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New species and new records of *Coleophora* Hübner, 1822 from Spain (Lepidoptera: Coleophoridae)

Ignác Richter & Jan Šumpich

Abstract

A new species of Coleophoridae, *Coleophora inconspicua* Richter & Šumpich, sp. nov., is described from rocky habitat near Albarracín (Teruel) in Spain. *Coleophora afrodianthi* Tabell, 2023, until recently confused with *C. dianthi* Herrich-Schäffer, [1855], is recorded from Europe for the first time. Photographs of adults, as well as photos of their genitalia and abdominal segment, are provided for both species.
Keywords: Lepidoptera, Coleophoridae, *Coleophora afrodianthi*, *Coleophora inconspicua,* Spain.

Nuevas especies y nuevos registros de *Coleophora* Hübner, 1822 en España (Lepidoptera: Coleophoridae)

Resumen

Se describe una nueva especie de Coleophoridae, *Coleophora inconspicua* Richter & Šumpich, sp. nov., procedente de un hábitat rocoso cerca de Albarracín (Teruel), en España. *Coleophora afrodianthi* Tabell, 2023, hasta hace poco confundida con *C. dianthi* Herrich-Schäffer, [1855], se registra por primera vez en Europa. Se proporcionan fotografías de los adultos, así como fotos de sus genitales y segmento abdominal, de ambas especies.
Palabras clave: Lepidoptera, Coleophoridae, *Coleophora afrodianthi*, *Coleophora inconspicua,* España.

Introduction

Coleophoridae research has a long history on the Spanish mainland. In the 1980s, entomologists began to pay more attention to the fauna of Coleophoridae, among them Dr. Antonio Vives (Madrid, Spain) and Dr. Giorgio Baldizzone (Asti, Italy), who made the most important contributions. The first review of Spanish Coleophoridae was published by Agenjo (1965), followed by Vives Moreno (1987, 1994, 2014). In 1965, 126 species of Coleophoridae were known from Spain (Agenjo, 1965); by 1987, this number increased to 205 (Vives Moreno 1987), ultimately reaching 254 species in 2014 (Vives Moreno, 2014). Since then, the number of species known from Spain has continued to increase, with many new faunistic records having been made in the country (e. g. Laštůvka & Laštůvka, 2017, 2020; Gastón, 2024), and several new species having been described (Baldizzone 2019a, 2023; Tabell 2013, 2017). Considering that 280+ species of Coleophoridae are known from countries with comparable Lepidopteran diversity, such as France and Italy (Nel, 2001; Baldizzone. 2019b), one can expect more discoveries to be made in Spain in the future. In this paper, we report first records of two more *Coleophora* species, one of which is described as a new species to science: *C. inconspicua* sp. nov.

Material and methods

Study material collected by the second author was attracted via ultraviolet light (8W/12V tubes) installed in portable light traps.

Pinned specimens were photographed using a Canon 750D camera fitted with a Canon MP-E-65 mm lens (J. Šumpich). Preparations of genitalia (in glycerol) were photographed using a Bresser MikroCam II 12MP camera mounted to a BIM stereomicroscope (Ig. Richter), as well as a Canon EOS 200D DSLR camera mounted to an Olympus CX-31 stereomicroscope (J. Šumpich). For each photograph, sets of 20-40 images were taken at different focal planes and focused-stacked using Helicon Focus 6, with the final image edited in Adobe Photoshop CS5.

The holotype of *Coleophora inconspicua* Richter & Šumpich, sp. nov. was barcoded at the Canadian Centre for DNA Barcoding (CCDB, Biodiversity Institute of Ontario, University of Guelph). DNA was isolated from a dry specimen leg. Barcoding using conventional primers failed, but it is expected that barcoding will be repeated in the future using primers on older or degraded material to allow comparison of the genetic information of the new species with the existing DNA library.

This study is based on material from the following collections:

NMPC	National Museum of the Czech Republic, Prague, Czech Republic
IGR	Research collection of Ignác Richter, Malá Čausa, Slovakia

Results

Coleophora inconspicua Richter & Šumpich, sp. nov.

https://zoobank.org/20BE2197-38AD-460C-BFBD-B4FD5296876A

Material examined: Holotype ♂, Spain, Aragon Region, Albarracín env., 40º26'08"N, 01º25'34"W, 1100 m, 3-V-2003, Jan Šumpich leg. (gen. prep. 23484 Ig. Richter; photo 25039 J. Šumpich; DNA Barcode NMPC-LEP-1925 [failed] (NMPC).

Diagnosis: *Coleophora inconspicua* sp. nov. is a sister species of the recently described *Coleophora dikeratella* Tabell & Kullberg, 2023, from which it can be distinguished mainly by its monochromatic brown antennae (*C. dikeratella* has white ringed antennae) and the length of the costal stripe, which in *C. inconspicua* sp. n. spans from the base of the forewing to 1/3 of its length (as opposed to 2/3 of its length in *C. dikeratella*). The male genitalia of both species are similar in structure, but in *C. inconspicua* sp. nov. the ventral process of the sacullus is stouter, only slightly bent and with an even taper distally; the cucullus is slightly narrower, the tegumen slightly shorter and wider at the base, and the vesica has a cornutus. *Coleophora inconspicua* sp. n. may somewhat resemble *C. internitens* Baldizzone & van der Wolf, 1999, which was described from southern Spain, especially in the structure of the male genitalia. However, in *C. internitens*, the dorsal process is nearly at a right angle to the ventral process, whereas in *C. inconspicua* sp. nov., both processes protrude from the sacculus parallelly (Baldizzone & van der Wolf 1999).

Description: Adult (Figures1-2). Wingspan 10.0 mm. Antenna brown, with an admixture of fine white scales, scape brown. Labial palpus white dorsally, brown ventrally, second segment 1.5x longer than the third. Head, thorax, and tegulae brown. Forewing lanceolate, brown, covered in dark brown and whitish scales. Costal streak thin, white, from base to 1/3 of the forewing. Cilia light grey-brown. Hindwing light grey, cilia concolorous.

Male genitalia (Figures 3-4): Spinose part of gnathos oval. Tegumen short, greatly expanding proximally. Cucullus narrow, elongate, club-shaped, slightly tapered basally. Sacculus broad with two distinct, strongly sclerotized processes: dorsal much wider than ventral, rectangular, with a small tooth in the centre of the distal edge, apically pointed; ventral process slightly longer than dorsal, slightly bent and evenly tapering, pointed distally. Phallus with two robust rods, the longer terminating in a conical point, the other hook-shaped apically. Vesica with cornutus in the shape of an arrowhead encased in a sclerotized oval.

Abdominal structures (Figure 5). No posterior lateral struts: transverse strut slightly curved, strongly sclerotized on proximal margin. Tergal sclerite 3x as long as it is wide, with 22-24 small conical spines (3rd tergite).

Female: unknown.

Biology: Host plant unknown. Adults were collected in rocky steppe habitat in early May, at altitudes of 1100 m (Figure 6).

Distribution: Spain.

Etymology: The species name is derived from the Latin *inconspicuus* (= inconspicuous), a reference to the small wingspan of this species in nature that has so far caused it to be overlooked.

