la Colección Ibérica) por parte de MOG los siguientes ejemplares de *G. nostrodamus* que estaban en el fondo de colecciones entomológicas del MNCN y de otras colecciones, que por primera vez son publicados, aportando los siguientes registros: Alicante, 1 ♂, 4-IX-1950, UTM 30SYH25, nº genitalia 54038, MNCN_Ent 255889, V. Duart leg. R. Agenjo det. **Nueva cuadrícula para Alicante**; Alicante, UTM 30SYH14, 2 ♂, 24-VI-2008, E. García-Barros, M. López Munguira det., CEDB. Badajoz, Montijo, Los Arenales, UTM 29SQD01, 1 ♀, 18-V-2003, Fulgencio Curiel Pérez leg., Fulgencio Curiel Pérez Ex_Coll., Gómez Fernández, J. det., CFJG. **Nueva cuadrícula para Badajoz**; Corte de Peleas, UTM 29SQC08, 1 ♀, 20-IX-2004, J. A. Moreno T. leg., Fulgencio Curiel Pérez Ex_Coll., JGF. det., n**ueva cuadrícula para Badajoz**; La Codosera, UTM 29SPD54, 1 ♂ 23-IX-2004, J. A. Moreno T. leg., Fulgencio Curiel Pérez Ex_Coll., JGF det., **nueva cuadrícula para Badajoz.** Barcelona, Alella, a 12 m. altitud, 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 197, MNCN_Ent 255854, R. Agenjo leg. y det.; 1 ♂, VIII-1956, UTM 31TDF49, nº genitalia 181, MNCN_Ent 255855, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 170, MNCN_Ent 255856, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 191, MNCN_Ent 255857, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 198, MNCN_Ent 255858, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 179, MNCN_Ent 255859, R. Agenjo leg. y det.; 1 ♂, VIII-1956, UTM 31TDF49, nº genitalia 182, MNCN_Ent 255860, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 178, MNCN_Ent 255861, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 172, MNCN_Ent 255862, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 173, MNCN_Ent 255863, R. Agenjo leg. y det.; 1 ♂, VIII-1956, UTM 31TDF49, nº genitalia 176, MNCN_Ent 255864, R. Agenjo leg. & det.; 1 ♂, VIII-1956, UTM 31TDF49, nº genitalia 183, MNCN_Ent 255866, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 187, MNCN_Ent 255867, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 192, MNCN_Ent 255868, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 177, MNCN_Ent 255868, R. Agenjo leg. y det.; 1 ♂, VIII-1956, UTM 31TDF49, nº genitalia 171, MNCN_Ent 255870, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 169, MNCN_Ent 255870, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 184, MNCN_Ent 255872, R. Agenjo leg. y det.; 1 ♂, VIII-1959, UTM 31TDF49, MNCN_Ent 255873, R. Agenjo leg. MOG det.; 1 ♂, UTM 31TDF49, nº genitalia

186, MNCN_Ent 255874, R. Agenjo leg. y det.; 1 ♂, VIII-1959, UTM 31TDF49, MNCN_Ent Nº Cat. 74714, R. Agenjo leg. MOG det. 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 175, MNCN_Ent 255875, R. Agenjo leg. y det.; 1 ♂, VIII-1956, UTM 31TDF49, nº genitalia 188, MNCN_Ent 255876, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 180, MNCN_Ent 255877, R. Agenjo leg. y det.; 1 ♂, 20-VIII-1956, UTM 31TDF49, nº genitalia 199, MNCN_Ent 255878, R. Agenjo leg. y det.; 1 ♂, VIII-1956, UTM 31TDF49, nº genitalia 196, MNCN_Ent 255879, R. Agenjo leg. y det.; 1 ♂, IX-1956, UTM 31TDF49, nº genitalia 174, MNCN_Ent 255880, R. Agenjo leg. y det.; 1 ♂, VII-1948, UTM 31TDF49, nº genitalia 54925, MNCN_Ent 255881, R. Agenjo leg. y det.; 1 ♂, UTM 31TDF49, nº genitalia 55104, MNCN_Ent 255882, R. Agenjo det.; Sant Celoni, a 155 m. altitud, 1 ♂, UTM 31TDG61, genitalia en una etiqueta, MNCN_Ent 255883, R. Agenjo leg. y det. **Nueva cuadrícula para Barcelona**; El Garraf, 1 ♂, 10-IV-1961, UTM 31TDF07, MNCN_Ent 255884, J. Ganzo leg. R. Agenjo det.; Salamó, 1 ♂, UTM 31TDG21, nº genitalia 54919, MNCN_Ent 255885, J. Vives leg., R. Agenjo det. **Nueva cuadrícula para Barcelona**; Parets, a 130 m. altitud, 1 ♂, VII-1948, UTM 31TDG30, nº genitalia 54926, MNCN_Ent 255886, R. Agenjo leg. y det. Cáceres, Tornavacas, 1 ♀, VIII-1952, UTM 30TTK75, genitalia pinchada, MNCN_Ent 255905, C. Callejo leg. MOG det. **Nueva cuadrícula para Cáceres**; Cádiz, Algeciras, UTM 30STF70. 6-IX-1982 (1 ♂), 3-IX-1986 (1 ♀), y 9-IX-1990 (1 ♀), J. L. Torres leg. y det. CFMO.; Chiclana, 1 ♂, UTM 29SQA53, MNCN_Ent 255891, A. Benítez leg., MOG det.; 1 ♂, UTM 29SQA53, MNCN_Ent 255892, A. Benítez leg., MOG det.; Jerez de la Frontera, 1 ♂, UTM 29SQA56, nº genitalia 54922, MNCN_Ent 255893, G. del Salto leg., R. Agenjo det.; La Línea de la Concepción, 1 ♂, 12-IX-1980, UTM 30STF80, MNCN_Ent 264394, J. L. Torres leg. Alberto del Saz Coll. JGF det.; UTM 30STF80, 1 ♂, 20-IX-1979. J. L. Torres leg. y det. CFMO; UTM 30STF80, 2 ♂, 1 ♀, 3-X-1974, J. L. Torres leg. y det. CFTM.; 1 ♂, 30-V-1976, UTM 30STF80, MNCN_Ent 264395, J. L. Torres leg., Alberto del Saz Coll. JGF det.; La Línea de la Concepción, 1 ♂, 22-VIII-1979, UTM 30STF80, MNCN_Ent 264397, J. L. Torres leg. Alberto del Saz Coll., JGF det.; 1 ♂, 12-X-1979, UTM 30STF80, MNCN_Ent 264398, J. L. Torres leg., Alberto del Saz Coll. JGF det.; 1 ♂, 1-VII-1976, UTM 30STF80, MNCN_Ent 264399, J. L. Torres leg., Alberto del Saz Coll. JGF det.; 1 ♂, 15-VI-1976, UTM 30STF80, MNCN_Ent 264400, J. L. Torres leg., Alberto del Saz Coll. JGF det.; 1 ♂, 2-VIII-1976, UTM 30STF80, MNCN_Ent 264401, J. L. Torres leg., Alberto del Saz Coll., JGF det.; 1 ♂, 26-IX-1978, UTM 30STF80, MNCN_Ent 264402, J. L. Torres leg., Alberto del Saz Coll., JGF det.; 1 ♀, 28-IX-1976, UTM 30STF80, MNCN_Ent 264403, J. L. Torres leg., Alberto del Saz Coll., JGF det.; 1 ♀, 12-IX-1980, UTM 30STF80, MNCN_Ent 264404, J. L. Torres leg., Alberto del Saz Coll., JGF det., 1 ♀, 28-IX-1976, UTM 30STF80, MNCN_Ent 264405, J. L. Torres leg. Alberto del Saz Coll. JGF det.; 1 ♀, 12-IX-1980, UTM 30STF80, MNCN_Ent 264406, J. L. Torres leg., Alberto del Saz Coll., JGF det.; 1 ♀, 4-X-1977, UTM 30STF80, MNCN_Ent 264407, J. L. Torres leg., Alberto del Saz Coll., JGF det.; 1 ♀, 28-IX-1976, UTM 30STF80, MNCN_Ent 264408, J. L. Torres leg., Alberto del Saz Coll., JGF det.; 1 ♀, 12-IX-1978, UTM 30STF80, MNCN_Ent 264409, J. L. Torres leg., Alberto del Saz Coll., JGF det.; 2 ♂, 3-IX-1979 y 20-IX-1979, UTM 30STF80, José Luis Torres Méndez leg. y det. CFMO.; Parque El Cerro, a 0 m. altitud, 1 ♂, 23-IX-1981, UTM 29SQA53, MNCN_Ent 264396, A. Verdugo leg., Alberto del Saz Coll. JGF det. Los Barrios, Parque Natural de Los Alcornocales, Monte de la Torre, Arroyo del Prior, UTM 30STF70, 1 ♂, 29-VI-1982, J. L. Torres leg. y det. CFTM.; UTM 30STF70, 1 ♂, 1 ♀, 29-VIII-1990, J. L. Torres leg. y det. CFTM.; UTM 30STF70, 1 ♂, 1 ♀, 30-VIII-1990, J. L. Torres leg. y det. CFTM.; UTM 30STF70, 4 ♂, 2 ♀, 9-IX-1990, Torres, J. L. leg. & det. CFTM; Sierra Carbonera, UTM 30STF80, 1 ♂, 21-VI-1972, J. L. Torres leg. y det. CFTM; Sierra Carbonera, UTM 30STF80, 1 ♂, 2 ♀, 31-V, 4-VI y 10-VI-1974, Torres, J. L. leg. & det. CFTM; 1 ♂, 1 ♀, 18-VIII y 8-IX-1974, J. L. Torres leg. & det. CFTM; 2 ♂, 16-VII-1975, J. L. Torres leg. y det. CFTM; 2 ♂, 15-VI- y 1-VII-1976, J. L. Torres leg. y det. CFTM; 4 ♂, 1 ♀, 10-IX, 20-IX y 3-X-1979, J. L. Torres leg. y det. CFTM; 2 ♂, 18-V-1980 y 29-V-1982, J. L. Torres leg. y det. CFTM. Castellón, Cabanes, Barranco Miravet, a 150 m. altitud, UTM 31TBE54, 1 ♂, 20-VI-1991, Engra, A. leg., F. Fernández Rubio det., CFME.; 3-VII-1991, Engra, A. leg., F. Fernández Rubio det., CFME.; 1 ♂, 24-VI-1991, Engra, A. leg., Fernández Rubio, F. det., CFME.; 1 ♀, 20-VI-1991, Engra, A. leg., Fernández Rubio, F. det., CFME. Ciudad Real, El Molino Viejo, UTM 30SVJ75, 2 ♀, 14-VIII-1981 y 23-VII-1982, B. Sánchez Cerro leg., M. López Munguira det., CEDB; Tablas de Daimiel, UTM 30SVJ43, 1 ej., 15-IX-2002. Cuaderno de campo de Miguel López Munguira, UAM. Gerona, Les Fons, 1 ♂, 9-VI-1947, UTM 31TDG57, MNCN_Ent 255904, D. Hospital leg. MOG det. **Nueva cuadrícula para Gerona**. Cuenca, Manjavacas, UTM 30SWJ16, 1 ♂, 2-VIII-2001, S. Jiménez y J. I. Arce leg., M. López Munguira, CEDB. Granada, Dúrcal, 1 ♂, 20-VII-1945, UTM 30SVF49, nº genitalia 54920, MNCN_Ent 255890, M. Bohigas leg., R. Agenjo det.

Huelva, Mazagón, 1 ♂, 15-IX-1968, UTM 29SPB81, MNCN_Ent 255894, J. P. F. leg., P. García Pereira det.; Mazagón, 1 ♂, 15-IX-1968, UTM 29SPB81, MNCN_Ent 255895, J. P. F. leg., P. García Pereira det.; 1 ♂, 16-IX-1968, UTM 29SPB81, MNCN_Ent 255896, J. P. F. leg., P. García Pereira det.; 1 ♂, 16-IX-1968, UTM 29SPB81, MNCN_Ent 255897, J. P. F. leg., P. García Pereira det.; 1 ♂, IX-1968, UTM 29SPB81, MNCN_Ent 255898, J. P. F. leg., P. García Pereira det. La Rioja, Santa Coloma, Carretera de Santa Coloma a Castroviejo, a 850 m. altitud, UTM 30TWM28, 1 ♀, 30-VII-1990, T. Latasa Asso leg. y det. CCTL. Madrid, Alcalá de Henares, 1 ♂, a 590 m. altitud, UTM 30TVK78, MNCN_Ent 255901, R. Agenjo leg., MOG det.; Alcalá de Henares, a 590 m. altitud, 1 ♀, 13-VIII-1946, UTM 30TVK78, MNCN_Ent 255907, genitalia pinchada, R. Agenjo leg. MOG det.; Aranjuez, a 515 m. altitud, 1 ♂, UTM 30TVK43, MNCN_Ent 255900, nº genitalia 54927, R. Agenjo det.; 1 ♀, 27-IX-2006, E. García-Barros leg., M. López Munguira det., CEDB.; El Regajal, UTM 30TVK43, 2 ♂, 3-VIII-1994, J. L. Viejo leg., M. López Munguira det., CEDB.; Mataelpino, La Ponderosa, 1200 m. altitud, UTM 30TVL20, 1 ej., sin fecha de captura, M. Ortego Gamboa leg. y det., CEMO. **Nueva cuadrícula para Madrid**; Rivas-Vaciamadrid, a 600 m altitud, UTM 30TVK56, 4 ♂, 1 ♀, 24-VII-1990, Manuel Ortiz leg. y det. CFMO; 2 ♂, 26-VII-1991, J. M. Mateo leg. y det., CFJM; 1 ♂, 10-VIII-1991, Mateo, J. M. leg. & det., CFJM.; 3 ♂, 1-IX-1991,14-IX-1991 y 13-IX-1992, J. M. Mateo leg. y det., CFJM.; 1 ♂, 1 ♀, 19-IX-1992, J. M. Mateo leg. y det., CFJM.; 1 ♂, 4-X-1992, J. J. Luna y det., CFJJ.; 1 ♂, 29-VII-1990, J. J. Luna leg. y det., CFJJ.; 2 ♂, 29-VII-1990, J. J. Luna leg. y det., CFJJ.; Fuentidueña de Tajo, a 550 m. altitud, UTM 30TVK8739, 1 ♀, 26-VI-2013, J. J. Luna leg. y det., CFJJ.; 1 ♂, 4-VII-2013, J. J. Luna leg. y det., CFJJ.; 1 ♀, J. J. Luna leg. y det., CFJJ.; 1 ♂, 2-IX-2013, J. J. Luna leg. y det., CFJJ.; 1 ♂, 9-X-2013, J. J. Luna leg. y det., CFJJ; Ciempozuelos, Cerros de Palomero, a 600 m. altitud, UTM 30TVK44, 1 ♂, 1 ♀, 25-VIII-2002, G. E. King leg., M. López Munguira det., CEDB. **Nueva cuadrícula para Madrid**. Málaga, Torrox, a 10 m. altitud, UTM 30SVF16, 1 ♂, 28-IX-1990, Luna, J. J. leg. & det., CFJJ. **Nueva cuadrícula para Málaga**; Estepona, Río Padrón, UTM 30SUF03, 1 ♂, 30-IX-1980. Torres, J. L. leg. & det. CFTM. Murcia, Torrealta, a 75 m. altitud, UTM 30SXH51, 1 ♀, 7-IX-1996, J. M. Mateo leg. y det., CFJM.; 3 ♂, 2 ♀, 29-IX-2001, J. M. Mateo leg. y det., CFJM.; 2 ♂, 2 ♀, 11-IX-2004, J. M. Mateo leg. y det., CFJM. Ribera de Molina, 75 m. altitud, UTM 30SXH50, 3 ♂, 2 ♀, 10-IX-1995, J. M. Mateo leg. y det., CFJM.; La Manga del Mar Menor, a 10 m. altitud, UTM 30SYG06, 3 ♂, 10-IX-1994, J. M. Mateo leg. y det., CFJM; 2 ♂, 20-VII-1995, Mateo, J. M. leg. y det., CFJM; 1 ♂ y 3 ♀, 18-VIII-1996, J. M. Mateo leg. y det., CFJM. **Nueva cuadrícula para Murcia**; Molina de Segura, Ribera de Molina, a 75 m. altitud, UTM 30SXH50, 1 ♂, 1 ♀, 10-IX-2002, A. Albadalejo leg. y det., CFAA; Las Torres de Cotillas, Huerta, 80 m. altitud, UTM 30SXH51, 1 ♂, 12-IX-2001, J. J. Guerrero Fernández leg. y det. DZUM; Las Torres de Cotillas, Rambla Salada, 80 m. altitud, UTM 30SXH51, 1 ♀, 5-X-2001, J. J. Guerrero Fernández, leg. y det. DZUM. Navarra, Marcilla, Sotocontienda-orilla río Aragón, a 285 m. altitud, UTM 30TXM08, 1 ♀, 8-IX-2013, T. Latasa Asso leg y det. CCTL. **Nueva cuadrícula para Navarra**; 2 ♂, 31-VIII-2013 y 14-IX-2013, T. Latasa Asso leg y det. de visu.; El Presón-canal de riego, a 289 m. altitud, UTM 30TXM08, 1 ♂, 8-IX-2013, T. Latasa Asso leg y det. de visu; El Presón-camino, a 288 m. altitud, UTM 30TXM08, 1 ♀, 31-VIII-2013, T. Latasa Asso leg y det. CCTL; Laguna de Pitillas, UTM 30TXM19, 1 ej., 4-VIII-2006, Cuaderno de campo de Miguel López Munguira, UAM. Tarragona, Vilaseca, 1 ♂, 9-IX-1977, UTM 31TCF45, nº genitalia 60436, MNCN_Ent 255887, J. Gastón leg., A. Vives det. Teruel, Orihuela del Tremedal, Cruce Río Gallo con A-2707, a 1.455 m. altitud, UTM 30TXK18, 1 ♂, 30-VII-2010, Correas, A. leg & det. CCAC. **Nueva cuadrícula para Teruel**. Toledo, Calzada de Oropesa, 1 ♂, 4-VI-1972, UTM 30SUK01, nº genitalia 60462, MNCN_Ent 255899, A. Vives leg. y det.; Estación de Algodor, 1 ♀, 9-X-1996, UTM 30SVK21, genitalia pinchada, MNCN_Ent 255906, M. García París leg., MOG det. Valencia, Enguera, UTM 30SXJ81, 1 ♂, 1-VI-1991, J. M. Mateo leg. y det., CFJM. **Nueva cuadrícula para Valencia**; Valencia, 1 ♂, UTM 30SYJ27, nº genitalia 54921, MNCN_Ent 255888, Cruz Nathan leg., R. Agenjo det.; Requena, UTM 30SXJ65, 1 ♂, 7-VII-2007, J. Estela Andreu leg. y det. CFGA; Venta del Moro, UTM 30SXJ35, 1 ♂, 3-VIII-2007, J. Estela Andreu leg. y det. CFGA; Jalance, UTM 30SXJ64, 1 ♂, 19-VIII-2014, J. Estela Andreu leg. y det. CFGA. **Nueva cuadrícula para Valencia**; Valencia, UTM 30SYJ35, 1 ♂, 15-VI-1991, J. A. García Alamá leg. & det. CFGA; Lliria, UTM 30SYJ08, 5 ♂, 14-VI-1992 (1 ej.) y 3 al 17-IX-1992 (4 ejs.), J. A. García Alamá leg. y det. CFGA; 1 ♂, 25-V-1994, J. A. García Alamá leg. y det. CFGA; 9 ♂, 1 ♀, 1-16-VIII-2004, J. A. García Alamá leg. y det. CFGA; ♂, 28-VII a 2-VIII-2005, J. A. García Alamá leg. y det. CFGA; Domeño, UTM 30SXJ79, 1 ♀, 14-VII-1992, J. A. García Alamá leg. y det. CFGA; Chulilla, UTM 30SXJ89, 1 ♂, 30-IV-2001, S. Montagud leg. y det. CFSM; Valencia, UTM 30SYJ35, 2 ♂, 12-VIII-1995 y 9-X-1997, S. Montagud leg. y det. CFSM.