Coleophora afrodianthi Tabell, 2023

Material examined: SPAIN, Almería, Sierra de Alhamilla, route Turrilas - Pico Colativi, 37º0’13.489”N, 2º17’14.371”W, 7 ♂, 1 ♀, 15-16-VI-2007, J. Šumpich & M. Dvořák leg. (gen. prep. 19510, 23468, 23474, 23475 Ig. Richter; photo 25012, 25013 J. Šumpich) (NMPC, IGR); Sierra Cabrera, Mojacar env., El Agua del Medio, 37º4’31.772”N, 1º51’18.873”W, 0-150 m, 3 ♂, 4-V-2008, J. Šumpich leg. (gen. prep. 23469, 23515 Ig. Richter; gen. prep. 25013 J. Šumpich) (NMPC).

Biology: unknown. Tabell et al. (2023) assume the development of caterpillars on *Dianthus* sp., which occurs at the type locality. The Spanish sites have the character of xerothermic steppe in the Sierra de Alhamilla (Almería) (Figure 14) and dry riverine habitat in the Sierra de Cabrera (Almería).

Distribution: Morocco, Spain (first records). **First report for Europe**.

Remark: This species was recently separated from the widely distributed *C. dianthi* by Tabell (Tabell et al. 2023) based on minor differences in the genitalia of both sexes and supported by DNA analysis. The distance to the nearest neighbour, *C. dianthi*, is 2.18% (p-dist).

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Conflict of interests

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

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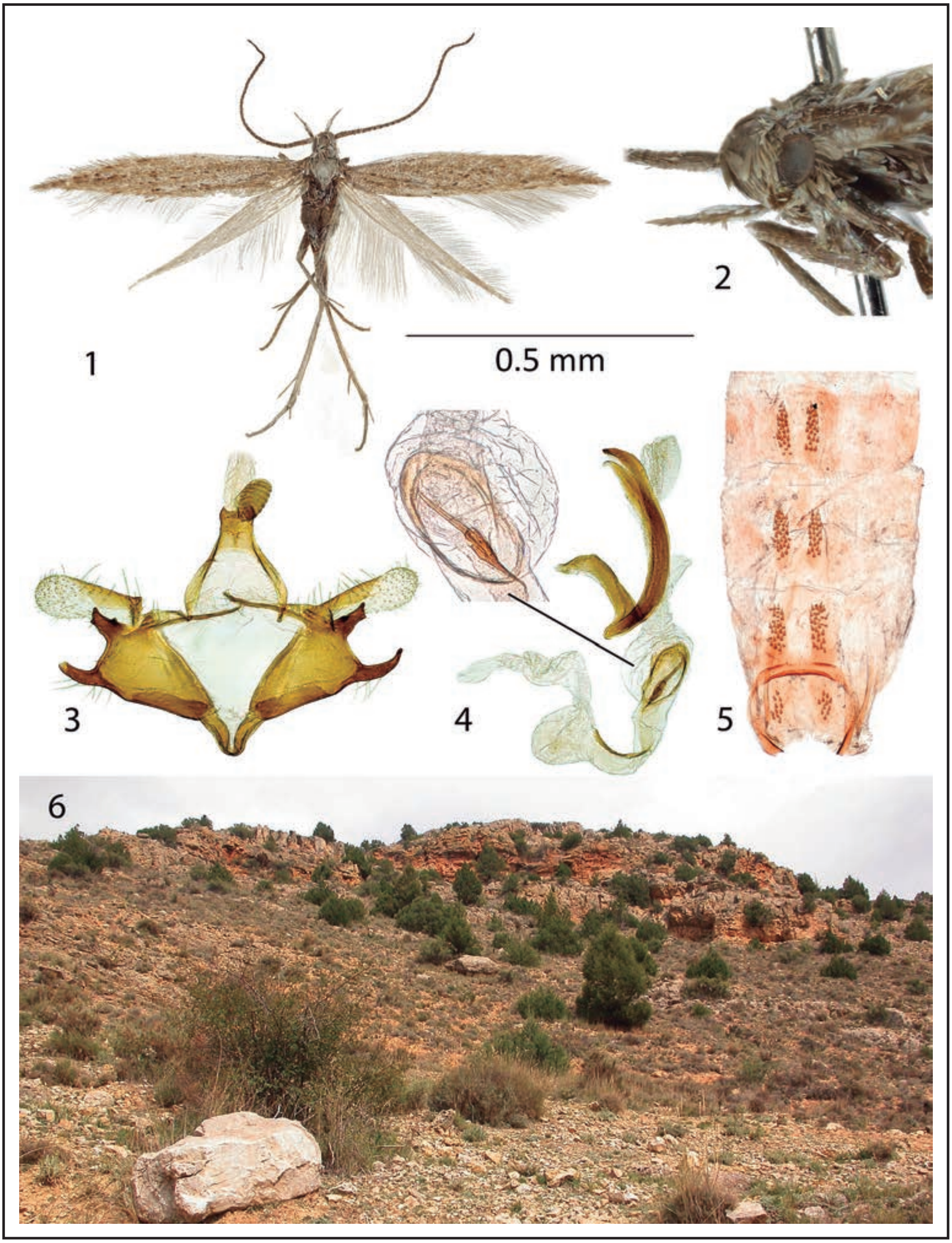

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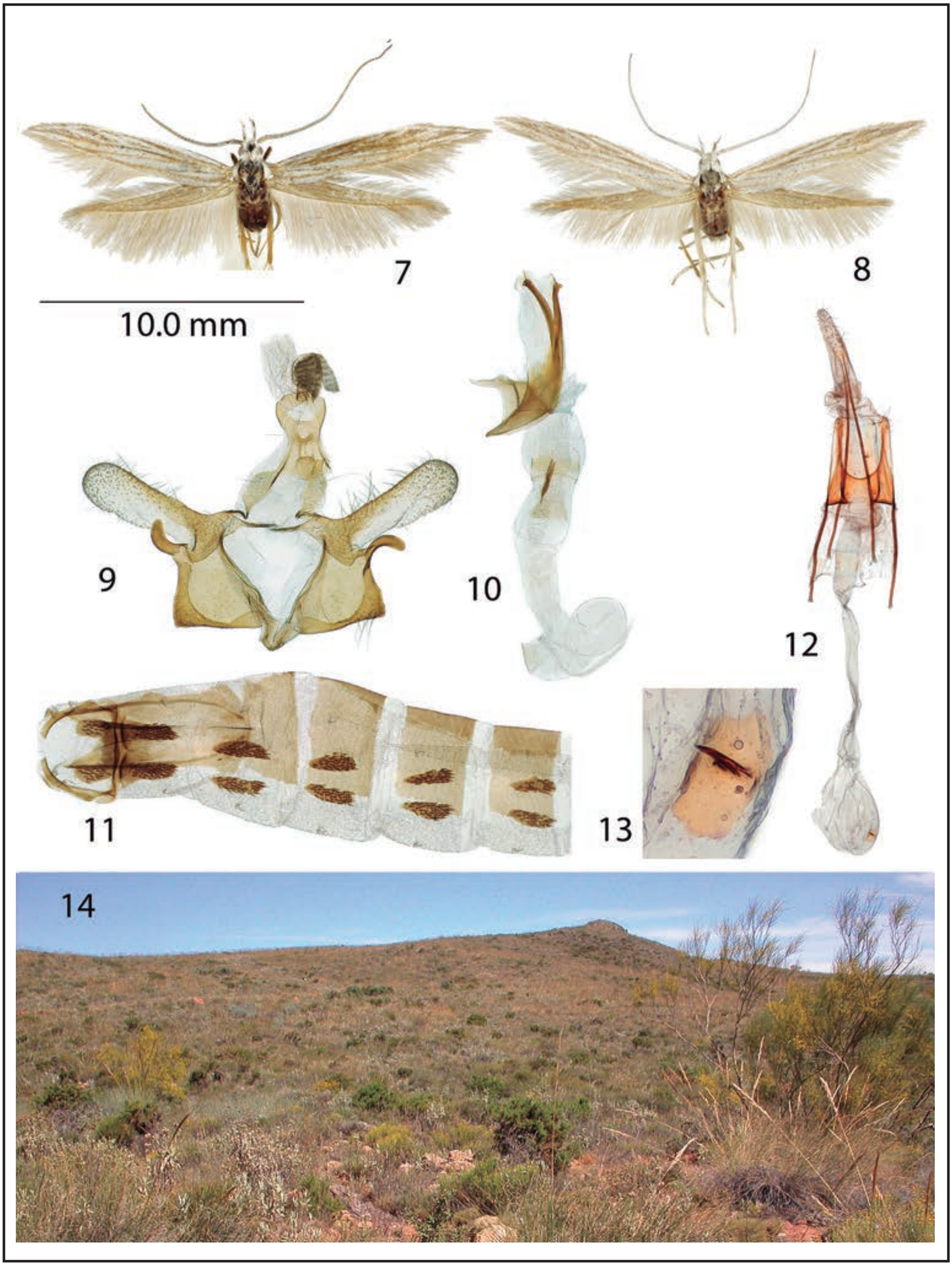

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Se describe una nueva especie del género *Stomopteryx* Heinemann, 1870, de Navarra, España (Lepidoptera: Gelechiidae)

Javier Gastón, Antonio Vives Moreno, Peter Huemer & Teresa Farino

Resumen

Se describe una nueva especie del género *Stomopteryx* Heinemann, 1870, como *Stomopteryx tudelana* Gastón, Vives, Huemer & Farino, sp. nov. de Navarra, España. Se presentan caracteres diferenciales con su especie más próxima *Stomopteryx urartua* Kemal, Kizildaĝ & Koçak, 2020, descrita de Turquía. Las diferencias se refieren al aspecto externo y a la genitalia del macho. Los códigos de barras de ADN del fragmento 5' del gen mitocondrial COI de la nueva especie se agrupan en un BIN único.
Palabras clave: Lepidoptera, Gelechiidae, *Stomopteryx*, taxonomía, nueva especie, código de barras ADN, Navarra, España.

A new species of the genus *Stomopteryx* Heinemann, 1870, is described from Navarre, Spain (Lepidoptera: Gelechiidae)

Abstract

A new species of the genus *Stomopteryx* Heinemann, 1870, is described as *Stomopteryx tudelana* Gastón, Vives, Huemer & Farino, sp. nov. from Navarre, Spain. Differential characters are presented as compared to its closest relative, *Stomopteryx urartua* Kemal, Kizildaĝ & Koçak, 2020, described from Türkiye. The differences concern the external appearance and the male genitalia. The DNA barcodes of the 5' fragment of the mitochondrial COI gene of the new species cluster within a unique BIN.
Keywords: Lepidoptera, Gelechiidae, *Stomopteryx*, taxonomy, new species, DNA barcoding, Navarre, Spain.

Une nouvelle espèce du genre *Stomopteryx* Heinemann, 1870, est décrite en Navarre, Espagne (Lepidoptera: Gelechiidae)

Résumé

Une nouvelle espèce du genre *Stomopteryx* Heinemann, 1870, est décrite sous le nom de *Stomopteryx tudelana* Gastón, Vives, Huemer & Farino, sp. nov. de Navarre, Espagne. Des caractères différentiels sont présentés par rapport à son espèce la plus proche, *Stomopteryx urartua* Kemal, Kizildaĝ & Koçak, 2020, décrite de Turquie. Les différences concernent l'aspect extérieur et les organes génitaux du mâle. Les codes-barres ADN du fragment 5' du gène mitochondrial COI de la nouvelle espèce se regroupent dans un BIN unique.
Mots-clés: Lepidoptera, Gelechiidae, *Stomopteryx*, taxonomie, nouvelle espèce, code-barres ADN, Navarre, Espagne.

Introducción

La familia Gelechiidae Stainton, 1854, es una de las más extensas entre los Microlepidoptera pero aún existen grandes lagunas de conocimiento que deben llenarse, incluso en la fauna europea (Huemer et al. 2020). Dentro de esta familia se encuentra el género *Stomopteryx* Heinemann, 1870, incluido en la tribu Anacampsini Bruand, [1851] 1850 (Viette, 1977), del que no se ponen de acuerdo, hoy en día, los especialistas para establecer el número exacto de especies que vuelan en Europa (Huemer & Karsholt, 2020). Ante la dificultad de hacer una revisión urgente de este género, que sería lo óptimo, algunos autores, como es nuestro caso, aportamos nuestras investigaciones puntuales que sin duda enriquecen el conjunto del género con fines taxonómicos o de conservación, aunque como ya hemos indicado sería preferible describirlas en un marco de revisión.

La cuarta coautora del presente artículo ha centrado su trabajo en la realización de muestreos intensivos en los diferentes biotopos de la península ibérica, especialmente en la zona norte, lo que le ha llevado a la localización de una pequeña colonia de ejemplares de *Stomopteryx* en el municipio de Tudela, en su límite con el municipio de Cintruénigo, al sur de Navarra (España). Analizados dichos especímenes, no coinciden ni por morfología externa ni por genitalia con ninguna otra especie de este grupo que se haya citado de España, como es el caso del endemismo *Stomopteryx nugatricella* Rebel, 1893. Ampliando el ámbito de búsqueda, hemos localizado un grupo de especies con biotopos en áreas del extremo oriental de Turquía, en los Urales meridionales o en el desierto de Kyzylkum en Asia, que presentan una morfología similar con bandas longitudinales oscuras en sus alas anteriores y que son: *Stomopteryx gaesata* (Meyrick, 1913), *Stomopteryx lineolella* (Eversmann, 1844), *Stomopteryx radicalis* Falkovitsh & Bidzilya, 2003 y, más recientemente, la descrita *Stomopteryx urartua* Kemal, Kizildaĝ & Koçak, 2020. Ésta última especie es la más próxima morfológicamente a los ejemplares localizados al sur de Navarra, por lo que descartadas las tres anteriores, centramos nuestro análisis diferencial con ella, constatando la gran similitud en su morfología externa pero también hay claras diferencias en su genitalia. Por otro lado, el biotopo de *Stomopteryx urartua* es subalpino (2.250 m.), mientras que el biotopo de la especie que designamos a continuación es mesomediterráneo (Rivas, 1987), a 405 m de altitud.

Los resultados obtenidos de los análisis morfológicos externos e internos (genitalia), se han completado con los moleculares mediante secuenciación del COI (barcoding) que revelan que los nuevos especímenes de *Stomopteryx* se agrupan en grupos de secuencias únicas. La especie recogida en España difiere de otras especies de *Stomopteryx* en caracteres morfológicos y moleculares y se describe como una nueva especie.