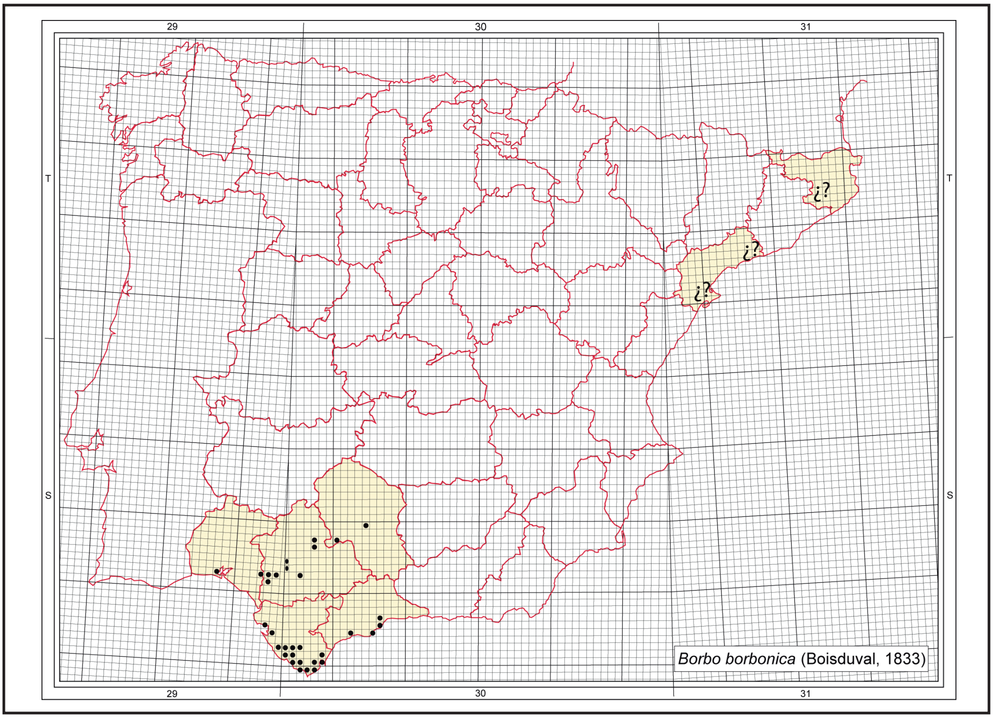
Italia, Exilles, 1 ♀, VI-1933, MNCN_Ent 255908, R. Mendizábal leg. MOG det. Marruecos, Tánger, 1 ♂, UTM 30STE46, MNCN_Ent 255903, nº genitalia 54918, M. escalera leg., O. Querci det. Estos ejemplares no los incluimos al ser de España.



El día 14 de enero de 2020 se determinan y catalogan (asignándoles número de catálogo y pasando a formar parte de la Colección Ibérica) por parte de JGF los siguientes ejemplares de *B. borbonica zelleri* que estaban en el fondo de colecciones entomológicas del MNCN y que por primera vez son publicados, aportando los siguientes registros: Cádiz, Algeciras, 1 ♂, 10-IX-1981, UTM 30STF70, MNCN_Ent 264410, Alberto del Saz Coll., JGF det.; 1 ♂, 13-IX-1981, UTM 30STF70, MNCN_Ent 264411, Alberto del Saz Coll., JGF det.; 1 ♀, 3-IX-1984, UTM 30STF70, MNCN_Ent 264420, J. L. Torres leg., Alberto del Saz Coll., JGF det.; 1 ♀, 10-IX-1981, UTM 30STF70, MNCN_Ent 264412, Alberto del Saz Coll. JGF det.; 1 ♀, 4-IX-1981, UTM 30STF70, MNCN_Ent 264413, Alberto del Saz Coll., JGF det.; 1 ♀, 8-IX-1981, UTM 30STF70, MNCN_Ent 264414, Alberto del Saz Coll., JGF det.; 1 ♀, 8-IX-1981, UTM 30STF70, MNCN_Ent 264415, Alberto del Saz Coll., JGF det.; 1 ♀, 8-IX-1981, UTM 30STF70, MNCN_Ent 264416, Alberto del Saz Coll., JGF det.; 1 ♀, 8-IX-1981, UTM 30STF70, MNCN_Ent 264417, Alberto del Saz Coll., JGF det.; 1 ♀, 4-IX-1981, UTM 30STF70, MNCN_Ent 264418, Alberto del Saz Coll., JGF det.; 1 ♀, 3-IX-1984, UTM 30STF70, MNCN_Ent 264421, Alberto del Saz Coll., JGF det.; 1 ♀, 20-IX-1980, UTM 30STF70, MNCN_Ent 264419, Alberto del Saz Coll., JGF det.

Finalmente se añaden las cuadrículas de *G. nostrodamus* 30SVG47, 30SVG67, 30SVG68 y 30SVG59 (Obregón et al. 2020) y las cuadrículas 30SUG59, 30SUG47 y 30STG97 (Fernández et al. 2020) al mapa de distribución.

Ni *G. nostrodamus* ni *B. borbonica zelleri* han sido nunca abundantes, siendo taxones escasos y en ocasiones raros, máxime en los tiempos actuales con la degradación sufrida por sus hábitats. Sería conveniente tomar alguna medida de protección más eficaz para poder evitar su desaparición, como es el caso de lo ocurrido en Francia con *G. nostrodamus*.



Agradecimiento

Nuestro más sincero agradecimiento para la Dra. Amparo Blay y para Mercedes París, conservadoras del Museo Nacional de Ciencias Naturales de Madrid, por su amabilidad, colaboración y ayuda para la consulta de las colecciones de Lepidoptera de dicha institución, a Rocío Bautista Carrascosa, conservadora del Centro Entomológico Manuel Ortego de Madrid, por su colaboración y ayuda, al Dr. Miguel López Munguira del Departamento de Biología de la UAM por su colaboración con ejemplares de la Colección Entomológica de la UAM y registros de su cuaderno de campo, al Dr. Antonio Salvador Ortiz Cervantes del Departamento de Zoología y Antropología Física de la Universidad de Murcia por su aportación y colaboración, al Dr. Antonio Vives Moreno por su colaboración y ayuda, a Ángel Blázquez Caselles por su inestimable colaboración y ayuda con los mapas, a Miguel Engra, Juan Manuel Mateo, José Juan Luna Rodríguez, Aquilino Albadalejo, José Antonio García Alamá, José Luis Torres Méndez, Antonio Correas y Tomás Latasa Asso por todas sus aportaciones y colaboración. A María Antonia del Prado Gómez y María Rosario García Romo, por todo su gran apoyo y ayuda, sin ellas no hubiera sido posible la realización de este trabajo. Y finalmente, a la Consejería de Agricultura, Medio Ambiente y Desarrollo Rural, Viceconsejería de Medio Ambiente, Dirección General de Política Forestal y Espacios Naturales, Junta de Comunidades de Castilla-La Mancha, por los permisos concedidos para poder realizar nuestro trabajo de campo y poder realizar las capturas de los ejemplares aquí aportados, dentro del Proyecto Científico de SHILAP (para Jesús Gómez Fernández) y de SEACAM (para Manuel Ortiz García).

Conflicto de interés

Los autores declaran que no existe ningún interés financiero ni relaciones personales que pudieran haber influido en el trabajo que se presenta en este artículo.

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(Recibido para publicación / *Received for publication* 24-I-2024)
(Revisado y aceptado / *Revised and accepted* 1-IX-2024)
(Publicado / *Published* 30-IX-2025)

SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 602 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1096

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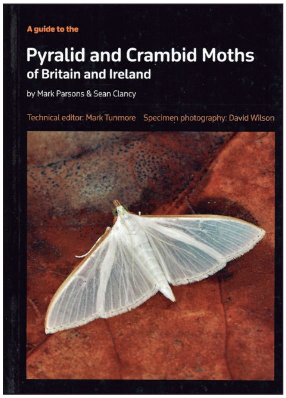

M. Parsons & S. Clancy
Pyralidae and Crambid Moths of Britain and Ireland
508 páginas
Formato 24,5 x 17,5 cm
Atropos Publishing, Cornwall, 2023
ISBN: 978-0-9551086-4-8

Tenemos en nuestras manos, una nueva actualización de la fauna Pyraloidea del Reino Unido e Irlanda, que podríamos considerarlo como una revisión actualizada, después de más de 37 años de trabajo, del libro de Goater (1986) "*British Pyralid Moth: A Guide to their identification*" cubriendo un total de 208 especies, que serían 248 especies, si incluimos las encontradas accidentalmente como introducidas, en el estudio de los Pyralidae y Crambidae.

El libro comienza con los agradecimientos y la introducción a la obra, en la que nos hablan de la taxonomía de estas familias, sobre los nombres comunes, el estatus de las especies consideradas; también continúa con unas ilustraciones de la morfología alar y de la genitalia, seguida de unos datos sobre su conservación, sobre los casos de introducción accidental de especies, indicando la especie y la fecha de introducción por primera vez desde 1885 al 2022. Sigue con una bibliografía selectiva y una lista detallada de las especies consideradas.

Ya dentro de la parte más importante de la obra, cada especie es tratada con su nombre científico y el nombre común conocido, seguida de fotografías del adulto en su estado natural y de su oruga, así como una descripción de la especie, las especies similares con las que se podría confundir, su ciclo biológico, hábitat, estatus y su distribución, acompañado de un mapa indicando las zonas donde se conoce la especie actualmente.

A continuación, nos encontramos con el Apéndice 1, donde nos presentan 32 especies introducidas accidentalmente pero que, todavía, no están aclimatadas. En el 2 nos presentan 5 especies de estatus dudoso sobre su presencia en el área de estudio. En el 3, nos presentan 26 especies interceptadas por la actividad comercial. De todas ellas, nos presentan fotografías de los adultos, con su nombre científico y común, su descripción, especies similares, estatus y distribución.

A continuación, nos presentan todas las especies consideradas en el libro a tamaño original y fotografiadas a todo color, a lo largo de 10 planchas y en 18 planchas la genitalia del macho y de la hembra, de las especies que presentan dificultad de identificación a simple vista.

En el Apéndice 4, nos muestran las plantas nutricias asociadas a sus respectivas especies y en el 5, los nombres comunes británicos de cada una de las especies consideradas; finalizando la obra con un índice.

No podemos terminar estas líneas, sin felicitar a los autores por este extenso y detallado trabajo realizado a lo largo de tantos años y a la Editorial por la excelente presentación del libro y la labor realizada. El precio de este libro es de 80 libras esterlinas y los interesados lo pueden pedir a:

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SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 603-623 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1092 https://shilap.org
https://zoobank.org/6D8D45EB-A362-43D9-B967-A3AB7641CBFA

New records of Tortricidae from south Italy (Insecta: Lepidoptera)

Ilaria Latella, Sara La Cava, Giuseppe Rijllo, Stefano Scalercio, Giada Zucco, Axel Hausmann & Pasquale Trematerra

Abstract

We report new records for ninety-one species of Lepidoptera Tortricidae from southern Italy and Sicily. Twelve species are new to the fauna of the Basilicata region, twelve from Calabria and one from Sicily. One species is new for the Italian fauna: *Bactra simpliciana* Chrétien, 1915. We provide information on DNA barcodes and chorotypes for all species.

Keywords: Insecta, Lepidoptera, Tortricidae, new data, fauna, DNA barcoding, Italy.

Nuevos registros de Tortricidae en el sur de Italia (Insecta: Lepidoptera)

Resumen

Reportamos nuevos registros de noventa y una especies de Lepidoptera Tortricidae del sur de Italia y Sicilia. Doce especies son nuevas en la fauna de la región de Basilicata, doce de Calabria y una de Sicilia. Una especie es nueva para la fauna italiana: *Bactra simpliciana* Chrétien, 1915. Proporcionamos información sobre los códigos de barras de ADN y los corotipos de todas las especies.

Palabras clave: Insecta, Lepidoptera, Tortricidae, nuevos datos, fauna, código de barras de ADN, Italia.

Nuove registrazioni di Tortricidae dall’Italia meridionale (Insecta: Lepidoptera)

Riassunto

Vengono riportati nuovi dati per novantuno specie di Lepidotteri Tortricidae dell’Italia meridionale e della Sicilia. Dodici specie sono nuove per la fauna della regione Basilicata, dodici per la Calabria e una per la Sicilia. Una specie è nuova per la fauna italiana: *Bactra simpliciana* Chrétien, 1915. Per tutte le specie vengono fornite informazioni sul DNA barcoding e sui corotipi.

Parole chiave: Insecta, Lepidoptera, Tortricidae, nuovi dati, fauna, DNA barcoding, Italia.

Introduction

Several contributions have been made regarding the family Tortricidae (Lepidoptera) of Calabria (southern Italy). Trematerra (1990, 1991) provided information on the Pollino mountains, while Trematerra et al. (1994) focused on a chestnut-growing area of the Sila Massif. Baldizzone and Scalercio (2018) collected some species in the Aspromonte Massif and the estuary of river Amendolea. Trematerra et al. (2018)

summarised the knowledge of Calabrian tortricids, specifically those from the northern part of the Pollino and Sila mountains, citing 181 species, many of which are of biogeographical interest. Trematerra et al. (2023) presented additional investigations on the Sila Massif and surrounding area. This report presents the findings of a study conducted on specimens collected from 2013 to 2023 in the Calabrian, Basilicata, and Sicily and adds genetic data (COI barcoding) for all investigated species.

Material and Methods

The material was identified morphologically and confirmed molecularly through the BOLD Identification Engine by DNA barcoding (COI 5'), following the Canadian Centre for DNA Barcoding protocol (Ratnasingham and Hebert, 2007). Intraspecific and interspecific distances were assessed for the specimens using the distance synthesis tool available among the sequence analysis options in BOLD Systems. Barcode Index Numbers (BINs) are provided for each species. When more BINs are available for a given species, records belonging to a different BIN were separated accordingly.

For each species, the text provides information on the region, province, municipality, and collection site, including the altitude above sea level and geographical coordinates, Distribution in Italy and Chorotype. Additionally, the date of collection, number of specimens collected, name(s) of the collector(s), and BOLD specimen ID number are indicated.