La secuenciación del gen citocromo-oxidasa 1 (COI) es una herramienta eficaz para el diagnóstico de especies en el reino animal que ayuda a resolver problemas que surgen entre la información taxonómica existente y la necesidad de una identificación fiable de las especies, especialmente en el caso de los Lepidoptera (Hebert et al. 2003). Este método es una alternativa rápida para identificar especies descritas y descubrir nuevas especies (Hebert et al. 2003; Savolainen et al. 2005; Mitchell, 2008). La combinación de los métodos morfológicos tradicionales, con los métodos moleculares, puede ayudar a incrementar el conocimiento de la diversidad y resolver el estatus taxonómico de algunos grupos de especies.

Material y métodos

El material utilizado para el estudio se ha obtenido mediante muestreos nocturnos, utilizando una variedad de trampas y reclamos de luz ultravioleta distribuidos 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.

Para el montaje de la genitalia se ha efectuado siguiendo a Robinson (1976), con modificaciones. Para la documentación fotográfica de las preparaciones de la genitalia se han utilizado los microscopios Leica DMLB, Leica MZAPO, Nikon Eclipse E400, Nikon SMZ1 Stereo microscope y las cámaras digitales Leica DFC550 y NIKON D3100. Mientras que los ejemplares adultos se fotografiaron con una cámara digital Sony α100 DSLR-A100K con objetivo AF 100 MACRO 1:2.8 (32) y los retoques fotográficos se realizaron con el programa Adobe Photoshop 8©.

Se procesaron y secuenciaron tejidos de 12 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 utilizó una secuencia pública de BOLD (https://boldsystems.org/; Ratnasingham & Hebert, 2007). Un gran número de 224 secuencias de *Stomopteryx* a las que tuvimos acceso resultaron pertenecer a otros grupos de especies y, por lo tanto, no se analizaron. Los datos de los especímenes analizados, 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 públicos "DS-STOMOESP New Stomopteryx species from Spain". 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 Gelechiidae 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

JG	Javier Gastón, Vizcaya, España
MNCN	Museo Nacional de Ciencias Naturales, Madrid, España
prep. gen.	preparación de genitalia
sp. nov.	especie nueva
fot.	fotografía

Resultados

GELECHIIDAE

***Stomopteryx tudelana* Gastón, Vives, Huemer & Farino, sp. nov.**
https://zoobank.org/491C1FDE-F964-4F06-821F-1E750192717B

Material estudiado: Holotipo, 1 ♂, ESPAÑA, Navarra, El Boquerón, Tudela, a 405 m, 23-IX-2024, T. Farino leg., J. Gastón col., prep. gen. 10547JG, depositado en el Museo Nacional de Ciencias Naturales, en Madrid, España (MNCN).

Paratipos, 2 ♂: ESPAÑA, Navarra, El Boquerón, Tudela, a 405 m, 1 ♂, 23-IX-2024, T. Farino leg., J. Gastón col., prep. gen. 10591JG; ídem, 29-IX-2024, T. Farino leg., J. Gastón col., prep. gen. 10590JG.

Diagnosis: Especie muy próxima a *Stomopteryx urartua* Kemal, Kizildaĝ & Koçak, 2020 (Figura 3), con la que comparte características morfológicas externas, como son el fondo ocre oscuro relativamente uniforme de las alas anteriores y las bandas oscuras características de este grupo de *Stomopteryx*. En *Stomopteryx urartua* la banda que recorre el espacio entre la vena A, junto al margen interno del ala y la vena que forma la parte inferior de la celda, está bien definida, lo mismo que en *Stomopteryx tudelana* sp. nov., sin embargo, la segunda banda oscura que presenta *S. tudelana* sp. nov. en el extremo de la celda hacia el ápice del ala, se sustituye por un punto negro ligeramente alargado en *S. urartua*. En ambas especies se observa una extensa mancha triangular oscura en el ápice de las alas anteriores; la diferencia entre ambas está en la presencia de una leve banda vertical postdiscal más clara que se aprecia en *S. urartua* (banda frecuente en este género), mientras que en *S. tudelana* sp. nov., esa banda vertical no existe. Las genitalias masculinas de ambas especies son similares, como ocurre en la mayoría de las especies de *Stomopteryx*, lo que dificulta su diferenciación utilizando el método de preparación de genitalias. Sin embargo, en el phallus de ambas especies se observa una clara diferencia, tanto en el volumen geométrico, como en la forma y tamaño del apéndice esclerotizado presente en el mismo. Además, la valva de la nueva especie está claramente ensanchada en la parte medial.

En el código de barras de ADN, *S. tudelana* sp. nov. se agrupa en un BIN propio, BOLD:AGX6976, mientras que la especie morfológicamente más cercana, *S. urartua*, se agrupa en un BIN separado, BOLD:ACB3380, junto con las especies fenotípicamente claramente diferenciadas *S. nugatricella* Rebel, 1893, *S. lineolella* (Eversmann, 1844) y *S. mongolica* Povolný, 1975.

Descripción del adulto (Figuras 1-2): Envergadura, macho 17,30 mm (n=3), cabeza bien desarrollada con pelos escamiformes de color ocre casi blanco, compactos en la frente y en la zona alta del epicráneo, incluyendo las órbitas oculares. Palpos labiales bien desarrollados, ocre claros, cortos y curvados hacia la parte superior de la cabeza. Antenas filiformes recubiertas de pequeñas cerdas de color marrón oscuro, casi negro, destacándose ligeramente el escapo, algo más grueso. Abdomen recubierto de escamas ocres. Alas anteriores con un fondo relativamente uniforme de escamas ocres medianamente oscuras en las que se destacan dos bandas longitudinales de escamas casi negras; la de mayor tamaño recorre el espacio entre la vena A, junto al margen interno del ala, y la vena del borde inferior de la celda; la menor está formada por dos puntos negros alargados que casi se fusionan dando el aspecto de una banda alargada emplazándose en el extremo de la celda y dirigiéndose hacia el ápice del ala; una tercera mancha triangular se sitúa en la zona submarginal del ala, junto al ápice de la misma.

Se desconoce la hembra.

Genitalia del macho (Figuras 5, 6): Tegumen alargado y elíptico. Uncus con pelos largos y gruesos que alcanzan la mitad del tegumen. Gnathos redondeado. Valvas estrechas y alargadas con los extremos ligeramente redondeados e inclinados levemente hacia el interior, presentando un ensanchamiento en su parte central. Vínculo con brazos curvados y láminas membranosas que cubren el phallus, como es frecuente en las especies de este género; phallus voluminoso y corto, con el extremo apuntado recto y una apófisis en forma de diente esclerotizado de forma piramidal con el extremo en forma de un pequeño gancho.

Datos moleculares: BIN: BOLD:AGX6976. La distancia p media intraespecífica de la región del código de barras es del 0% (n = 3). La distancia p mínima al BIN vecino más cercano, BOLD:ACB3380 (n = 17), es del 4,71%. En este BIN genéticamente variable (distancia p media del 1,11%) se reconocen cuatro especies (*S. urartua*, *S. nugatricella*, *S. lineolella* y *S. mongolica*).

Biotopo: las capturas se realizaron al norte del río Boquerón, en la parte alta de la cuenca del Queiles (Figura 8). Según IDENA, la geología de esta parte de la depresión del Ebro se identifica como "arcillas limos y areniscas y conglomerados". Las laderas de esta localidad están dominadas por *Lygeum spartum* Loefl. ex L., intercalados con elementos halófilos como *Atriplex halimus* L. y *Salsola vermiculata* L. También observamos la presencia de especies leñosas perennes de bajo porte como *Artemisa herba-alba* Asso, *Thymus* spp. y *Limonium* spp. Múltiples acequias atraviesan la parte baja de la cuenca, proporcionando condiciones ecológicas adecuadas para pequeños rodales de *Phragmites australis* Trin. y otras especies higrófilas. Más abajo, hacia el este, la cuenca se dedica al cultivo de *Vitis vinifera* L. y *Prunus dulcis* (Mill.) D. A. Webb.

Biología: Los estados larvarios y las plantas nutricias de las orugas, se desconocen. Los adultos se han capturado a finales de septiembre, y a pesar de haberse muestreado el biotopo en otras fechas (abril, mayo y junio), no hemos tenido éxito, por lo que suponemos que vuelan en una sola generación.

Distribución: Se conoce exclusivamente de la localidad de El Boquerón, municipio navarro de Tudela, España, volando a una altura de 405 m.

Datos genéticos: BIN BOLD:AGX6976 (n = 3). La nueva especie se caracteriza por un BIN único (Figura 7). El BIN más cercano (BOLD:ACB3380, n=17), con una distancia p del 4,71 %, agrupa tres especies genéticamente inseparables en BOLD: *S. nugatricella*, *S. lineolella* y *S. mongolica*. Sin embargo, debido a la gran cantidad de problemas taxonómicos sin resolver, no parece conveniente realizar un análisis de lagunas en el código de barras dentro del género *Stomopteryx*.

Discusión

Los Gelechiidae, con unas 6.000 especies descritas, son una de las familias más diversas dentro del orden Lepidoptera, pero a pesar de su importancia, muchas de sus géneros carecen de revisiones modernas. Así, muchas de las 75 especies del género *Stomopteryx* enumeradas por Hobern et al. (2025) están insuficientemente descritas y delimitadas taxonómicamente y a menudo faltan estudios pertinentes sobre el material tipo. Por lo tanto, la descripción de nuevas especies conlleva ciertos riesgos residuales, que, sin embargo, pueden aclararse, por ejemplo, mediante condiciones biogeográficas únicas, como las especies descritas recientemente por Falck & Karsholt (2025) en las Islas Canarias, o mediante características morfológicas inusuales. Las descripciones de grupos de especies no revisados y morfológicamente crípticos, como *Stomopteryx remissella* (incluidos cuatro sinónimos), deben evaluarse aquí de forma mucho más crítica (Nel & Varenne, 2016; Varenne & Nel, 2020), aunque los 14 BIN documentados hasta ahora hacen probable un mayor número de especies (Huemer, sin publicar). Sin embargo, antes de introducir nuevos nombres, es necesario examinar en primer lugar los tipos de los nombres disponibles. Así pues, mientras que en este caso se sospecha que se ha subestimado la diversidad real de especies, en otras especies es probable que se haya producido una división excesiva. Un posible ejemplo de ello es el grupo de especies *S. nugatricella-lineolella-mongolica*, que no solo presenta códigos de barras de ADN idénticos, sino que tampoco resulta convincente desde el punto de vista morfológico sin diagnósticos diferenciales claros.

La especie aquí descrita no puede asignarse a ninguna especie conocida por criterios morfologicos y genéticos, con presencia en el norte de España, hace muy improbable la cospecíficidad, por ejemplo, con taxones norteafricanos no revisados. De hecho, sus parientes más cercanos parecen estar más bien en las estepas de Asia Menor.

Etimología: Se adopta el nombre del topónimo, Tudela.

Siguiendo a Vives Moreno (2014), *Stomopteryx tudelana* Gastón, Vives, Huemer & Farino sp. nov. debería de situarse delante de *Stomopteryx basalis* Staudinger, 1876.

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Conflicto de interés

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Figuras 1-6. Adultos. **4-6.** genitalia. **1.** *Stomopteryx tudelana* Gastón, Vives, Huemer & Farino, 2025, Holotipo ♂, Tudela, Navarra, España. **2.** Ídem, (paratipo). **3.** *Stomopteryx urartua* Kemal, Kizildaĝ & Koçal, 2020, Mt. Goören, Tuşba, este de Turquía. **4.** *Stomopteryx urartua* Kemal, Kizildaĝ & Koçal, 2020, prep. gen. GP3259. **5.** *Stomopteryx tudelana* Gastón, Vives, Huemer & Farino, 2025, Holotipo, prep. gen. 10547JG. **6.** *Stomopteryx tudelana* Gastón, Vives, Huemer & Farino, 2025, Paratipo, prep. gen. 10591JG.