The genitalia of specimens were prepared using standard methods, where the abdomen was macerated in 10% KOH and sectioned under a stereoscopic microscope. Male and female genitalia were then separated and mounted in Euparal on a slide. New species for one or more locations under study are marked by an asterisk. The chorotype of each species was determined based on Vigna Taglianti et al. (1992, 1999).

The specimens studied were from the following collections:

CREA-FL: Collection of the Research Centre for Forestry and Wood (Rende, Italy);
ZSM (SNSB): Bavarian State Collection of Zoology (Munich, Germany).

TORTRICIDAE
TORTRICINAE
Cochylini

Cochylis flaviciliana (Westwood, 1854)

Records: Calabria, Mt. Pollino, 0.8 km SW Gipfel, 2000 m, 39.9012ºN-16.1811ºE, 1 ♂, 09-VIII-2017, leg. A. Hausmann, BC ZSM Lep 101644 (SNSB-ZSM).

Genetic Data - Bin: Bold:ADR8529; intra-BIN variation (maximum distance): 0.64%; nearest neighboring BIN: *Cochylis flaviciliana* (1.27%) (intraspecific BIN-split).

Distribution in Italy: Reported in northwestern Italy, central Italy, Sicily and Sardinia. **New for Calabria**.

Chorotype: West Palaearctic.

Cochylidia rupicola (Curtis, 1834)

Records: Calabria, Cosenza, 1.5 km E Orsomarso F. Argentino, 140 m, 39.7946°N-15.9234°E, 1 ♂, 22-VIII-2018, leg. A. Hausmann, BC ZSM Lep 104339 (SNSB-ZSM); Basilicata, Piano dei Peri/ Trecchina, 280 m, 39.9913°N-15.1938°E, 1 ♀, 24-VIII-2014, leg. A. Hausmann, BC ZSM Lep 85029 (SNSB-ZSM).

Genetic Data - Bin: Bold:AAJ6914; intra-BIN variation (maximum distance): 0.8%; nearest neighboring BIN: *Cybilla hubbardana* (Busck) (6.12%).

Distribution in Italy: Present in most regions. **New for Basilicata**.

Chorotype: Turano-European.

Cochylidia heydeniana (Herrich-Schäffer, 1851)

Records: Calabria, Rende, 205 m, 39.3675ºN-16.2282ºE, 1 ♂, 21-IV-2022, leg. S. Scalercio, LEP-SS-05574 (CREA-FL).

Genetic Data - Bin: BOLD:AAD7781; intra-BIN variation (maximum distance): 2.36%; nearest neighboring BIN: *Cochylidia implicitana* (Wocke) (3.05%).

Distribution in Italy: Present in various regions.

Chorotype: Trans-Palaearctic.

Cochylimorpha straminea (Haworth, 1811)

Records: Basilicata, 3 km S Trecchina, Mte. S. Maria, 1035 m 40.0038ºN-15.7682ºE, 2 exx. (1 ♀, BC ZSM Lep 59320; 1 ♂, BC ZSM Lep 59321) 05-IX-2016, leg. A. Hausmann (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAJ0624; intra-BIN variation (maximum distance): 1.28%; nearest neighboring BIN: unidentified *Cochylimorpha* species (1.92%).

Distribution in Italy: Present in several regions.

Chorotype: Centralasiatic-European-Mediterranean.

Cochylimorpha scalerciana (Trematerra, 2019)

Records: Calabria, Sila, Vivaio Sbanditi (CS), 1351 m, 39.3889ºN-16.6022ºE, 1 ♂, 18-VI-2015, leg. Scalercio and Infusino, LEP-SS-00831 (CREA-FL).

Genetic Data - Bin: BOLD:ADN5386; intra-BIN variation (maximum distance): N/A (only one barcode on BOLD); nearest neighboring BIN: *Cochylimorpha alternana* (Stephens) (6.83%).

Distribution: Calabria: various locations of the Sila mountains, Cosenza (Trematerra, 2019a).

Distribution in Italy: So far, recorded only for Calabria.

Chorotype: South-Apenninic.

Cochylimorpha decolorella (Zeller, 1839)

Records: Calabria, Marcellinara, 260 m, 38.9188ºN-16.5035ºE, 1 ♂, 2-IV-2019, leg. S. Scalercio, LEP-SS-05341 (CREA-FL).

Genetic Data - Bin: BOLD:ADM4859; intra-BIN variation (maximum distance): 0.17%; nearest neighboring BIN: "*Cochylimorpha decolorella*" (3.69%), the large split into two BINs requiring further integrative study.

Distribution in Italy: Recorded in Tuscany, Latium, Calabria, Sicily, and Sardinia

Chorotype: Mediterranean.

Neocochylis hybridella (Hübner, [1813])

Records: Basilicata, Potenza, S. p. Mad. di Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 2 exx. (1 ♀, BC ZSM Lep 104321; 1 ♂, BC ZSM Lep 104344), 31-VIII-2018, leg. A. Hausmann (SNSB-ZSM), 1 ♂, 09-VIII-2019, leg. A. Hausmann, BC ZSM Lep 109587 (SNSB-ZSM); Basilicata, Mt. Sirino N, Felswand, 1390 m, 40.16ºN-15.84ºE, 1 ♂, 29-VIII-2013, leg. A. Hausmann, BC ZSM Lep 78448 (SNSB-ZSM); Basilicata, Sirino NW, 2 km N Lagonegro, 1000 m, 40.1563ºN-15.7607ºE, 1 ♀, 27-VIII-2023, leg. A. Hausamann, BC_ZSM_Lep_119173 (SNSB-ZSM); Calabria, Sila, 1 km N Lg. Ariamacina, 1390 m, 39.3434ºN-16.5435ºE, 1 ♂, 25-VIII-2016, leg. A. Hausmann, BC ZSM Lep 94679 (SNSB-ZSM); Calabria, Simeri-Crichi, 425 m, 38.9567ºN-16.6489ºE, 1 ♂, 05-IX-2019, leg. S. Scalercio, LEP-SS-05271 (CREA-FL); Calabria, San Fili, 740 m, 38.9567ºN-16.6489ºE, 1♂, 25-VI-2015, leg. S. Scalercio & M. Infusino LEP-SS-05273 (CREA-FL).

Genetic Data - Bin: BOLD:AAJ0623; intra-BIN variation (maximum Distance): 1.62%; nearest neighboring BIN: *Neocochylis dubitana* (Hübner) (4.1%).

Distribution in Italy: Present in Calabria, this species has been reported primarily in northern and central Italy.

Chorotype: Turano-European.

**Neocochylis sannitica* (Trematerra, 1995)

Records: Basilicata, Sirino NW, 2 km N Lagonegro, 1000 m, 40.1563°N-15.7607°E, 1 ♀, 27-VIII-2023, leg. A. Hausmann, BC_ZSM_Lep_119140 (SNSB-ZSM); Calabria, Sellia, 161 m, 38.9586°N-16.6192°E, 1♂, 24-VII-2019, leg. S. Scalercio, LEP-SS-05270 (CREA-FL).

Genetic Data - Bin: BOLD:ADL5171; intra-BIN-variation (maximum Distance): 0.16%; nearest neighboring BIN: *Neocochylis salebrana* (Mann) (4.01%).

Distribution in Italy: Collected only in central and southern Italy. **New for Calabria**.

Chorotype: East-Mediterranean.

Pontoturania posterana (Zeller, 1847)

Records: Basilicata, Mt. Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 1 ♂, 09-VIII-2019, leg. A. Hausmann, BC ZSM Lep 109567 (SNSB-ZSM); Basilicata, 3 km S Trecchina, Mte. S. Maria, 40.0038ºN-15.7682ºE, 1 ♀, 05-IX-2016, leg. A. Hausmann, BC ZSM Lep 59325 (SNSB-ZSM); Calabria, Cosenza, Praia a Mare, 10 m, 39.8933ºN-15.7827ºE, 1 ♀, 22-VIII-2021, leg. A. Hausmann, BC ZSM Lep 114889 (SNSB-ZSM), 1 ♂, 07-IX-2021, leg. A. Hausmann, BC ZSM Lep 115110 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAO2590; intra-BIN variation (maximum distance): 1.28%; nearest neighbor: "*Pontoturania posterana*" (4.01%), the large split into two BINs requiring further integrative study.

Distribution in Italy: Present in most regions.

Chorotype: Palaearctic.

Agapeta zoegana (Linnaeus, 1767)

Records: Calabria, S. p. Mad. Di Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 1 ♂, 09-VIII-2019, leg. A. Hausmann, BC ZSM Lep 109586 (SNSB-ZSM); Calabria, Sila, 1 km N Lg. Ariamacina, 1390 m, 39.3434ºN-16.5435ºE, 1 ♂, 25-VIII-2016, leg. A. Hausmann, BC ZSM Lep 94675 (SNSB-ZSM).

Genetic Data - Bin: BOLD:ACJ6816; intra-BIN variation (maximum distance): 1.77%; nearest neighboring BIN: "*Agapeta zoegana*" (3.89%), the large split into two BINs requiring further integrative study.

Distribution in Italy: Present in most regions.

Chorotype: Europe-Asia Minor.

**Aethes rubigana* (Treitschke, 1830)

Records: Basilicata, S. p. Mad. Di Sirino, 3 km E Lagonegro, 1065 m, 40.119°N-15.802°E, 1 ♂, 27-VII-2020, leg. A. Hausmann, BC ZSM Lep 111819 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC2885; intra-BIN variation (maximum distance): 2.25%; nearest neighboring BIN: *Aethes kyrkii* Itamies and Mutanen (3.66%).

Distribution in Italy: Present throughout Italy. **New for Basilicata**.

Chorotype: European-Mediterranean.

Aethes francillana (Fabricius, 1794)

Records: Calabria, Praia a Mare Ort, 10 m, 39.8933°N-15.7827°E, 1 ♂, 08-VI-2023, leg. A. Hausmann, BC_ZSM_Lep_118628 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAP7561; intra-BIN variation (maximum distance): 1.44%; nearest neighboring BIN: unidentified *Aethes* species (3.3%).

Distribution in Italy: Present in most regions.

Chorotype: West-Palaearctic.

Aethes williana (Brahm, 1791)

Records: Basilicata, Sirino NW, 2 km N Lagonegro, 1000 m, 40.1563ºN-15.7607ºE, 1 ♂, 01-VI-2023, leg. A. Hausmann, BC_ZSM_Lep_118633 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAF5281; intra-BIN variation (maximum distance): 2.09%; nearest neighboring BIN: *Aethes margarotana* (Duponchel) (2.37%).

Distribution in Italy: Present throughout Italy.

Chorotype: Palaearctic.

Phtheochroa rugosana (Hübner, [1799])

Records: Basilicata, Mt. Sirino, 3km E Lagonegro, 1065 m, 40.119ºN-15.802ºE, 1 ♀, 11-VI-2022, leg. A. Hausmann, BC_ZSM_Lep_116368 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAL5376; intra-BIN variation (maximum distance): 2.09%; nearest neighboring BIN: *Phtheochroa annae* Huemer (4.3%).

Distribution in Italy: Mentioned only in some regions of north-western Italy and Calabria.

Chorotype: European.

Phtheochroa duponchelana (Duponchel, 1843 in Godart)

Records: Calabria, Praia a Mare Ort, 10 m, 39.8933ºN-15.7827ºE, 1 ♂, 08-VI-2023, leg. A. Hausmann, BC_ZSM_Lep_118620 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAL5363; intra-BIN variation (maximum distance): 1.12%; nearest neighboring BIN: *Phtheochroa accurata* Tsvetkov (5.13%).

Distribution in Italy: Found only in a few regions in central and southern Italy.

Chorotype: Mediterranean.

Phalonidia contractana (Zeller, 1847)

Records (BIN BOLD:ACJ7428): Calabria, S. Domenica Talao, 5 km E Scalea, 240 m, 39.821ºN-15.783ºE, 1 ♀, 19-VIII-2013, leg. A. Hausmann, BC ZSM Lep 78455 (SNSB-ZSM).

Records (BIN BOLD:ADZ8563): Calabria, Praia a Mare Ort, 10 m, 39.8933ºN-15.7827ºE, 1 ♀, 08-VI-2023, leg. A. Hausmann, BC_ZSM_Lep_118629 (SNSB-ZSM).

Genetic Data - Two BINs: BOLD:ACJ7428: intra-BIN variation (maximum distance): 0%; nearest neighboring BIN: unidentified *Phalonidia* species (2.88%) and BOLD:ADZ8563: intra-BIN variation (maximum distance): 0.48%; nearest neighboring BIN: *Phalonidia contractana* (1.6%).

Distribution in Italy: Present in most regions.

Chorotype: Centralasiatic-European-Mediterranean.

Cnephasiini

Eana penziana (Thunberg & Becklin, 1791)

Records: Calabria, Mt. Pollino, 0.8 km SW Gipfel, 2000 m, 39.9012ºN-16.1811ºE, 1 ♀, 09-VIII-2017, leg. A. Hausmann, BC ZSM Lep 101654 (SNSB-ZSM).

Genetic Data - Bin: BOLD:ABV9984; intra-BIN variation (maximum distance) 0.48%; nearest neighboring BIN: *Eana nirvana* Joannis (3.04%).

Distribution in Italy: Cited in northern Italian regions, Abruzzo and Calabria.

Chorotype: Central-European.

Cnephasia cupressivorana (Staudinger, 1871)

Records: Basilicata, Fme Noce, Aue, nr. Parutta, 110 m, 40.0035°N-15.7983°E, 1 ♂, 15-IV-2018, leg. A. Hausmann, BC ZSM Lep 102410 (SNSB-ZSM); Basilicata, Fm Noce, Piano dei Peri/Trecchina, 280 m, 39.9914°N-15.7939°E, 1 ♀, 11-III-2019, leg. A. Hausmann, BC ZSM Lep 105177 (SNSB-ZSM), 1 ♂, 31-III-2016, leg. A. Hausmann, BC ZSM Lep 94145 (SNSB-ZSM); Calabria, Cosenza, 6 km S Cosenza, Pianette di Dipignano, 750 m, 39.2303°N-16.2497°E, 1 ♂, 01-V-2015 leg. G. Posa, BC ZSM Lep 91881 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAQ1950; intra-BIN variation (maximum distance): 1.26%; nearest neighboring BIN: *Cnephasia alticolana* (Herrich-Schäffer) (6.12%).

Distribution in Italy: Present in several regions.

Chorotype: Centralasiatic-European.

Cnephasia communana (Herrich-Schäffer, 1851)

Records: Basilicata, 3 km S Trecchina, Mte. S. Maria, 960 m, 40.005ºN-15.778ºE, 1 ♀, 15-VI-2022, leg. A. Hausmann, BC_ZSM_Lep_116372 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAI4103; intra-BIN variation (maximum distance): 1.61%; nearest neighboring BIN: *Cnephasia alfacarana* Razowski (3.68%).

Distribution in Italy: Widely distributed in Italy, absent from Sardinia.

Chorotype: Centralasiatic-European-Mediterranean.

Cnephasia longana (Haworth, 1811)

Records: Calabria, Praia a Mare Ort, 10 m, 39.8933°N-15.7827°E, 2 ♂, 17-VI-2022, leg. A. Hausmann, (BC_ZSM_Lep_116380, BC_ZSM_Lep_118624) (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC7742; intra-BIN variation (maximum distance): 2.08%; nearest neighboring BIN: *Cnephasia hellenica* Obraztov (4.65%).

Distribution in Italy: Present in northern, central and southern Italy.

Chorotype: Holarctic

**Cnephasia alticolana* (Herrich-Schäffer, 1849)

Records: Basilicata, 1.7 km N Mad. del Sirino, 1000 m, 40.1371ºN-15.8175º1E, 1 ♀, 28-VIII-2023, leg. A. Hausmann, BC_ZSM_Lep_118623 (SNSB-ZSM); Calabria, Longobucco, 1325 m, 39.3930ºN-16.6149ºE, 2 exx. (1♂, LEP-SS-05299; 1♀, LEP-SS-5300), 01-VI-2018, leg. S. Scalercio (CREA-FL); Calabria, Saracena, 1431 m, 39.7804ºN-16.0675ºE, 1 ♂, 06-VI-2016, leg. S. Scalercio, LEP-SS-05557 (CREA-FL).

Genetic Data - Bin: BOLD:ACF2531; intra-BIN variation (maximum distance): 0.96%; nearest neighboring BIN: *Cnephasia asseclana* ([Denis & Schiffermüller]) (1.39%).

Distribution in Italy: Found in northern and central Italy but absent in Sicily. **New record in Basilicata and Calabria**.

Chorotype: Sibero-European.

Cnephasia genitalana (Pierce & Metcalfe, 1915)

Records: Calabria, Porta Sole, 5 m, 38.4929°N-15.917°E, 1 ♂, 13-V-2018, leg. Domenico Bonelli, LEP-SS-00911 (CREA-FL).

Genetic Data - Bin: BOLD:AAC7742; intra-BIN variation (maximum distance): 2.08%; nearest neighboring BIN: *Cnephasia Hellenica* Obraztov (4.65%).

Distribution in Italy: Present in several regions, not recorded in Sardinia.

Chorotype: European.

Cnephasia chrysantheana (Duponchel, 1843)

Records: Calabria, Rende, 205 m, 39.3675ºN-16.2282ºE, 1 ♂, 15-V-2022, leg. S. Scalercio, LEP-SS-05573 (CREA-FL).

Genetic Data - Bin: BOLD:AEF6417; intra-BIN variation (maximum distance): 1.93%; nearest neighboring BIN: *Doloploca punctulana* ([Denis & Schiffermüller]) (6.10%).

Distribution in Italy: Present in several regions.

Chorotype: West-Palaearctic.

Tortricodes alternella ([Denis & Schiffermüller], 1775)

Records: Basilicata, Fm Noce, Piano dei Peri/Trecchina, 280 m, 39.9914ºN-15.7939ºE, 1 ♀, 11-III-2019, leg. A. Hausmann, BC ZSM Lep 105169 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAI0647; intra-BIN variation (maximum distance): 2.25%; nearest neighboring BIN: unidentified *Platynota* species (5.18%).

Distribution in Italy: Present in several regions, not recorded in Sardinia.

Chorotype: European.

**Pseudargyrotoza conwagana* (Fabricius, 1775)

Records (BIN: BOLD:AAC8984): Calabria, Cosenza, Praia a Mare, 10 m, 39.8933ºN-15.7827ºE, 1 ♀, 20-VIII-2019, leg. A. Hausmann, BC ZSM Lep 109557 (SNSB-ZSM).

Records (BIN: BOLD:AAC8983): Basilicata, Sirino NW, 2 km N Lagonegro, 1000 m, 40.1563ºN-15.7607ºE, 1 ♂, 04-VI-2023, leg. A. Hausmann, BC_ZSM_Lep_118630 (SNSB-ZSM).

Genetic Data: Two BINs: BOLD:AAC8984: intra-BIN variation (maximum distance): 0.8%; nearest neighboring BIN: *Pseudargyrotoza conwagana* (2.98%) and BOLD:AAC8983: intra-BIN variation (maximum distance): 2.02%; nearest neighbor: *Pseudargyrotoza conwagana* (2.98%).

Distribution in Italy: It is widely distributed, not reported in Puglia. **New for Calabria**.

Chorotype: Palaearctic.

Tribe Grapholitini

Cydia triangulella (Goeze, 1783)

Records: Basilicata, 1.7 km N Mad. del Sirino, 1800 m, 40.1371ºN-15.8175ºE, 1 ♀, 28-VIII-2017, leg. A. Hausmann, BC ZSM Lep 101662 (SNSB-ZSM); Basilicata, Fm Noce, Piano dei Peri/Trecchina, 280 m, 39.991ºN-15.794ºE, 3 exx. (1 ♀, BC ZSM Lep 112100; 1♂, BC ZSM Lep 112104; 1 ♀, BC ZSM Lep 85026), 11-X-2020, leg. A. Hausmann (SNSB-ZSM); Basilicata, 3 km S Trecchina, Mte. S. Maria, 40.0038ºN-15.7682ºE, 1 ♀, 05-IX-2016, leg. A. Hausmann, BC ZSM Lep 59322 (SNSB-ZSM); Calabria, Praia a Mare, 10 m, 39.8933ºN-15.7827ºE, 1 ♀, 07-VIII-2021, leg. A. Hausmann, BC ZSM Lep 114909 (SNSB-ZSM); Calabria, 2 km S Aieta, 670 m, 39.9123ºN-15.8145ºE, 1 ♀, 04-IX-2023, leg. A. Hausmann, BC_ZSM_Lep_119165 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC0640; intra-BIN variation (maximum distance): 3.75%; nearest neighboring BIN: *Cydia illutana* (Herrich-Schäffer) (5.6%).

Distribution in Italy: Present in most regions.

Chorotype: Palaearctic.

Cydia fagiglandana **(**Zeller, 1841)

Records (BIN: BOLD:AAC5023): Basilicata, Fme Noce, Flussaue, 40 m, 39.956ºN-15.7702°E, 1 ♀, 21-VIII-2017, leg. A. Hausmann, BC ZSM Lep 101673 (SNSB-ZSM); Basilicata, Potenza, Mt. Pollino, Spezzavummulo, 1680 m, 39.9149ºN-16.1776°E, 1 ♀, 13-VIII-2015, leg. A. Hausmann, BC ZSM Lep 91916 (SNSB-ZSM); Calabria, Praia a Mare, 10 m, 39.8933ºN-15.7827ºE, 1 ♀, 20-VIII-2019, leg. A. Hausmann, BC ZSM Lep 109559 (SNSB-ZSM); Calabria, P. del faggio, Acquaformosa (CS), 1357 m, 39.7587ºN-16.0763ºE, 1♂, 01-VI-2016, leg. Scalercio and Infusino, LEP-SS-00829 (Coll. Trematerra); Sicilia, 1 km NW Zafferana Etnea, 670 m, 37.7003ºN-15.1008ºE, 1 ♀, 25-VIII-2021, leg. A. Hausmann, BC ZSM Lep 114601 (SNSB-ZSM).

Records (BIN: BOLD:ACS3074): Basilicata, S. p. Mad. Di Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 1 ♀, 09-VIII-2019, leg. A. Hausmann, BC ZSM Lep 109583 (SNSB-ZSM); Basilicata, Sirino NW, 2 km N Lagonegro, 1000 m, 40.1563ºN-15.7607ºE, 2 ♀ (BC_ZSM_Lep_119168, BC_ZSM_Lep_119169), 27-VIII-2023, leg. A. Hausamann (SNSB-ZSM); Basilicata, Piano dei Peri/ Trecchina, 280 m, 39.9913ºN-15.1938ºE, 1 ♀, 24-VIII-2014, leg. A. Hausmann, BC ZSM Lep 85025 (SNSB-ZSM).

Genetic Data - Two Bins: BOLD:AAC5023: intra-BIN variation (maximum distance): 2.76%; nearest neighboring BIN: *Cydia fagiglandana* (2.63%) and BIN: BOLD:ACS3074: intra-BIN variation (maximum distance): 0.64%; nearest neighboring BIN: *Cydia fagiglandana* (1.44%). The large intraspecific divergence requires further integrative taxonomic research.

Distribution in Italy: Present in most regions.

Chorotype: W-Palaearctic.

Cydia pomonella (Linnaeus, 1758)

Records: Basilicata, Potenza, S. p. Mad. di Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 1 ♀, 31-VIII-2018, leg. A. Hausmann BC ZSM Lep 104316 (SNSB-ZSM), 1 ♂, 11-VI-2022, leg. A. Hausmann, BC ZSM Lep 116166 (SNSB-ZSM); Calabria, Cosenza, 6 km S Cosenza, Pianette di Dipignano, 750 m, 39.2303ºN-16.2497ºE, 1 ♂, 01-VI-2015, leg. G. Posa, BC ZSM Lep 91908 (SNSB-ZSM); Sicilia, 1 km NW Zafferana Etnea, 670 m, 37.7003ºN-15.1008ºE, 1 ♂, 25-VIII-2021, leg. A. Hausmann, BC ZSM Lep 114604 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAA3532; intra-BIN variation (maximum distance): 3.42%; nearest neighboring BIN: *Cydia pyrivora* Danilivsky (4.41%).

Distribution in Italy: Present throughout Italy.

Chorotype: Palaearctic.

Cydia amplana (Hübner, [1799])

Records: Calabria, Praia a Mare, 10 m, 39.8933ºN-15.7827ºE, 1 ♀, 20-VIII-2019, leg. A. Hausmann BC ZSM Lep 109558 (SNSB-ZSM), 1 ♀, 07-IX-2021, leg. A. Hausmann, BC ZSM Lep 114910 (SNSB-

ZSM); Calabria, 2 km S Aieta, 670 m, 39.9123ºN-15.8145ºE, 2 ♂, 04-IX-2023, leg. A. Hausmann, BC_ZSM_Lep_119170, BC_ZSM_Lep_119171 (SNSB-ZSM); Sicilia, 1 km NW Zafferana Etnea, 670 m, 37.7003ºN-15.1008ºE, 1 ♂, 25-VIII-2021, leg. A. Hausmann, BC ZSM Lep 114597 (SNSB-ZSM).

Genetic Data - Bin: BOLD:ABW2550; intra-BIN variation (maximum distance): 1.19%; nearest neighboring BIN: *Cydia rymarczyki* Varenne & Nel (5.92%).

Distribution in Italy: Present in most regions.

Chorotype: Turanian-European.

**Cydia rymarczyki* (Varenne & Nel, 2013)

Records: Basilicata, Fm Noce, Piano dei Peri/Trecchina, 280 m, 39.991ºN-15.794ºE, 2 exx. (1 ♀), BC ZSM Lep 112103; 1 ♂, BC ZSM Lep 112105), 11-X-2020 leg. A. Hausmann (SNSB-ZSM).

Genetic Data - Bin: BOLD:ACF9264; intra-BIN variation (maximum distance): 1.28%; nearest neighboring BIN: *Cydia amplana* (5.92%).

Distribution in Italy: Cited only for Veneto. **New for southern Italy and Basilicata**.

Chorotype: South-European.

Cydia succedana ([Denis & Schiffermüller], 1775)

Records (BIN BOLD:ACF3585): Basilicata, Sirino NW, 2 km N Lagonegro, 1000 m, 40.1563ºN-15.7607ºE, 1 ♂, 01-VI-2023, leg. A. Hausmann, BC_ZSM_Lep_118626 (SNSB-ZSM).

Records (BIN BOLD:AAB7159): Calabria, Praia a Mare Ort, 10 m, 39.8933ºN-15.7827ºE, 1 ♂, 08-VI-2023, leg. A. Hausmann, BC_ZSM_Lep_118644 (SNSB-ZSM).

Genetic Data - Two BINs: BOLD:AAB7159 and BOLD:ACF3585; intra-BIN variation (maximum distances): 1.17% resp. 1.32%; minimum distance between both BINs 1.32%. Requiring further integrative taxonomic research.

Distribution in Italy: Present in most regions.

Chorotype: Centralasiatic-European-Mediterranean.

Cydia pyrivora (Danilevsky, 1947)

Records: Basilicata, Sirino NW, 2 km N Lagonegro, 1000 m, 40.1563ºN-15.7607ºE, 1 ♂, 27-VIII-2023, leg. A. Hausmann, BC_ZSM_Lep_119166 (SNSB-ZSM).

Genetic Data - Bin: BOLD:ACJ4811; intra-BIN variation (maximum distance): 0.76%; nearest neighboring BIN: *Cydia pomonella* (4.41%).

Distribution in Italy: A rather rare species found in a few regions, including Sicily and Sardinia.

Chorotype: Centralasiatic-European-Mediterranean.

Grapholita molesta (Busck, 1916)

Records: Calabria, Praia a Mare Ort, 10 m, 39.8933ºN-15.7827ºE, 1 ♀, 20-VIII-2019, leg. A. Hausmann, BC ZSM Lep 109536 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAB0523; intra-BIN variation (maximum distance): 0.81%; nearest neighboring BIN: *Grapholita dimorpha* Komai (4.17%).

Distribution in Italy: Present in a few regions.

Chorotype: Centralasiatic-European-Mediterranean.

Grapholita funebrana (Treitschke, 1835)

Records: Calabria, Cosenza, Praia a Mare, 10 m, 39.8933°N-15.7827°E, 1 ♀, 22-VIII-2021, leg. A. Hausmann, BC ZSM Lep 114908 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAB9236; intra-BIN variation (maximum distance): 0.36%; nearest neighboring BIN: "*Grapholita funebrana*" (5.01%) the large split into two BINs requiring further integrative study.

Distribution in Italy: Distributed in various regions.

Chorotype: Palaearctic.

Lathronympha strigana (Fabricius, 1775)

Records: Basilicata, S. p. Mad. Di Sirino, 3 km E Lagonegro, 1065 m, 40.119ºN-15.802ºE, 1 ♂, 27-VII-2020, leg. A. Hausmann, BC ZSM Lep 111821 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC1866; intra-BIN variation (maximum distance): 2.64%; nearest neighboring BIN: *Lathronympha strigana* (1.2%).

Distribution in Italy: Present in most regions.

Chorotype: Sibirian-European.

**Dichrorampha sedatana* (Busck, 1906)

Records: Basilicata, 3 km S Trecchina, Mte. S. Maria, 1035 m, 40.0038ºN-15.7682ºE, 2 ♂, 05-IX-2016, leg. A. Hausmann, (BC ZSM Lep 59323, BC ZSM Lep 94655) (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAA8636; intra-BIN variation (maximum distance): 1.93%; nearest neighboring BIN: *Dichrorampha petiverella* (Linnaeus) (4.5%).

Distribution in Italy: The presence of this species has been reported in a limited number of northern regions as well as in Molise. **New for Basilicata**.

Chorotype: Holarctic.

Pammene fasciana (Linnaeus, 1761)

Records: Basilicata, Sirino NW, 2 km N Lagonegro, 1000 m, 40.1563ºN-15.7607ºE, 1 ♀, 27-VIII-2023, leg. A. Hausmann, BC_ZSM_Lep_119163 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC8302; intra-BIN variation (maximum distance): 1.77%; nearest neighboring BIN: *Pammene gallicolana* (Lienig & Zeller) (3.85%).

Distribution in Italy: Present throughout Italy.

Chorotype: Turanian-European.

Pammene gallicolana (Lienig & Zeller, 1846)

Records: Basilicata, Piano dei Peri/ Trecchina, 280 m, 39.9913ºN-15.1938ºE, 1 ♀, 24-VIII-2014, leg. A. Hausmann, BC ZSM Lep 85027 (SNSB-ZSM).

Genetic Data - Bin: BOLD:ACS0107; intra-BIN variation (maximum distance): 2.08%; nearest neighboring BIN: *Pammene fasciana* (Linnaeus) (3.85%).

Distribution in Italy: Cited mainly from central and southern Italy.

Chorotype: European.

Strophedra weirana (Douglas, 1850)

Records: Calabria, Taverna, 1262 m, 39.0947ºN-16.5902ºE, 1 ♂, 1-VII-2019, leg. S. Scalercio and C. Di Marco, LEP-SS-05293 (CREA-FL); Calabria, Spezzano Sila, 1402 m, 39.3328ºN-16.4143ºE, 1 ♀, 16-VII-2018, leg. S. Scalercio, LEP-SS-05294 (CREA-FL).

Genetic Data - Bin: BOLD:AAF3264; intra-BIN variation (maximum distance): 0.37%; nearest neighboring BIN: *Strophedra nitidana* (Fabricius) (1.77%).

Distribution in Italy: Present in few regions, not recorded in Sardinia.

Chorotype: European with Anatolian-Caucasian extension.

Eucosmini

**Epinotia immundana* (Fischer von Röslerstamm, 1839)

Records: Basilicata, Fme Noce, Aue, nr. Parutta, 110 m, 40.0035°N-15.7983°E, 1 ♂, 15-IV-2018, leg. Axel Hausmann, BC ZSM Lep 102412 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC9103; intra-BIN variation (maximum distance): 0%; nearest neighboring BIN: *Epinotia immundana* (2.55%).

Distribution in Italy: Reported in northern and central Italy, and Calabria, absent in Sicily and Sardinia. **New for Basilicata**.

Chorotype: Turanian-European.

Epinotia tenerana ([Denis & Schiffermüller], 1775)

Records: Basilicata, S. p. Mad. Di Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 1 ♀, 09-VIII-2019, leg A. Husmann BC ZSM Lep 109584 (SNSB-ZSM), 1 ♂, 04-XI-2021, leg. A. Hausmann, BC ZSM Lep 115167 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAD1776; intra-BIN variation (maximum distance): 0.96%; nearest neighboring BIN: *Epinotia momonana* (Kearfott) (2.17%).

Distribution in Italy: Distributed in various regions, not recorded in Sardinia.

Chorotype: Palaearctic.

**Epinotia tedella* (Clerck, 1759)

Records: Basilicata, S. p. Mad. Di Sirino, 3 km E Lagonegro, 1065 m, 40.119°N-15.802°E, 1 ♀, 27-VII-2020, leg. A. Hausmann, BC ZSM Lep 111826 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAD1782; intra-BIN variation (maximum distance): 1.84%; nearest neighboring BIN: *Epinotia granitana* (Herrich-Schäffer) (4.73%).

Distribution In Italy: The species has been reported in northern and central Italy, absent in southern regions, including Sicily and Sardinia. **New for Basilicata**.

Chorotype: North-Central Europe and Japan.

**Epinotia maculana* (Fabricius, 1775)

Records: Calabria, Longobucco, 1350 m, 39.3888ºN- 16.6025ºE, 1 ♂, 13-X-2014, leg. S. Scalercio, LEP-SS-05525 (CREA-FL).

Genetic Data - Bin: BOLD:AAF4061; intra-BIN variation (maximum distance): 1.28%; nearest neighboring BIN: *Epinotia solandriana* (Linnaeus) (8.03%).

Distribution In Italy: Cited in the northern regions, in Abruzzo and Calabria, not recorded in Sicily and Sardinia. **New for Calabria**.

Chorotype: Palaearctic.

**Rhopobota naevana* (Hübner, [1817])

Records: Basilicata, Potenza, S. p. Mad. di Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 1 ♂, 31-VIII-2018, leg. A. Hausmann, BC ZSM Lep 104319 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAA9812; intra-BIN variation (maximum distance): 3.99%; nearest neighboring BIN: unidentified *Rhopobota* species (3.47%).