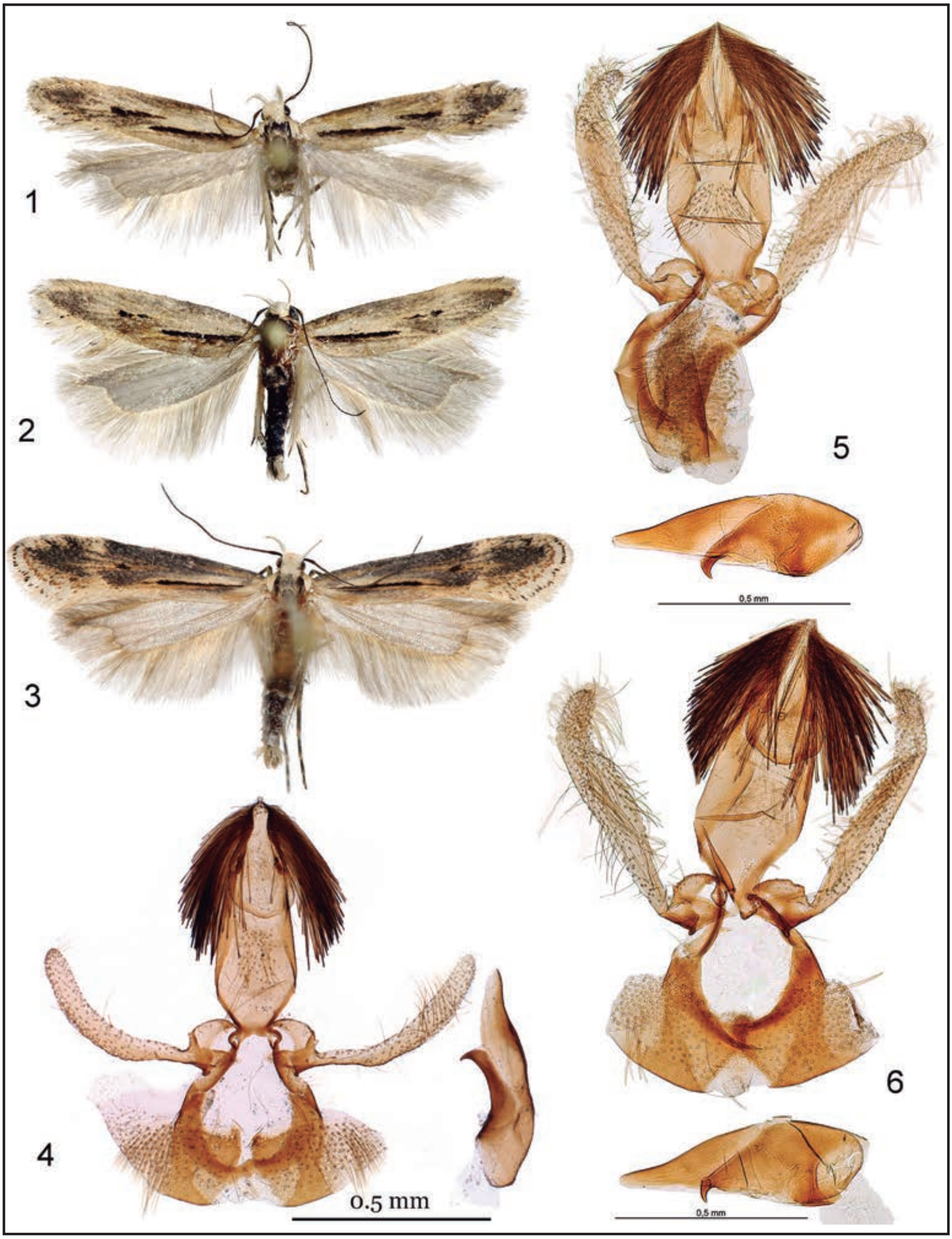

Figura 7. Árbol filogenético de especies seleccionadas del género *Stomopteryx* (Kimura 2 parámetros), creado con MEGA 11 (Tamura et al. 2021), con raíz para *S. lusitaniella* como representante de un grupo de especies no más cercano; fuente: datos de códigos de barras de ADN de BOLD (Barcode of Life Database; Ratnasingham, 2018).

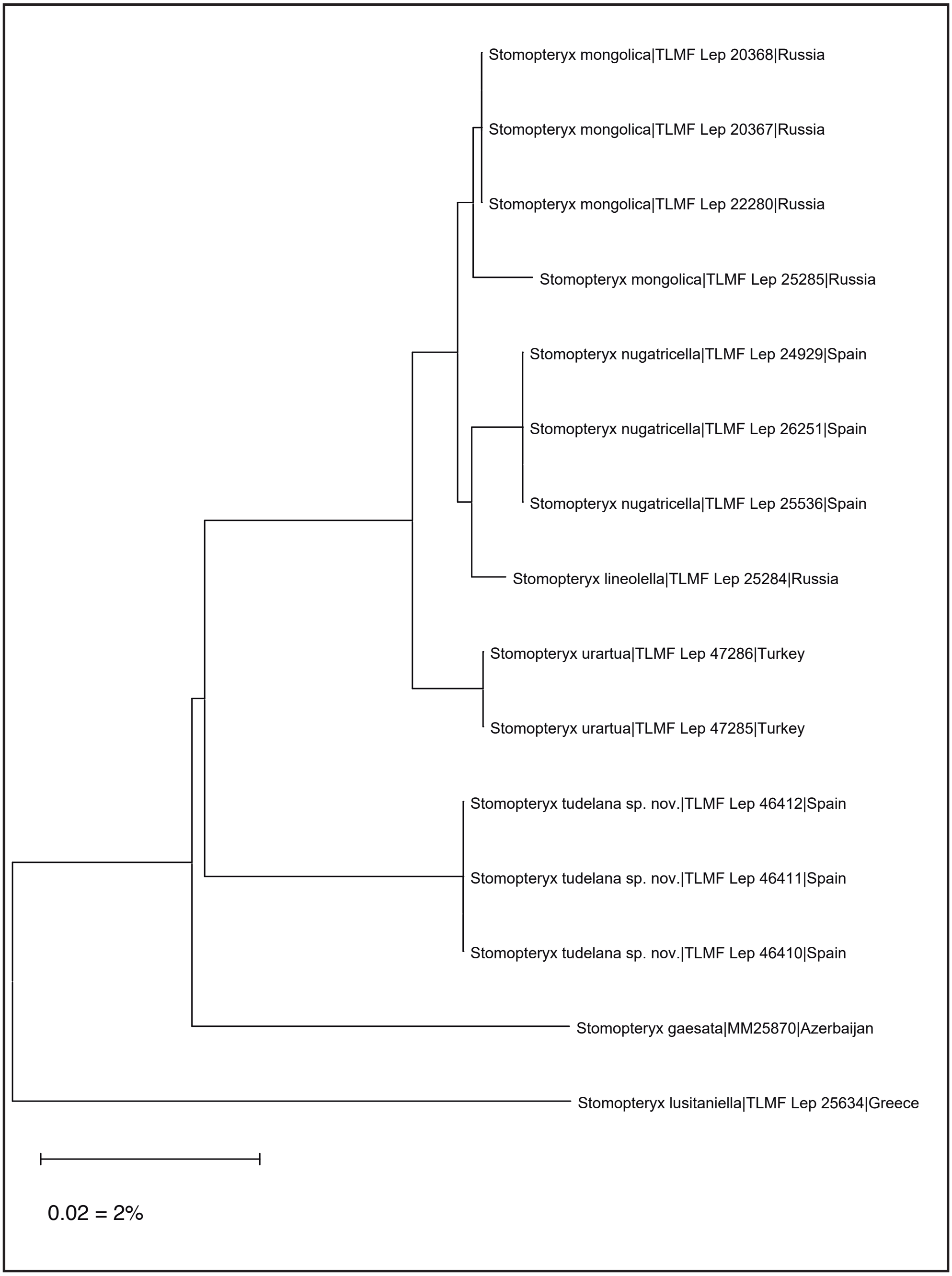

Figura 8. Biotopo de la zona de captura de la nueva especie en Navarra (España).

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Distribución y hábitos de *Azamora sororia* Druce, 1899 asociado al cultivo de *Passiflora ligularis* Juss. en el bosque de conservación Carpish, Perú (Lepidoptera: Pyralidae, Chrysauginae)

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Resumen

El estudio analiza la distribución y hábitos alimenticios de *Azamora sororia* Druce, 1899 (Lepidoptera: Pyralidae, Chrysauginae) en cultivos de *Passiflora ligularis* Juss, en el bosque de conservación Carpish, Huánuco, Perú. Se identificó a este Lepidoptera como un perforador de frutos que afecta significativamente la producción. La investigación se desarrolló en 77,15 hectáreas, dividiéndose en seis zonas con variaciones altitudinales entre 1.566 y 2.594 msnm: Challana, Mallqui, Villa Gloria, Chinchao, Mirador y Taprag. Se recolectaron 414 frutos afectados y se criaron las larvas en laboratorio para su identificación. La mayor infestación se registró en Challana, donde se encontraron 206 individuos, representando el 49,76% del total de muestras recolectadas. Esta zona, situada entre los 1.566 y 1.699 msnm, posee condiciones climáticas y vegetativas favorables para la plaga. Le siguieron Mallqui (20,29%), Villa Gloria (10,14%) y Taprag (9,18%). En contraste, Chinchao y Mirador presentaron las menores abundancias con 4,11% y 6,52% respectivamente, lo que sugiere que la plaga encuentra menos condiciones propicias en altitudes más elevadas. Esta distribución indica que factores como temperatura, humedad, disponibilidad de alimento y presencia de cultivos asociados como *Capsicum pubescens* Ruiz & Pav. y *Physalis peruviana* L. influyen en la presencia y proliferación de *A. sororia*. Además, se observará que las áreas con mayor infestación corresponden a altitudes intermedias, mientras que las zonas más elevadas o de menor altitud presentan menor incidencia de la plaga. Las larvas perforan la epidermis del fruto, se alimentan internamente y abandonan el fruto al madurar, sugiriendo un posible comportamiento caníbal entre ellas.
Palabras clave: Lepidoptera, Pyralidae, Chrysauginae, *Passiflora ligularis*, agroecología, bosque de Conservación Carpish, *Azamora sororia*, Perú.