Distribution in Italy: Present in most regions. **New for Basilicata**.

Chorotype: Sub-Cosmopolitan.

Crocidosema plebejana (Zeller, 1847)

Records: Basilicata, Fm Noce, Piano dei Peri/Trecchina, 280 m, 39.9914ºN-15.7939ºE, 1 ♂, 11-III-2019, leg. A. Hausmann BC ZSM Lep 105176 (SNSB-ZSM), 1 ♀, 31-III-2016, leg. A. Hausmann, BC ZSM Lep 94146 (SNSB-ZSM); Calabria, Praia a Mare, 10 m, 39.8933ºN-15.7827ºE, 1 ♀, 20-VIII-2019, leg. A. Hausmann BC ZSM Lep 109539 (SNSB-ZSM), 2 ♀, 08-XI-2021, leg. A. Hausmann, (BC ZSM Lep 114904; BC ZSM Lep 115102) (SNSB-ZSM).

Genetic Data - Bin: BOLD:ACE9795; intra-BIN variation (maximum distance): 1.58%; nearest neighboring BIN: *Crocidosema plebejana* (1.41%).

Distribution in Italy: Present in most regions.

Chorotype: Cosmopolitan.

Eucosma hohenwartiana ([Denis & Schiffermüller], 1775)

Records: Basilicata, Mt. Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 1 ♂, 09-VIII-2019, leg. A. Hausmann, BC ZSM Lep 109581 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAB4295; intra-BIN variation (maximum distance): 3.05%; nearest neighboring BIN: *Eucosma crassana* (McDunnough) (4.64%).

Distribution in Italy: Present in most regions.

Chorotype: Asiatic-European.

**Eucosma cana* (Haworth, 1811)

Records: Basilicata, S. p. Mad. Di Sirino, 3 km E Lagonegro, 1065 m, 40.119ºN-15.802ºE, 1 ♀, 27-VII-2020, leg. A. Hausmann BC ZSM Lep 111813 (SNSB-ZSM), 1 ♂, 11-VI-2022, leg. A. Hausmann, BC ZSM Lep 116161 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAB4296; intra-BIN variation (maximum distance): 1.66%; nearest neighboring BIN: *Eucosma subvittana* (Staudinger) (2.08%).

Distribution in Italy: Reported in all regions of Italy. **New for Basilicata**.

Chorotype: Asiatic-European.

Notocelia uddmanniana (Linnaeus, 1758)

Records: Basilicata, S. p. Mad. Di Sirino, 3 km E Lagonegro, 1065 m, 40.119ºN-15.802ºE, 1♀, 27-VII-2020, leg. A. Hausmann BC ZSM Lep 111820 (SNSB-ZSM), 40.1192ºN, 15.8018ºE, 1 ♀, 11-VI-2022, leg. A. Hausmann, BC_ZSM_Lep_116167 (SNSB-ZSM); Basilicata, Piano dei Peri/ Trecchina, 280 m, 39.9913ºN-15.1938ºE, 1 ♀, 24-VIII-2014, leg. A. Hausmann, BC ZSM Lep 85023 (SNSB-ZSM); Calabria, Cosenza, 6 km S Cosenza, Pianette di Dipignano, 750 m, 39.2303ºN-16.2497ºE, 1 ♂, 01-V-2015, leg. G. Posa, BC ZSM Lep 91892 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC1148; intra-BIN variation (maximum distance): 1.28%; nearest neighboring BIN: unidentified *Notocelia* species (3.29%).

Distribution in Italy: Present in most regions.

Chorotype: Palaearctic.

Notocelia incarnatana (Hübner, [1799])

Records: Basilicata, Mt. Sirino N, Erlenwald, 1230 m, 40.154ºN-15.822ºE, 1 ♀, 29-VIII-2013, leg. A. Husmann BC ZSM Lep 78447 (SNSB-ZSM), 1390 m, 40.16ºN-15.84ºE, 1 ♂, 29-VIII-2013, leg. A. Hausmann, BC ZSM Lep 78452 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAY8762; intra-BIN variation (maximum distance): 2.69%; nearest neighboring BIN: *Notocelia incarnatana* (6.87%) the large split into two BINs requiring further integrative study.

Distribution in Italy: Present in most regions.

Chorotype: Palaearctic.

Pelochrista agrestana (Zeller, 1841)

Records: Sicilia, 1 km NW Zafferana Etnea, 670 m, 37.7003ºN-15.1008ºE, 1 ♂, 25-VIII-2021, leg. A. Hausmann, BC ZSM Lep 114603 (SNSB-ZSM).

Genetic Data - Bin: BOLD:ADL5479; intra-BIN variation (maximum distance): 0.64%; nearest neighboring BIN: *Pelochrista mancipiana* (Staudinger) (2.4%).

Distribution in Italy: Cited in central and southern Italy, not recorded in north Italy and Sardinia.

Chorotype: South-European.

**Clavigesta purdeyi* (Durrant, 1911)

Records: Sicilia, Catania, 1 km NW Zafferana Etnea, 670 m, 37.7003ºN-15.1008ºE, 1 ♀, 25-VIII-2021, leg. A. Hausmann, BC ZSM Lep 114873 (SNSB-ZSM); Calabria, Cosenza, Sila gr., 1 km SW Magara, 1390 m, 39.3223ºN-16.4749ºE, 1 ♀, 01-IX-2015, leg. A. Hausmann, BC ZSM Lep 91912 (SNSB-ZSM); Calabria, Sila, 1 km N Lg. Ariamacina, 1390 m, 39.3434ºN-16.5435ºE, 3 exx. (1 ♂), BC ZSM Lep 94682; 1 ♂, BC ZSM Lep 94684; 1 ♀, BC ZSM Lep 94674), 25-VIII-2016, leg. A. Hausmann, (SNSB-ZSM).

Genetic Data - Bin: BOLD:ADF3131; intra-BIN variation (maximum distance): 0.8%; nearest neighboring BIN: *Clavigesta purdeyi* (1.92%).

Distribution in Italy: There are few reports from northern and central Italy, and none from Sardinia. **New for Sicily**.

Chorotype: North-Central Europe.

Rhyacionia pinicolana (Doubleday, 1850)

Records: Calabria, Sila, Lago Cecita, Longobucco, 1170 m, 39.3865ºN-16.552ºE, 1 ♀, 13-VIII-2014, leg. A. Hausmann, BC ZSM Lep 85008 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC4601; intra-BIN variation (maximum distance): 0.8%; nearest neighboring BIN: *Gravitarmata margarotana* (Heinemann) (4.65%).

Distribution in Italy: Reported in north Italy, Calabria, and Sicily.

Chorotype: Asiatic-European.

Rhyacionia pinivorana (Zeller, 1846)

Records: Calabria, Sila-Mangiatoie, 1275 m, 39.2369ºN-16.6625ºE, 1 ♂, 11-V-2016, leg. Scalercio-Infusino, LEP-SS-00669 (CREA-FLC); Calabria, Quaresima-Aprigliano, 1310 m, 39.2129ºN-16.4552ºE, 1 ♂, 15-VI-2015, leg. Scalercio and Infusino LEP-SS-00670 (CREA-FLC).

Genetic Data - Bold:AAB9878; intra-BIN variation (maximum distance): 1.77%; nearest neighboring BIN: *Rhyacionia dativa* Heinrich (2.4%).

Distribution in Italy: Reported only in north Italy and Calabria.

Chorotype: Asiatic-European.

**Thiodia citrana* (Hübner, [1799])

Records: Cosenza, 6 km S, Pianette di Dipignano, 750 m, 39.2303ºN-16.2497ºE, 1 ♂, 01-VI-2015, leg. G. Posa, BC ZSM Lep 91904 (SNSB-ZSM).

Genetic Data - Bin: BOLD:ACY8824; intra-BIN variation (maximum distance): N/A (only one barcode on BOLD); nearest neighboring BIN: unidentified *Thiodia* species (7.53%).

Distribution In Italy: Absent in Friuli and Puglia has been observed in almost all regions. **New for Calabria**.

Chorotype: Siberian-European.

Epiblema costipunctana (Haworth, 1811)

Records: Basilicata, 3 km S Trecchina, Mte. S. Maria, 960 m, 40.005ºN-15.778ºE, 1 ♂, 15-VI-2022, leg. A. Hausmann, BC_ZSM_Lep_116391 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC0718; intra-BIN variation (maximum distance): 2.65%; nearest neighboring BIN: *Epiblema turbidana* (Treitschke) (6.94%).

Distribution in Italy: Present in most regions.

Chorotype: European.

Tortricini

Acleris hastiana (Linnaeus, 1758)

Records: Cosenza, 1.5 km E Orsomarso F. Argentino, 140 m, 39.7946ºN-15.9234ºE, 1 ♀, 22-VIII-2018, leg. A. Hausmann, BC ZSM Lep 104288 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAA9796; intra-BIN variation (maximum distance): 0.45%; nearest neighboring BIN: *Acleris hippophaeana* (Heyden) (1.92%).

Distribution in Italy: Present in most regions.

Chorotype: Holarctic

Acleris rhombana ([Denis & Schiffermüller], 1775)

Records: Basilicata, Potenza, S. p. Mad. di Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 1 ♂, 31-VIII-2018, leg. A. Hausmann BC ZSM Lep 104317 (SNSB-ZSM); 1 ♂, 09-X-2020, leg. A Hausmann BC ZSM Lep 112068 (SNSB-ZSM), 2 ♀ (BC ZSM Lep 115166; BC ZSM Lep 115600), 04-XI-2021, leg. A. Hausmann (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAE3741; intra-BIN variation (maximum distance): 2.57%; nearest neighboring BIN: *Acleris foliana* (Wasingham) (4.48%).

Distribution in Italy: Present in most regions.

Chorotype: Holarctic.

**Acleris sparsana* ([Denis & Schiffermüller], 1775)

Records: Basilicata, Mt. Sirino, 3km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 1 ♂, 09-X-2020, leg. A. Hausmann BC ZSM Lep 112069 (SNSB-ZSM), 1 ♂, 04-XI-2021, leg. A. Hausmann, BC ZSM Lep 115165 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAD2160; intra-BIN variation (maximum distance): 0.32%; nearest neighboring BIN: *Acleris cervinana* Fernald (2.62%).

Distribution in Italy: The presence of this species has been reported in northern and central Italy, absent in southern regions and Sicily. **New for Basilicata**.

Chorotype: European with Anatolian-Caucasian extension.

Acleris variegana ([Denis & Schiffermüller], 1775)

Records: Basilicata, Potenza, Fm Noce, Piano dei Peri/Trecchina, 290 m, 39.9914ºN-15.7939ºE, 1 ♂, 03-XI-2021, leg. A. Hausmann BC ZSM Lep 115157 (SNSB-ZSM), 1 ♀, 22-XI-2015, leg. A. Hausmann, BC ZSM Lep 91158 (SNSB-ZSM); Basilicata, Potenza, S. p. Mad. di Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 1 ♀, 04-XI-2021, leg. A. Hausmann, BC ZSM Lep 115161 (SNSB-ZSM); Basilicata, 3 km S Trecchina, Mte. S. Maria, 1035 m, 40.0038ºN-15.7682ºE, 1 ♂, 5-IX-2016, leg. A. Hausmann, BC ZSM Lep 59324 (SNSB-ZSM).

Genetic Data - Bin: BOLD:ACE3007; intra-BIN variation (maximum distance): 0.65%; nearest neighboring BIN: *Acleris variegana* (0.97%).

Distribution in Italy: Present in most regions.

Chorotype: Holarctic.

Acleris cristana ([Denis & Schiffermüller], 1775)

Records: Basilicata, Potenza, Fm Noce, Piano die Peri/Trecchina, 280 m, 39.9913ºN-15.7942ºE, 1 ♂, 04-XII-2022, leg. A. Hausmann, BC_ZSM_Lep_117055 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAF7935; intra-BIN variation (maximum distance): 0.96%; nearest neighboring BIN: unidentified *Acleris* species (3.94%).

Distribution in Italy: Distributed in various regions, not recorded from Sicily and Sardinia.

Chorotype: Asiatic-European.

Acleris ferrugana ([Denis & Schiffermüller], 1775)

Records: Calabria, Sila, Vivaio Sbanditi (CS), 1350 m, 39.3888ºN-16.6022ºE, 1♂, 27-X-2017, leg. S. Scalercio, LEP-SS-00828 (Coll. Trematerra).

Genetic data - Bin: BOLD:AAC3487; intra-BIN variation (maximum distance): 1.47%; nearest neighboring BIN: *Acleris cervinana* (2.81%).

Distribution in Italy: Reported mainly in northern regions, less so in central and southern regions, not recorded in Sicily.

Chorotype: Turanian-European.

**Acleris hippophaeana* (Heyden, 1865)

Records: Calabria, Rende, 205 m, 39.3675ºN-16.2282ºE, 1 ♂, 18-XII-2022, leg. S. Scalercio, LEP-SS-01432 (CREA-FL).

Genetic Data - Bin: BOLD:ABZ6730; intra-BIN variation (maximum distance): 1.83%; nearest neighboring BIN: *Acleris hastiana* (Linnaeus) (1.92%).

Distribution in Italy: Reported in northern regions, not recorded in Sicily and Sardinia. **New for Calabria**.

Chorotype: West-Palaearctic.

**Acleris hyemana* (Haworth, 1811)

Records: Calabria, Sellia, 470 m, 38.9886ºN-16.6218ºE, 2 ♀ (LEP-SS-01527; LEP-SS-01556), 12-III-2021, leg. S. Scalercio (CREA-FL).

Genetic Data - Bin: BOLD:AAD4495; intra-BIN variation (maximum distance): 0.81%; nearest neighboring BIN*:* *Acleris maximana* (Barnes & Busck) (3.56%).

Distribution in Italy: Collected in Veneto, Umbria and Latium. **New for Calabria**.

Chorotype: European.

Acleris kochiella (Goeze, 1783)

Records: Calabria, Simeri-Crichi, 425 m, 38.9567ºN-16.6489ºE, 1 ♂, 24-VII-2019, leg. S. Scalercio, LEP-SS-01575 (CREA-FL).

Genetic Data - Bin: BOLD:AAJ2884; intra-BIN variation (maximum distance): 0.83%; nearest neighboring BIN: *Acleris boscanoides* Razowski (2.09%).

Distribution in Italy: Present throughout Italy.

Chorotype: European.

Aleimma loeflingiana (Linnaeus, 1758)

Records: Calabria, 6 km S Cosenza, Pianete di Dipignano, 750 m 39.2303ºN-16.2497ºE, 1 ♂, 31-V-2016, leg. G. Posa, BC ZSM Lep 59330 (SNSB-ZSM); Calabria, Praia a Mare Ort, 10 m, 39.893ºN-15.783ºE, 1 ♀, 10-VI-2022, leg. A. Hausmann, BC_ZSM_Lep_116371 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC3136; intra-BIN variation (maximum distance): 0.97%; nearest neighboring BIN: *Tortrix viridana* Linnaeus (4.92%).

Distribution in Italy: Present throughout Italy.

Chorotype: West-Palaearctic.

Archipini

Clepsis consimilana (Hübner, [1817])

Records: Calabria, Cosenza, 1.5 km E Orsomarso F. Argentino, 140 m, 39.7946ºN-15.9234ºE, 1 ♂, 22-VIII-2018, leg. A. Hausmann, BC ZSM Lep 104289 (SNSB-ZSM); Basilicata, Piano dei Peri/ Trecchina, 280 m, 39.9913ºN-15.1938ºE, 1♀, 24-VIII-2014, leg. A. Hausmann, BC ZSM Lep 85021 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC4212; intra-BIN data (maximum distance): 1.93%; nearest neighboring BIN: *Clepsis siciliana* (Ragonot) (2.24%).

Distribution in Italy: Present in most regions.

Chorotype: Cosmopolitan.

**Clepsis dumicolana* (Zeller, 1847)

Records: Calabria, Marina di Tortora, F. Noce-Mdg., 10 m, 39.9248ºN-15.7607ºE, 1 ♂, 08-VI-2022, leg. A. Hausmann, BC ZSM Lep 116163 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAJ3885; intra-BIN variation (maximum distance): 0.17%; nearest neighboring BIN: *Clepsis davisi* Austin & Dombroskie (6.01%).

Distribution in Italy: Not reported in Basilicata, but widespread. **New for Calabria**.

Chorotype: South-European-Anatolian.

Pandemis heparana ([Denis & Schiffermüller], 1775)

Records: Calabria, Cosenza, 1.5 km E Orsomarso F. Argentino, 140 m, 39.7946°N-15.9234°E, 1 ♀, 22-VIII-2018, leg. A. Hausmann, BC ZSM Lep 104290 (SNSB-ZSM); Calabria, Sila, Lago Cecita, Longobucco, 1170 m, 39.3865ºN-16.552ºE, 1 ♀, 13-VIII-2014, leg. A. Hausmann, BC ZSM Lep 85009 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAA9254; intra-BIN variation (maximum distance): 1.47%; nearest neighboring BIN: *Pandemis heparana* (1.52%).

Distribution In Italy: Present in most regions of Italy, not recorded in Sicily and Sardinia.

Chorotype: Asiatic-European.

Cacoecimorpha pronubana (Hübner, [1799])

Records: Calabria, Praia a Mare, 10 m, 39.8933ºN-15.7827ºE, 2 ♂ (BC ZSM Lep 109540; BC ZSM Lep 109541), 20-VIII-2019, leg. A. Hausmann (SNSB-ZSM); Basilicata, Fm Noce, Piano dei Peri/Trecchina, 280 m, 39.991ºN-15.794ºE, 1 ♂, 11-X-2020, leg. A. Hasmann, BC ZSM Lep 112101 (SNSB-ZSM), 2 ♀ (BC ZSM Lep 85019; BC ZSM Lep 85028), 24-VIII-2014, leg. A. Hausmann, (SNSB-ZSM).

Genetic Data: BIN - BOLD:AAD3477; intra-BIN variation (maximum distance): 0.96%; nearest neighboring BIN: *Cacoecimorpha pronubana* (1.96%).

Distribution in Italy: Present throughout Italy.
Chorotype: Cosmopolitan.

Archips podana (Scopoli, 1763)
Records: Sicilia, 1 km NW Zafferana Etnea, 670 m, 37.7003ºN-15.1008ºE, 1 ♂, 25-VIII-2021, leg. A. Hausmann, BC ZSM Lep 114610 (SNSB-ZSM); Basilicata, Piano dei Peri/ Trecchina, 280 m, 39.9913ºN-15.1938ºE, 1 ♀, 24-VIII-2014, leg. A. Hausmann, BC ZSM Lep 85020 (SNSB-ZSM); Calabria, 3 km E Orosmarso, Fiume Argentino, 185 m, 39.7944ºN-15.9227ºE, 1 ♂, 27-VIII-2014, leg. A. Hausmann, BC ZSM Lep 85075 (SNSB-ZSM); Calabria, 6 km S Cosenza, Pianette di Dipignano, 750 m, 39.2303ºN-16.2497ºE, 1 ♂, 01-V-2015, leg. G. Posa, BC ZSM Lep 91882 (SNSB-ZSM).
Genetic Data - Bin: BOLD:AAB5839; intra-BIN variation (maximum distance): 2.96%; nearest neighboring BIN: unidentified Tortricidae species (1.28%).
Distribution in Italy: Present throughout Italy.
Chorotype: Palaearctic.

**Avaria hyerana* (Millière, 1858)
Records: Cosenza, Praia a Mare, 10 m, 39.8933ºN-15.7827ºE, 1 ♂, 08-XI-2021, leg. A. Hausmann, BC ZSM Lep 114901 (SNSB-ZSM).
Genetic Data - Bin: BOLD:AEH8576; intra-BIN variation (maximum distance): 0.32%; nearest neighboring BIN: *Avaria hyerana* (1.28%).
Distribution in Italy: Citations are only provided for Piedmont, Sicily, and Sardinia. **New for Calabria**.
Chorotype: Mediterranean.

Ditula angustiorana (Haworth, 1811)
Records: Calabria, Donnici, 550 m, 39.2577ºN-16.2857ºE, 1 ♂, 12-V-2014, leg. S. Scalercio, BC ZSM Lep 84831 (SNSB-ZSM).
Genetic Data - Bin: BOLD:AAA8699; intra-BIN variation (maximum distance): 1.99%; nearest neighboring BIN: *Dichelia atristrigana* Meyrick (7.76%).
Distribution in Italy: Present in most regions of Italy, not recorded Sicily.
Chorotype: W-Palaearctic.

Argyrotaenia ljungiana (Thunberg, 1797)
Records: Basilicata, Piano dei Peri/ Trecchina, 280 m, 39.9913ºN-15.1938ºE, 1 ♀, 24-VIII-2014, leg. A. Hausmann, BC ZSM Lep 85022 (SNSB-ZSM).
Genetic Data - Bin: BOLD:AAA2955; intra-BIN variation (maximum distance): 4.01%; nearest neighboring BIN: *Argyrotaenia velutinana* (Walker) (1.17%).
Distribution in Italy: Present in most regions of Italy, not recorded Sicily and Sardinia.
Chorotype: Holoarctic.

Syndemis musculana (Hübner, [1799])
Records: Calabria, 6 km S Cosenza, Pianete di Dipignano, 750 m, 39.2303ºN-16.2497ºE, 1 ♂, 31-V-2016, leg. G. Posa, BC ZSM Lep 94707 (SNSB-ZSM); Basilicata, Sirino NW, 2 km N Lagonegro, 1000 m, 40.1563ºN-15.7607ºE, 1 ♀, 04-VI-2023, leg. A. Hausmann, BC_ZSM_Lep_118622 (SNSB-ZSM).
Genetic Data - Bin: BOLD:ABY7128; intra-BIN variation (maximum distance): 0.96%; nearest neighboring BIN: *Syndemis musculana* (1.29%).
Distribution in Italy: Present in most regions of Italy, not recorded in Sardinia.
Chorotype: Asiatic-European.

Paramesia gnomana (Clerck, 1759)
Records: Basilicata, Potenza, Mt. Pollino, Spezzavummula, 1680 m, 39.9149ºN-16.1776ºE, 1 ♀, 13-VIII-2015, leg. A. Hausmann, BC ZSM Lep 91917 (SNSB-ZSM); Calabria, Mt. Pollino, 0.8 km SW Gipfel, 2000 m, 39.9012ºN-16.1811ºE, 2 exx. (1 ♀, BC ZSM Lep 101648; 1 ♂, BC ZSM Lep 101649), 09-VIII-2017, leg. A. Hausmann (SNSB-ZSM).

Genetic Data - Bin: BOLD:ACY8692; intra-BIN variation (maximum distance): 0%; nearest neighboring BIN: *Paramesia gnomana* (2.88%).

Distribution in Italy: Present in most regions of Italy.

Chorotype: Turanian-European.

Olethreutini

******Endothenia oblongana* (Haworth, 1811)

Records: Calabria, Cosenza, 1.5 km E Orsomarso F. Argentino, 140 m, 39.7946ºN, 15.9234ºE, 1 ♀, 22-VIII-2018, leg. A. Hausmann, BC ZSM Lep 104292 (SNSB-ZSM); Calabria, S. Domenica Talao, 5 km E Scalea, 240 m, 39.821ºN-15.783ºE, 1 ♀, 19-VIII-2013, leg. A. Hausmann BC ZSM Lep 78458 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC5902; intra-BIN variation (maximum distance): 1.18%; nearest neighboring BIN: *Endothenia gentianaeana* Hübner (1.63%).

Distribution in Italy: The species has been reported in northern and central Italy, including Sicily and Sardinia. **New for southern Italy**.

Chorotype: European.

Endothenia marginana (Haworth, 1811)

Records: Basilicata, Potenza, S. p. Mad. di Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 1 ♂, 09-VIII-2019, leg. A. Hausmann, BC ZSM Lep 109585 (SNSB-ZSM); Calabria, 3 km E Orosmarso, Fiume Argentino, 185 m, 39.7944ºN-15.9227ºE, 1 ♂, 27-VIII-2014, leg. A. Hausmann, BC ZSM Lep 85080 (SNSB-ZSM); Basilicata, Sirino NW, 2 km N Lagonegro, 1000 m, 40.1563ºN-15.7607ºE, 2 exx. (1 ♀, BC_ZSM_Lep_119162; 1♂, BC_ZSM_Lep_119164), 27-VIII-2023, leg. A. Hausmann (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC9535; intra-BIN variation (maximum distance): 1.12%; nearest neighboring BIN: unidentified *Endothenia* species (1.76%).

Distribution in Italy: Distributed in various regions.

Chorotype: Palaearctic.

**Endothenia ustulana* (Haworth, 1811)

Records: Basilicata, Potenza, Fm Noce, Piano dei Peri/Trecchina, 290 m, 39.991ºN-15.794ºE, 1 ♂, 11-VIII-2021, leg A. Hausmann, BC ZSM Lep 115141 (SNSB-ZSM).

Genetic Data - Bin: BOLD:ACE5169; intra-BIN variation (maximum distance): 0.53%; nearest neighboring BIN: *Endothenia gentianaeana* (1.12%).

Distribution in Italy: Reported only in some northern and central Italian regions, absent in Sicily and Sardinia. **New for Basilicata**.

Chorotype: Centralasiatic-European.

Endothenia gentianaeana (Hübner, [1799])

Records: Calabria, 2km S Aieta, 670 m, 39.9123ºN-15.8145ºE, 1 ♀, 04-IX-2023, leg. A. Hausmann, BC_ZSM_Lep_119172 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC5902; intra-BIN variation (maximum distance): 1.18%; nearest neighboring BIN: *Endothenia gentianaeana* (1.63%).

Distribution in Italy: Distributed in various regions.

Chorotype: Palaearctic.

Celypha lacunana ([Denis & Schiffermüller], 1775)

Records: Basilicata, Potenza, S. p. Mad. di Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 1 ♂, 31-VIII-2018, leg. A. Hausmann, BC ZSM Lep 104318 (SNSB-ZSM); Calabria, Cosenza, 3 km E Orosmarso, Fiume Argentino, 185 m, 39.7944ºN-15.9227ºE, 1 ♂, 27-VIII-2014, leg. A. Hausmann, BC ZSM Lep 85084 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC3531; intra-BIN variation (maximum distance): 1.85%; nearest neighboring BIN: *Celypha lacunana* (1.12%).

Distribution in Italy: Present in most regions, not recorded Sicily.

Chorotype: Asiatic-European.

Bactra lancealana (Hübner, [1799])

Records: Basilicata, Potenza, S. p. Mad. di Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN, 15.8018ºE, 2 exx. (1 ♀, BC ZSM Lep 104320; 1 ♂, BC ZSM Lep 104322), 31-VIII-2018 leg. A. Hausmann (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAB8686; intra-BIN variation (maximum distance): 1.69%; nearest neighboring BIN: *Bactra bactrana* (Kennel) (3.02%).

Distribution in Italy: Distributed in various regions.

Chorotype: Sub-Cosmopolitan.

**Bactra simpliciana* Chrétien, 1915 (Figure 1)

Records: Calabria, Marcellinara, 195 m, 38.9180ºN-16. 4961ºE, 1 ♂, 10-VI-2019, leg. S. Scalercio, (CREA-FL), dissected (gen.praep.: CREA-0259, figure 2).

Genetic Data - Bin: BOLD:ABX8158; intra-BIN variation (maximum distance): 1.61%; nearest neighboring BIN: *Bactra minima* Meyrick (3.69%).

Distribution In Italy: **New to the Italian fauna**.

Chorotype: Turanian-Mediterranean.

Figures 1-2. 1. Adult male of *Bactra simpliciana* Chrétien (Marcellinara, Calabria, Italy). **2**. Male genitalia of Bactra simpliciana Chrétien (Marcellinara, Calabria, Italy, CREA-0259).

Bactra bactrana **(**Kennel, 1901)

Records: Cosenza, Praia a Mare, 10 m, 39.8933ºN-15.7827ºE, 1 ♂, 08-XI-2021, leg. A. Hausmann, BC ZSM Lep 114911 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAL5788; intra-BIN variation (maximum distance): 0.16%; nearest neighboring BIN: *Bactra bactrana* (1.89%).

Distribution in Italy: Distributed in various regions, not recorded in Sardinia.

Chorotype: Sub-Cosmopolitan.

Bactra venosana (Zeller, 1847)

Records: Calabria, Praia a Mare Ort, 10 m, 39.8933ºN-15.7827ºE, 1 ♀, 17-VI-2022, leg. A. Hausmann, BC_ZSM_Lep_116370 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAL5788; intra-BIN variation (maximum distance): 0.16%; nearest neighboring BIN: *Bactra bactrana* (1.89%).

Distribution in Italy: Present in most regions.

Chorotype: Sub-Cosmopolitan.

**Lobesia virulenta* (Bae & Komai, 1991)

Records: Basilicata, Potenza, S. p. Mad. di Sirino, 3 km E Lagonegro, 1065 m, 40.1192ºN-15.8018ºE, 1 ♂, 31-VIII-2018, leg. A. Hausmann, BC ZSM Lep 104334 (SNSB-ZSM).

Genetic Data - Bin: BOLD:ACD8827; intra-BIN variation (maximum distance): 0.32%; nearest neighboring BIN: "*Lobesia virulenta*" (4.44%) the large split into two BINs requiring further integrative study.

Distribution in Italy: Trentino-Alto Adige is the only region for which data has been reported. **New for southern Italy**.

Chorotype: Asiatic-European.

Lobesia botrana ([Denis & Schiffermüller], 1775)

Records: Calabria, Praia a Mare Ort, 10 m, 39.8933ºN-15.7827ºE, 1 ♂, 20-VIII-2019, leg. A. Hausmann, BC ZSM Lep 109563 (SNSB-ZSM), 1 ♂, 10-VI-2022, leg. A. Hausmann, BC_ZSM_Lep_116373 (SNSB-ZSM).

Genetic Data - Bin: BOLD:ACH2178; intra-BIN variation (maximum distance): 1.7%; nearest neighboring BIN: *Lobesia reliquana* (Hübner) (4.15%).

Distribution in Italy: Present throughout Italy.

Chorotype: Cosmopolitan.

Olethreutes arcuella (Clerck, 1759)

Records: Calabria, 6km S Cosenza, Pianette di Dipignano, 750 m, 39.2303ºN-16.2497ºE, 1 ♂, 1-VI-2015, leg. G. Posa, BC ZSM Lep 91896 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC2510; intra-BIN variation (maximum distance): 0.64%; nearest neighboring BIN: *Phiaris palustrana* (Lienig & Zeller) (5.33%).

Distribution in Italy: Distributed in various regions, not recorded in Sardinia.

Chorotype: Centralasiatic-European.

Piniphila bifasciana (Haworth, 1811)

Records: Calabria, Sila, 1 km N Lg. Ariamacina, 1390 m, 39.3434ºN-16.5435ºE, 1 ♂, 25-VIII-2016, leg. A. Hausmann, BC ZSM Lep 94677 (SNSB-ZSM); 1 ♀, Calabria, Praia a Mare Ort, 10 m, 39.8933ºN-15.7827ºE, 08-VI-2023, leg. A. Hausmann, BC_ZSM_Lep_118627 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAC5440; intra-BIN variation (maximum distance): 2%; nearest neighboring BIN: *Olethreutes atrodentana* (Fernald) (4%).

Distribution in Italy: Distributed in various regions.

Chorotype: Palaearctic.

Gypsonoma aceriana (Duponchel, 1843)

Records: Calabria, Marina di Tortora, F. Noce-Mdg, 10 m, 39.9248ºN-15.7607ºE, 1 ♂, 08-VI-2022, leg. A. Hausmann, BC ZSM Lep 116160 (SNSB-ZSM).

Genetec data - Bin: BOLD:AAB0379; intra-BIN variation (maximum distance): 1.86%; nearest neighboring BIN: *Capua deuterastis* Meyrick (7.05%).

Distribution in Italy: Present in most regions.

Chorotype: West-Palaearctic.

Hedya nubiferana (Haworth, 1811)

Records: Basilicata, Mt. Sirino, 3 km E Lagonegro, 1065 m, 40.1192°N-15.8018°E, 1 ♂, 11-VI-2022, leg. A. Hausmann, BC ZSM Lep 116165 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAA4552; intra-BIN variation (maximum distance): 2.9%; nearest neighboring BIN: *Hedya pruniana* (Hübner) (5.61%).

Distribution In Italy: Present throughout Italy.

Chorotype: Holarctic.

Enarmoniini

Ancylis obtusana (Haworth, 1811)

Records: Basilicata, Sirino NW, 2 km N Lagonegro, 1000 m, 40.1563ºN-15.7607ºE, 1 ♀, 04-VI-2023, leg. A. Hausmann, BC_ZSM_Lep_118625 (SNSB-ZSM).

Genetic Data - Bin: BOLD:AAE1260; intra-BIN variation (maximum distance): 0.38%; nearest neighboring BIN: *Ancylis comptana* (Froelich) (4.33%).

Distribution in Italy: Distributed in various regions, not recorded in Sicily.

Chorotype: Holarctic.

Discussions and Conclusions

Despite the recent works concerning the family of Tortricidae in southern Italy (Baldizzone & Scalercio, 2018; Trematerra et al. 2018; Trematerra, 2019; Trematerra et al. 2023), these territories continue to reveal interesting novelties. The studies by Trematerra and colleagues have provided a comprehensive overview of the geological, biological and environmental characteristics of these regions, highlighting both the peculiarities and evolutionary dynamics of the territory. Nevertheless, new research and discoveries suggest that exploring different habitats will increase tortricid diversity of the region as yet experienced for Macrolepidoptera (Rijllo et al. 2024). These recent findings provide a basis for further scientific investigation and may contribute significantly to our overall understanding of the biodiversity and natural resources of southern Italy.