Distribution and habits of *Azamora sororia* Druce, 1899 associated with the cultivation of *Passiflora ligularis* Juss. in the Carpish conservation forest, Peru (Lepidoptera: Pyralidae, Chrysauginae)

Abstract

The study analyses the distribution and feeding habits of *Azamora sororia* Druce, 1899 (Lepidoptera: Pyralidae, Chrysauginae) in *Passiflora ligularis* Juss crops in the Carpish conservation forest, Huánuco, Peru. This Lepidoptera was identified as a fruit borer that significantly affects production. The research was carried out over 77.15 hectares, divided into six areas with altitude variations between 1,566 and 2,594 metres above sea level: Challana, Mallqui, Villa Gloria, Chinchao, Mirador and Taprag. A total of 414 affected fruits were collected and the larvae were bred in the laboratory for identification. The highest infestation was recorded in

Challana, where 206 individuals were found, representing 49.76% of the total samples collected. This area, located between 1,566 and 1,699 metres above sea level, has climatic and vegetative conditions favourable to the pest. They were followed by Mallqui (20.29%), Villa Gloria (10.14%) and Taprag (9.18%). In contrast, Chinchao and Mirador had the lowest abundance with 4.11% and 6.52% respectively, which suggests that the pest finds less favourable conditions at higher altitudes. This distribution indicates that factors such as temperature, humidity, availability of food and the presence of associated crops such as *Capsicum pubescens* Ruiz & Pav., and *Physalis peruviana* L. influence the presence and proliferation of *A. sororia*. In addition, the areas with the highest infestation correspond to intermediate altitudes, while the higher or lower altitude areas have a lower incidence of the pest. The larvae bore into the fruit's epidermis, feed on its interior and leave the fruit when it ripens, suggesting a possible cannibalistic behaviour between them.
Keywords: Lepidoptera, Pyralidae, Chrysauginae, *Passiflora ligularis*, agroecology, Carpish Conservation Forest, *Azamora sororia,* Peru.

Introducción

La *Passiflora ligularis* Juss., un cultivo nativo de Perú ha experimentado un notable crecimiento como producto de agroexportación no tradicional en la última década. En el año 2021, la producción alcanzó las 62.000 toneladas, mostrando una ligera disminución del 1,6% en comparación con las 63.000 toneladas del año anterior. La Región Huánuco produjo alrededor de 1.911 toneladas en el año 2021 y comenzó las primeras exportaciones con 400 kilos hacia Canadá (Dirección Regional de Agricultura [DRA], 2021), en esta región la mayor parte de su área productora se encuentra en el bosque de Carpish, que forma parte del área de conservación del Bosque Regional y actúa como punto de transición entre la región Sierra y la Selva (ceja de selva). Este bosque ubicado entre los 2.110 y 3.690 m.s.n.m es un ecosistema protegido donde la deforestación masiva, particularmente en áreas como el sector Chinchao, ha facilitado la expansión del cultivo de esta especie a más de 50 hectáreas aproximadamente (Espinoza, 2016; Gobierno Regional Huánuco, 2021).

El bosque de Carpish, una zona de conservación con un ecosistema natural alberga especies de flora y fauna endémicas, incluyendo una rica diversidad de insectos. Estos insectos pueden encontrar nuevos recursos alimenticios en las áreas donde se ha expandido el cultivo. Los hábitos alimenticios de los insectos, especialmente de los Lepidoptera, son indicadores biológicos del hábitat, ya que permiten evaluar la calidad ambiental y responden a las perturbaciones causadas por actividades humanas (Lozano et al. 2007; Diaz, 2017).

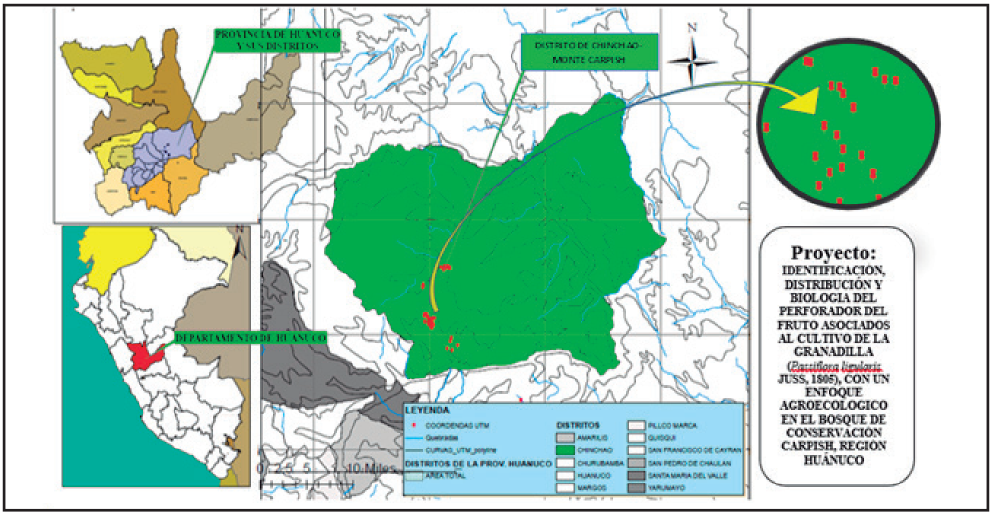
Los cambios en la vegetación conducen a variaciones en la disponibilidad de alimentos, lo cual altera tanto la prevalencia como el comportamiento de especies endémicas (Baddi et al. 2007; Bernal & Medina, 2018). A pesar de la gran aceptación de los frutales de la familia Pasisfloraceae en los mercados mundiales, existe una escasa investigación sobre la biología, ecología y manejo de plagas para este cultivo. Varias especies de Diptera que afectan al *Passiflora edulis* Sims han sido identificadas globalmente como plagas cuarentenarias importantes (Santamaría et al. 2014; Subhagan et al. 2020; López Cruz, 2022), pero hay pocos informes sobre otras plagas, incluidas las que han aparecido recientemente o se han adaptado a los cultivos de esta especie en expansión en varias regiones del Perú. Becker (2023) señala que las larvas de especies del género *Azamora* Walker, 1858 se alimentan de *Passiflora* sp. en América tropical, incluyendo especies como *A. sororia* Druce, 1899, *A. penicillana* (Walker, 1863) y *A. flammeana* (Sepp, [1844]), que se encuentran en zonas tropicales de América.

Materiales y métodos

Descripción del área de estudio: La investigación fue desarrollada en las zonas productoras de *Passiflora ligularis* situadas en el distrito de Chinchao, dentro del bosque protegido Húmedo Montano de Carpish, a una distancia aproximada de 29,1 km al sureste de la ciudad de Huánuco, Perú, a lo largo de la carretera que conecta Tingo María y Huánuco. Estas áreas se encuentran a altitudes que oscilan entre 2 110 y 3 690 metros sobre el nivel del mar, con coordenadas geográficas de 9º30'50"S y 76º02'06"O (Figura 1).

Muestreo de insectos para la descripción de los hábitos alimenticios: La obtención de muestras con el propósito de realizar la descripción de los hábitos alimenticios de la especie fue realizada dentro de un marco de superficie de 77,15 hectáreas. Se recolectaron 414 frutos afectados por larvas de insectos perforadores y se trasladaron al laboratorio de entomología de la Facultad de Ciencias Agrarias de la Universidad Nacional Hermilio Valdizan para su estudio y crianza.