Acknowledgements

Research funded under the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.4 - Call for tender No. 3138 of 16 December 2021, rectified by Decree n.3175 of 18 December 2021 of Italian Ministry of University and Research funded by the European Union - NextGenerationEU; Project code CN_00000033, Concession Decree No. 1034 of 17 June 2022 adopted by the Italian Ministry of University and Research, CUP 83D21014060006, Project title "National Biodiversity Future Centre - NBFC". Research co-funded also by Agritech National Research Centre European Union NextGenerationEU (PIANO NAZIONALE DI RIPRESA E RESILIENZA (PNRR)-MISSIONE 4 COMPONENTE 2, INVESTIMENTO 1.4-D-D 1032 17/06/2022, CN00000022).

Conflict of Interest

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

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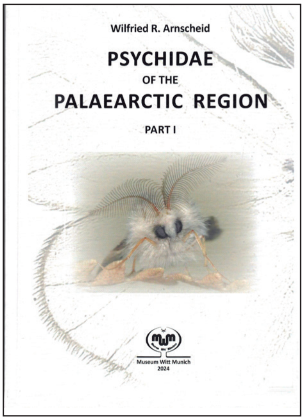
(Recibido para publicación / *Received for publication* 26-VI-2024)
(Revisado y aceptado / *Revised and accepted* 10-X-2024)
(Publicado / *Published* 30-IX-2025)

SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 624 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1097

REVISIÓN DE PUBLICACIONES
BOOK REVIEWS



W. R. Arnscheid
Psychidae of the Palaearctic Region Part I
475 páginas
Formato 30,5 x 21’0 cm
Museum Witt Munich, Munich, 2024
ISBN: 978-3-940732-63-7

Tenemos en nuestras manos, un interesante libro sobre la primera parte, de la fauna Paleártica de la familia Psychidae Boisduval, 1829, tratándose las subfamilias Placodominae Sauter & Hättenswiler, 1991, con la tribu Placodomini Sauter & Hättenswiler, 1991; Typhoniinae Lederer, 1853, con la tribu Typoniini Lederer, 1853 (en parte) y Oiketicinae Herrich-Schäffer, 1855, con las tribus Acanthopsychini Tutt, 1900, Metisini Dierl, 1971, Oreopsychini Tutt, 1900, Phalacropterigini Tutt, 1900 y Apteronini Tutt, 1900, dentro de la ya clásica serie Proceedings of the Museum Witt Munich, de la mano de nuestro estimado colega Wilfried R. Arnscheid, destacado especialista en esta familia.

Después de unas palabras del autor, le siguen los agradecimientos y un interesante capítulo histórico, sobre la historia natural de los Psychidae, sobre su biología, desde el huevo al adulto. La morfología y función del saco larvario, así como el procedimiento seguido para la dispersión y polifagia, sobre los parásitos y depredadores, sobre la pupa, seguido por un interesante capítulo sobre su ciclo biológico.

El siguiente capítulo, nos habla de la morfología del adulto, sobre la sistemática, filogenia; sobre la zoografía y su distribución; seguido por un interesante capítulo histórico con los más destacados especialistas de esta familia a lo largo de la historia como Boisduval, Millière, Bruand d’Uzelle, Zeller, Rambur, Hübner, Staudinger, Dalla Torre, Rebel, Wehrli, Leo Sieder, Ramón Agenjo, Bourgogne, Dierl, etc., seguida por una bibliografía específica.

Ya dentro de la parte principal de la obra, nos presenta una lista actualizada de las especies consideradas y de cada una de ellas, nos da una extensa explicación desde el género a la especie, con su diagnosis, distribución y datos bionómicos, con mapas donde podemos ver su distribución conocida.

Al final nos encontramos con dieciocho láminas con las fotografías, a todo color de los adultos y diez láminas de la genitalia de los machos, lamentablemente, las hembras no son consideradas, finalizando con un índice.

No podemos terminar estas líneas, sin fealicitar al autor por este extenso y detallado trabajo realizado a lo largo de tantos años (deseando ver pronto la segunda parte) y a la Editorial por la excelente presentación del libro y que continua con su excelente calidad, obra que no puede faltar en cualquier biblioteca que se precie. El precio de este libro es de 179 euros y los interesados lo pueden pedir a:

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SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 625-629 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1093 https://shilap.org
https://zoobank.org/746E77B0-3038-4F6A-97BC-9427F06433A3

First description on the female of *Crambus duospineus* Li, 2020 (Lepidoptera: Crambidae)

Jiaxin Wang, Hao Sun & Yunli Xiao

Abstract

The female of *Crambus duospineus* Li, 2020, collected from the Dabie Mountains National Nature Reserve in Hubei, China, is reported for the first time. Detailed description of its morphological characteristics is provided, along with the COI barcodes.

Keywords: Lepidoptera, Crambidae, *Crambus duospineus*, female, China.

Primera descripción de la hembra de *Crambus duospineus* Li, 2020 (Lepidoptera: Crambidae)

Resumen

Se presenta por primera vez la hembra de *Crambus duospineus* Li, 2020, recolectada en la Reserva Natural Nacional de las Montañas Dabie en Hubei, China. Se proporciona una descripción detallada de sus características morfológicas, junto con los códigos de barras COI.

Palabras clave: Lepidoptera, Crambidae, *Crambus duospineus*, hembra, China.

Introduction

Crambus is the type genus of Crambidae, with Curtis (1826) designating *Phalaena pascuella* Linnaeus, 1758 as the type species. Until now, 169 species have been known in *Crambus*, distributed worldwide (Nuss et al. 2003-2024), with 22 species recorded in China (Błeszyński & Collins, 1962; Błeszyński, 1965; Chen et al. 2005; Li, 2020). Among them, *Crambus duospineus* Li, 2020 was established based on two male specimens collected from Jiangxi Province, China. In this study, we reported the first record of the female specimen collected from the Dabie Mountains National Nature Reserve in Hubei, China, and provided DNA barcodes for both male and female specimens and reconstructed the phylogeny.

Material and Methods

The specimens in this study were collected by light traps in the Dabie Mountains National Nature Reserve in Hubei, China. Morphological terminology follows Nuss (2005). Genitalia were dissected and mounted according to the methods introduced by Li & Zheng (1996). Images of adults and genitalia were taken with a Canon EOS70D camera using an EF 180 mm F/3.5L USM lens and Nexcope NE930 microscope respectively. DNA was extracted from the legs of dry adult specimens using TINAamp Genomic DNA Kit (DP304). The 658 bp barcode region of COI was amplified with the LepF1 and LepR1 primers (Hajibabaei et al. 2006). PCR products were sent to Tianyi Huayu Gene (Wuhan, China, https://www.tyhygene.com/) for sequencing by using the aforementioned primers. Genetic distance estimation and neighbor-joining analysis were both conducted in MEGA 11 using the Kimura 2-Parameter model, with 5000 replications of bootstrap (Tamura et al. 2021). Two COI sequences of *Crambus duospineus* Li, 2020 were sequenced from female and male specimens respectively in this time. The 13 sequences from 7 species of *Crambus* species were selected as ingroups, one sequence of *Chilo infiuscatellus* Snellen, 1890 as outgroup, were downloaded from Bold Systems (https://www.boldsystems.org/), and the last few number of the name is Sample ID or Genbank Accession Number.

Specimens are deposited in the Biological Specimen Museum of Huanggang Normal University (HNU), Hubei, China.

Crambus duospineus Li, 2020 (Figures 1-5)
Crambus duospineus Li, 2020, *SHILAP Revta. lepid., 48*(192), 603-604, figs 1-4
Type locality: CHINA, Jiangxi Province, Wugong Mountain, 27º27'N 114º11'E, 1800 m.

Material examined: CHINA, Hubei Province, Yingshan County, Dabie Mountains National Nature Reserve, Wujiashan, Shigusi [31º6'45"N 115º47'59"], 793 m, 2 ♂, 4-IX-2022, Jiaxin Wang & Peng Yu, genitalia slide no. Lep3061♂, Lep3594♂, genBank accession no. PP726883♂. Hubei Province, Yingshan County, Dabie Mountains National Nature Reserve, Wujiashan, Main Peak of Tiantangzhai, [31º6'11"N 115º46'21"E], 1549 m, 1 ♂, 3 ♀ 6-IX-2022, Jiaxin Wang & Peng Yu, genitalia slide no. Lep2311♀, Lep3595♀, Lep3596♀, genBank accession no. PP726884♀.

Redescription. Adult (Figure 1): Forewing length 10.5-11.0 mm. Frons and vertex ochre yellow. Labial palpus twice as long as diameter of compound eye, ocherous mixed with pale brown except white basally; first and second segments porrect, third segment slightly downward. Maxillary palpus slightly upright, white at base, ochre yellow mixed with pale yellow ventrally. Antenna with scape dorsally white; flagellum dorsally white, ventrally ochre yellow. Thorax blackish brown. Forewing mixed with pale brown and ochre yellow scales; longitudinal stripe white and lined with brown, extending from base to apical part of distal cell, with basal two-thirds gradually broadened and distal third narrowed to triangular apex; cilia pale brown. Hindwing greyish brown; cilia white. Abdomen pale brown. Legs ochre yellow.

Male genitalia (Figures 2-3): Description of the male genitalia was provided by Li (2020).

Female genitalia (Figures 4-5): Antrum strongly ossified, sharply bent downwards at middle; extending upwards posteriorly, forming a clasp-like large, ossified plate; ostium bursae small, slanting downwards. Ductus bursae thin and short; anterior half membranous; posterior half ossified, with distinct ossified longitudinal ridges; ductus seminalis emerged at base of longitudinal ridge. Corpus bursae large, nearly circular, with diameter as long as ductus bursae; signum in pair near posterior one-fourth of corpus bursae.

Remarks: The morphological characteristics of the male specimens in this study were basically consistent with holotype in Li (2020), with only slight individual variations, such as the uncus being slightly longer than the gnathos. Additionally, the genetic distance of the COI sequences between male and female was 0 in this study (figure 6), which confirmed that the female specimen belonged to this species.

Distribution: China (Jiangxi, Hubei).

Acknowledgments

Thanks very much to Professor Weichun Li from Jiangxi Agricultural University for encouraging the publication of this research. This study was supported by the National Science & Technology Fundamental Resources Investigation Program of China (2019FY101800).

Conflict of interest

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

Figures 1-5. *Crambus duospineus* Li, 2020: **1**. Female adult. **2**. Male genitalia. **3**. Female genitalia. **4**. Apex of sacculus. **5**. Signum.

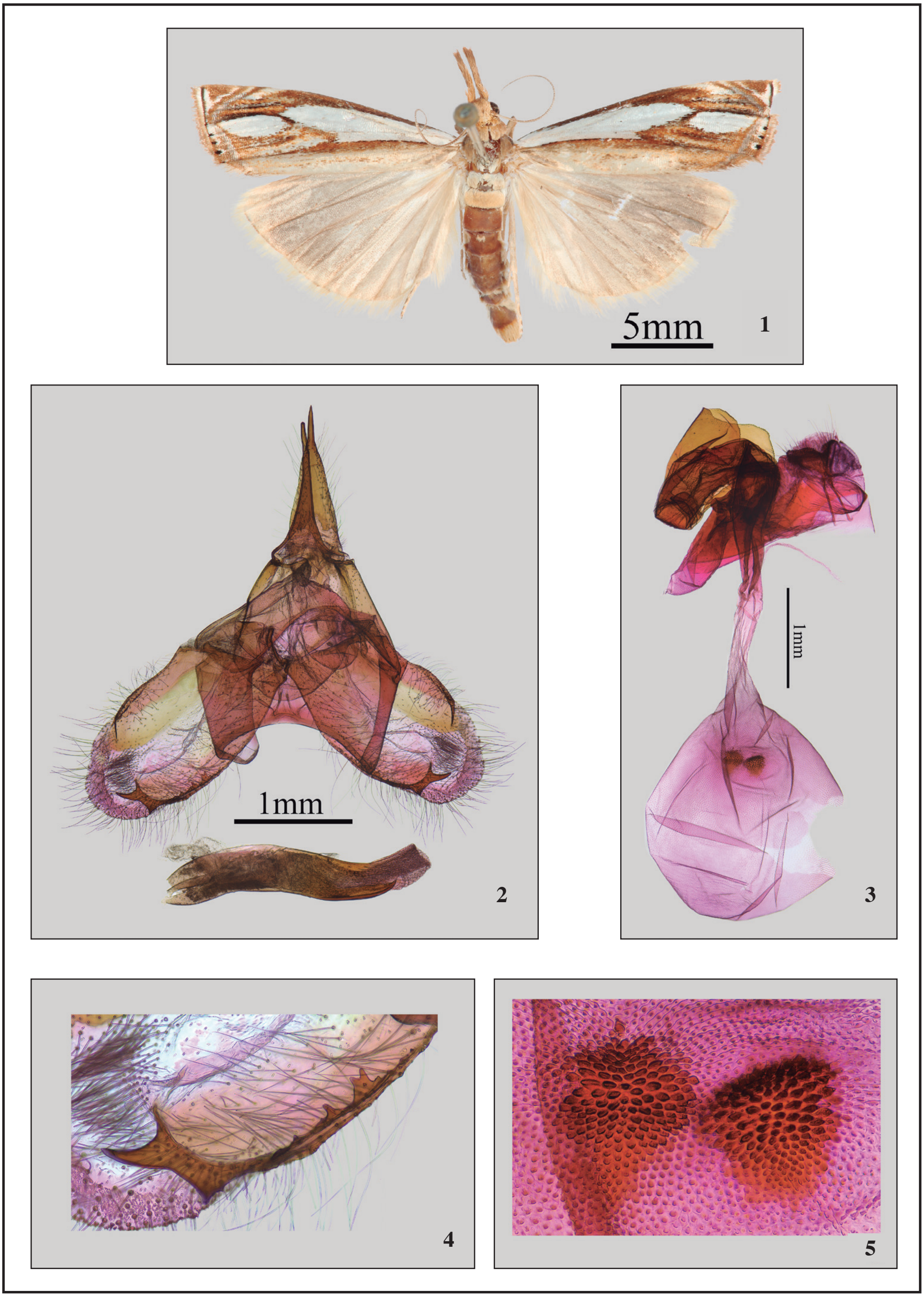
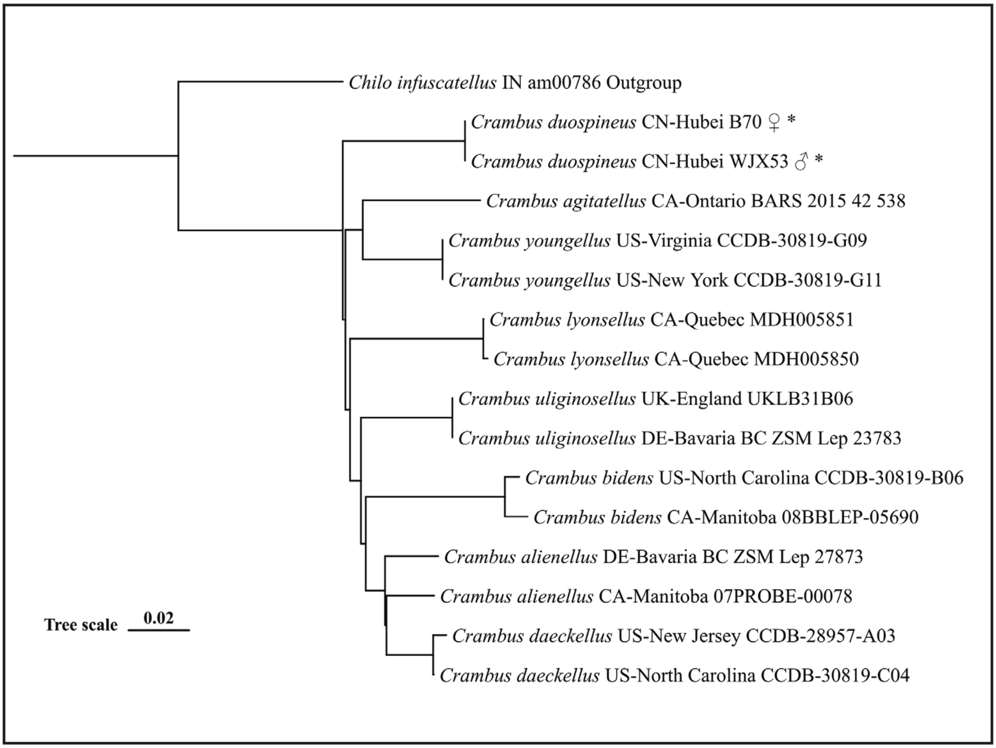


Figura 6. Phylogenetic tree (NJ tree) of some *Crambus* species based on COI sequences, with the genus *Chilo* as outgroup, the specimens marked with * are collected in this time, and the last few numbers is Sample ID or Genbank Accession Number.



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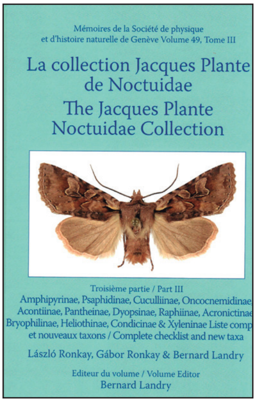
(Recibido para publicación / *Received for publication* 20-IX-2024)
(Revisado y aceptado / *Revised and accepted* 31-X-2024)
(Publicado / *Published* 30-IX-2025)

SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 630 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1099

REVISIÓN DE PUBLICACIONES
BOOK REVIEWS

L. Ronkay, G. Ronkay & B. Landry
La collection Jacques Plante de Noctuidae. Troisième partie
275 páginas
Formato 29,2 x 20’5 cm
Heterocera Press, Budapest, 2024
ISBN: 978-615.5279-12-6


Mémoires de la Société de physique
et d'histoire naturelle de Genève Volume 49, Tome III
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de Noctuidae
The Jacques Plante
Noctuidae Collection
Troisième partie / Part III
Amphipyrinae, Psaphidinae, Cuculliinae, Oncocnemidinae
Acontiinae, Pantheinae, Dyopsinae, Raphiinae, Acronictina
Bryophilinae, Heliothinae, Condicinae & Xyleninae Liste comp
et nouveaux taxons / Complete checklist and new taxa
László Ronkay, Gábor Ronkay & Bernard Landry
Editeur du volume / Volume Editor
Bernard Landry

Tenemos en nuestras manos, la tercera y última parte de esta interesante serie sobre la colección de Noctuidae de Jacques Plante (1951-2023), como un suplemento de las Mémoires de la Société de physiques et d’Histoire naturelle de Genève, siendo el volumen 49(3), tratándose especies de las 13 subfamilias consideradas, a saber: Amphipyrinae, Psaphidinae, Cuculiinae, Oncocnemidinae, Acontiinae, Pantheinae, Dyopsinae, Raphiinae, Acronictinae, Bryophilinae, Heliothinae, Condicinae y Xyleninae.

La colección de Jacques Plante es muy interesante para el estudio de la fauna lepidopterológica de la región occidental del Himalaya, Nepal y Bengala, además de la que podemos encontrar en el Atlas marroquí, Asia Menor, Irán, Afganistán, el sur del Tíbet, el norte de Indochina (parte continental del Sudeste Asiático), Japón y Taiwán, así como de la región biogeográfica de la Sonda (Sondalandia) y Wallacea (repartida entre Indonesia y Timor Oriental).

En este volumen se reconocen 2.299 especies y subespecies de 535 géneros y subgéneros pertenecientes a 13 subfamilias, basándose en el estudio de más de 30.000 ejemplares. Se describen un nuevo género *Pougetergis* y tres nuevos subgéneros *Bassicosmia*, *Droueticosmia* y *Sugicosmia*. Se revisa el estatus de nueve taxones, que pasan a género y se rehabilita a *Usbeca* Püngeler, 1914, como subgénero de *Mycteroplus* Herrich-Schäffer, 1850. Se elevan al rango de especie a cinco taxones; al igual que se considera la rehabilitación con el rango específico a 11 taxones y al rango subespecífico a 14 taxones. Se establecen 8 nuevas sinonimias y 6 nuevas combinaciones, revisándose 3 nuevas combinaciones. consideradas.

Ya dentro de la parte sistemática del trabajo, nos presentan una lista detallada de todas las especies consideradas, desde la subfamilia hasta la especie, incluyendo una adenda con los Noctuinae y Hadeninae que no se incluyeron en el volumen 1, todas ellas representadas en 170 láminas a todo color finalizando la obra con la descripción de los nuevos taxones en cuatro páginas con tres láminas de la genitalia macho y hembra, finalizando con una específica bibliografía y un índice.

No podemos terminar estas líneas, sin felicitar a los autores por este nuevo excelente trabajo realizado y que continuarán con el estudio de esta extraordinaria colección que nos dará nuevos e interesantes descubrimientos científicos, así como a la Editorial por la excelente presentación del libro y que continua con su excelente calidad, obra que no puede faltar en cualquier biblioteca que se precie. El precio de este libro es de 147 euros y los interesados lo pueden pedir a:

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SHILAP Revista de lepidopterología, 53 (211) septiembre 2025: 631-636 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1094 https://shilap.org
https://zoobank.org/45D2E0A7-CC92-4653-99E5-578C0D54957A

Batrachedra olei Falck, sp. nov. from the Canary Islands, Spain (Lepidoptera: Batrachedridae)

Per Falck

Abstract

Batrachedra olei Falck, sp. nov. is described based on specimens from La Gomera, Canary Islands, Spain. Adults, male and female genitalia are figured. DNA barcodes are analyzed. A differential diagnosis from the similar *B. parvulipunctella* Chrétien, 1915 is given. For comparison the male and female genitalia of *B. parvulipunctella* are figured.

Keywords: Lepidoptera, Batrachedridae, new species, DNA barcodes, Canary Islands, Spain.

Batrachedra olei Falck, sp. nov. de las Islas Canarias, España (Lepidoptera: Batrachedridae)

Resumen

Se describe *Batrachedra olei* Falck, sp. nov. a partir de ejemplares de La Gomera, Islas Canarias, España. Se ilustran los adultos y la genitalia del macho y de la hembra. Se analizan los códigos de barras de ADN. Se ofrece un diagnóstico diferencial con *B. parvulipunctella* Chrétien, 1915. A efectos comparativos, se muestran la genitalia del macho y de la hembra de *B. parvulipunctella*.

Palabras clave: Lepidoptera, Batrachedridae, nueva especie, ADN código de barras, Islas Canarias, España.

Introduction

The family Batrachedridae Heinemann & Wocke, 1876 comprises 10 genera (Nieukerken et al. 2011, p. 215), of which the most species rich genus is *Batrachedra* Herrich-Schäffer, 1853 with about 114 known species worldwide. It is recorded from all continents except Antarctic. Seven species are known from Europe and North Africa (Savela, 2024). During field work in La Gomera in 2021 the author collected three specimens of a *Batrachedra* species believed to belong to *B. parvulipunctella* Chrétien, 1915. Dissection of the genitalia and barcoding revealed an undescribed species dealt with in the present paper. The genus *Batrachedra* is recorded from the Canary Islands for the first time (Vives Moreno, 2014, p. 134).

Abbreviations used

PF Collection of Per Falck, Neksø, Denmark
MNCN Collection of Antonio Vives, Museo Nacional de Ciencias Naturales, Madrid, Spain

Material and methods

All of the specimens were collected by the author and attracted to actinic light.

Male and female genitalia were dissected and prepared following Robinson (1976).

Adults were photographed with a Canon EOS 700D camera equipped with a Canon EF 100 mm objective.

The genitalia slides were photographed using a Soptop CX40T Trinocular microscope in conjunction with a Toup Tek P10500AE3 / E3ISPM05000KPA-E3 / 5.0MP USB3 camera.

The author examined the morphology and the DNA barcodes from the new species. DNA samples were prepared as described by Falck & Karsholt (2023, p. 271). Details of successfully sequenced voucher specimens are publicly available through the dataset DS-BATACAN at www.boldsystems.org. and at dx.doi.org/10.5883/BS-BATACAN.

***Batrachedra olei* Falck, sp. nov.** (Figures 1, 2, 3, 3a, 5)

https://zoobank.org/45D2E0A7-CC92-4653-99E5-578C0D54957A

Holotype ♂: Spain, La Gomera, Hermigua, 250 m, 24-X-12-XI-2023, genitalia slide 3643PF, leg. P. Falck (MNCN).

Paratypes: Spain, La Gomera, Hermigua, 250 m, 2 ♂, 1 ♀, 9-12-VIII-2021, leg. P. Falck, DNA samples Lepid Phyl 0921PF/CILEP920-21, 0922PF/CILEP921-21, 0923PF/CILEP922-21, same data but 2 ♂, 2 ♀, 24-X-12-XI-2023, leg. P. Falck, genitalia slides 3642PF, 3644PF, 4123PF, same data but 2 ♂, 1 ♀, 9-23-III-2024, leg. P. Falck, genitalia slides 4120PF, 4121PF, same data but 1 ♀, 27-VIII-13-IX-2024, leg. P. Falck (PF); Tamargada, 450 m, 13 ♂, 6 ♀, 27-VIII-13-IX-2024, leg. P. Falck (MNCN, PF); La Caleta, 330 m, 8 ♂, 1 ♀, 27-VIII-13-IX-2024, leg. P. Falck (PF).

Diagnosis: *B. olei* resembles several yellowish ochreous *Batrachedra* species and especially *B. parvulipunctella* Chrétien, 1915. It differs from most species by the two longitudinal dark streaks bordering the cell and the lack of distinct black dots, which are characteristic in many species e. g. *B. pinicolella* (Zeller, 1839). It differs from *B. parvulipunctella* by the pure white head and neck. In the male genitalia *B. olei* is characterized by the moderately pointed gnathos, the short anellus lobes and the long straight, apically bent phallus. In *B. parvulipunctella* (Figures 4, 4a) the anellus lobes are longer and the phallus is slightly and evenly bent. In the female genitalia *B. olei* is characterized by the sclerotized, funnel-shaped structure in the antrum and the membranous posterior half of ductus bursae. In *B. parvulipunctella* (Figure 6) the sclerotized structure in antrum is arrow-shaped and slightly bent and the posterior, membranous part of ductus bursae is shorter. Adults and the genitalia of *B. parvulipunctella* are figured by Koster & Sinev (2003).

Description. Adult (Figures 1, 2): Wingspan 7.5-12.5 mm. Labial palp slender, upturned; segment 2 white, ventrally with raised scales which are mottled with a few grey scales; segment 3 slightly shorter than segment 2, white mottled with few grey scales. Scapus white. Antenna yellowish brown, in apical third irregularly ringed with grey. Head and neck pure white. Thorax white, laterally yellowish ochreous. Tegula yellowish ochreous. Forewing yellowish ochreous mottled with grey scales, more densely on costa; two indistinct, longitudinal streaks, one just below and one just above the cell; sometimes a small, distinct spot at the end of the cell; fringe yellowish grey. Hindwing shining yellowish grey. Abdomen yellowish grey.

Variation: There is some variation in the wingspan and the amount of grey mottling of the forewing.

Male genitalia (Figures 3, 3a): Uncus long and pointed. Gnathos as long as uncus, tip slightly pointed. Tegumen elongate. Valva simple, tapering and slightly upwardly bent; apex relatively pointed. Anellus lobes elongate and broad. Phallus longer than valva, straight, apically at ¾ bent.

Female genitalia (Figure 5): Papillae anales membranous, pointed posteriorly, covered with short setae. Posterior apophysis almost as long as anterior apophysis. Antrum weakly sclerotized, funnel-shaped, inside with a sclerotized, funnel-shaped structure posteriorly with an irregular margin. Ductus bursae narrow, membranous, spiculate in anterior half. Corpus bursae oval, membranous. Signum an oval weakly sclerotized plate, almost the same length as corpus bursae, covered with rows of sclerotized ridges.

DNA barcodes: We obtained full length DNA barcode (658 bp) from two specimens and DNA barcode fragments of 624 bp from one specimen. The barcodes fall within Barcode Index Number (BIN) BOLD: AEN1162. The maximum intraspecific p-distance is 0%. The minimum p-distance to nearest neighbor, an unnamed *Batrachedra* species from South Africa, is 3.21 %. The minimum divergence to *B. parvulipunctella* is 5.84%.

Biology: The early stages are unknown. The adults were collected at light from January to the beginning of November.

Distribution: Known only from the northern part of the island of La Gomera, Spain. Probably endemic to La Gomera.

Etymology: The species is dedicated to the Danish lepidopterist and my good friend Ole Karsholt.

Discussion

The larvae of the European *Batrachedra*-species are miners or live in seeds, catkins or buds, however, *B. parvulipunctella* lives in a silky case, and it is feeding on the waxy secretions of coccids, which have colonies on *Phragmites australis* (Cav.) Trin. ex. Steud. or *Arundo donax* L. (Koster & Sinev, 2003).

As stated, above *B. olei* is probably endemic to the Canary Islands, although it cannot be ruled out that the species is introduced by man and now have become established. However, the present study did not reveal any species corresponding with *B. olei* either in adult/genital morphology or in DNA barcodes.

Acknowledgements

I am grateful to Ole Karsholt (Natural History Museum of Denmark, Copenhagen) who read the final manuscript and improved both the English language and the content; Javier Gastón (Bilbao, Spain), for the photographic review and adjustments, and finally I am moreover grateful to Dr. Antonio Vives (Madrid, Spain) for translating the abstract into Spanish, for editing my manuscript, and for his kind help with obtaining permission to collect Lepidoptera in the Canary Islands into the Scientific Project of SHILAP.

Conflit of Interest

The authors declare that there are no known financial interest or personal relationships that could influence the work presented.

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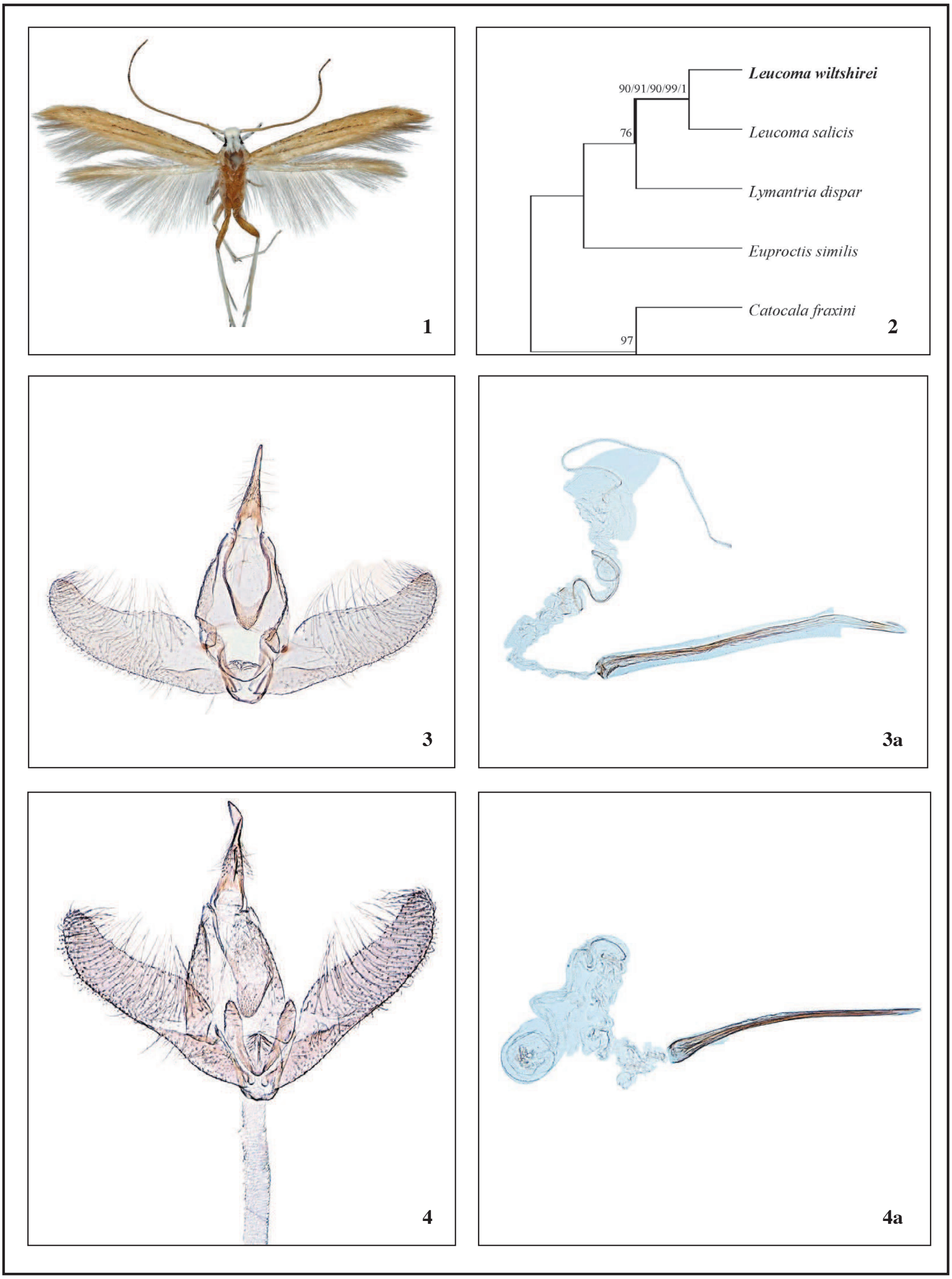
(Recibido para publicación / *Received for publication* 9-X-2024)
(Revisado y aceptado / *Revised and accepted* 15-XII-2024)
(Publicado / *Published* 30-IX-2025)

Figures 1-4. 1. *Batrachedra olei* Falck, sp. nov., ♂, La Gomera, 11.5 mm. **2.** *Batrachedra olei* Falck, sp. nov., ♀, La Gomera, 12 mm. **3.** *Batrachedra olei* Falck, sp. nov., ♂ genitalia, La Gomera, GP4120PF. **3a.** *Batrachedra olei* Falck, sp. nov., ♂, phallus, GP4121PF. **4.** *Batrachedra parvulipunctella* Chrétien, 1915, ♂ genitalia, Italy, GP4141ZM. **4a.** *Batrachedra parvulipunctella* Chrétien, 1915, ♂, phallus, GP4141ZM.



Figures 5-6. 5. *Batrachedra olei* Falck, sp. nov., ♀ genitalia, La Gomera, GP4123PF. **6.** *Batrachedra parvulipunctella* Chrétien, 1915, ♀ genitalia, France, GP4142ZM.