Figura 1. Ubicación de las parcelas muestreadas en el bosque de conservación Carpish, Región Huáco / 77,15 ha.



Se procedió a criar los Lepidoptera de manera natural para obtener pupas y adultos, manteniendo una temperatura ambiente que oscilaba entre 15,7 ºC y 28 ºC, con una Humedad Relativa del 65 %. Los frutos infestados con larvas fueron lavados y desinfectados externamente antes de ser colocados en bandejas individuales con una capa de 3 cm de tierra agrícola desinfectada en la base, lo cual facilitó la recuperación de las pupas. Una vez obtenidas, las pupas se separaron por género y se colocaron machos y hembras en frascos individuales de 120 ml, previamente desinfectados con alcohol al 90 %. Cada frasco se cubrió con malla fina en la parte superior y se añadió tierra desinfectada y humedecida al 60 % con agua destilada para mantener las condiciones necesarias (Figuras 2-3).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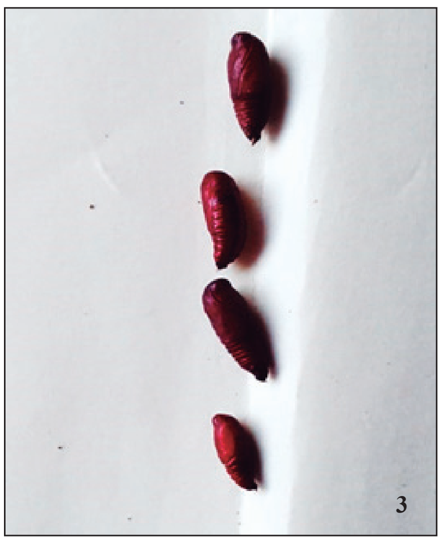
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Los adultos recuperados fueron seleccionados según su género, posteriormente fijados y etiquetados. Para la identificación se la especie se ocuparon las ilustraciones, literatura, patrones de color externo, claves dicotómicas (Dyar, 1908) e imágenes de referencia (NCBI, s. f.; Hernández et al. 2011; Metalmark Web and Data, 2023). Se emplearon platas de *Passiflora ligularis*, pinzas, pinceles y alfileres entomológicos SPHINX de tamaños dos, tres y cuatro para realizar el montaje de estos Lepidoptera, los cuales fueron preservados en cajas entomológicas.

Estudio de distribución de la especie: Para los estudios de la distribución de la especie *Azamora sororia* involucrada en la perforación de los frutos del cultivo de *Passiflora ligularis*, el área de estudio fue dividido en seis transectos de diferentes distancias, dependiendo de los accesos: Challana (1.601 msnm), Mallqui (1.713 msnm), Villa gloria (1.766 msnm), Chinchao (1.893 msnm), Mirador (2.284 msnm), y Taprag (2.594), involucrando en su totalidad 77,15 hectáreas. Se tomaron datos desde el 15 de noviembre de 2023, una vez por semana hasta el 31 de marzo de 2024, realizando un conteo de los frutos conteniendo larvas del insecto en estudio encontrados por sector y fecha de muestreo.

Resultados y discusión

Distribución y hábitos alimenticios de la especie involucrada en la perforación de los frutos del cultivo de *Passiflora ligularis* Juss., en el bosque de conservación Carpish.

Distribución de la especie: Se ha identificado a la especie *Azamora sororia* Druce, 1899, como la especie involucrada en la perforación de los frutos del cultivo de la *Passiflora ligularis*, en el bosque protegido montano de Carpish. El estudio más reciente que describe a *A. sororia* como plaga en el cultivo de la granadilla es de Becker (2023), quien hace la descripción morfológica y la identificación de tres especies del género *Azamora*, entre ellas a *A. sororia* Druce, 1899, que fueron encontrados alimentándose de especies de Passifloraceae en zonas tropicales y América. El estudio menciona que las larvas de esta especie han sido criadas hasta su estado adulto por el autor, permitiendo una observación detallada de su desarrollo y ciclo de vida, las descripciones son coincidentes con las que se encuentran en el presente estudio, con lo que se confirma la presencia de *A. sororia* como plaga involucrada en la perforación de los frutos del cultivo de esta especie, en el bosque protegido montano de Carpish. En tanto, Austin (2010) al estudiar la comunidad de Lepidoptera en el centro norte de Florida, registra a la especie *Tosale oviplagalis* (Walker, 1866) con patrones morfológicos similares al descrito, pero no exacto y el tamaño es muy diferente. *T. oviplagalis* es una especie muy pequeña, de 6-7 mm de largo en la ala anterior y *A. sororia* mide 14-15 mm de largo.

La distribución espacial de la especie *Azamora sororia*, perforador de los frutos del cultivo de *Passiflora ligularis* en el bosque de conservación Carpish, exhibe diferencias estadísticamente significativas entre las distintas zonas de muestreo. Se observa una notable disparidad en la cantidad de individuos registrados, siendo la zona de Challana la que presenta la mayor abundancia, con un total de 206 muestras de insectos. Le siguen en orden de cantidad la zona de Mallqui, Villa Gloria y Taprag, con valores de 84, 42 y 38 muestras de insectos respectivamente. Esta variabilidad en distribución de la población sugiere la influencia de diferentes factores ambientales o de manejo agrícola en cada área estudiada.

Para comprender mejor la dinámica de *Azamora sororia*, se considera algunas características relevantes de las zonas de muestreo. Estas peculiaridades pueden arrojar luz sobre los posibles motivos detrás de las disparidades observadas en la abundancia de los insectos que perforan los frutos del cultivo de esta especie en los agroecosistemas estudiados. En la Tabla 1, se proporciona una descripción concisa de estas características, las cuales son fundamentales para contextualizar los resultados obtenidos y entender la interacción entre la especie estudiada y su entorno.

Tabla 1. Breve descripción de las seis zonas seleccionadas, en el bosque de conservación Carpish.

Lugar	Altitudes msnm	Numero de Parcelas con plaga	Muestras colectadas	Muestras (%)
Taprag	Área: 5 h Altura: 2561 a 2594 msnm Temperatura: 16 °C Número de parcelas muestreadas: 5 Cultivo principal: granadilla (ecotipo colombiano) Asociación o cultivos en parcelas circundantes: aguaymanto.	5,00	38,00	9,18
Challana	Área: 26,5 h Altura: 1566 a 1699 msnm Temperatura: 17 °C Número de parcelas muestreadas:15 Cultivo principal: granadilla (ecotipo colombiano) Asociación o cultivos en parcelas circundantes: Rocoto y aguaymanto	15,00	206,00	49,76
Mirador	Área: 12 h Altura: 2073 a 2093 msnm Temperatura: 14 °C Número de parcelas muestreadas: 8 Cultivo principal: granadilla (ecotipo colombiano) Asociación o cultivos en parcelas circundantes: aguaymanto	8,00	27,00	6,52
Chinchao	Área: 14 h Altura: 1843 a 1890 msnm Temperatura: 12 °C Número de parcelas muestreadas: 7 Cultivo principal: granadilla (ecotipo colombiano) Asociación o cultivos en parcelas circundantes: Rocoto	7,00	17,00	4,11
Villa gloria	Área:9,7 5 h Altura: 1732 a 1823 msnm Temperatura: 12 °C Número de parcelas muestreadas: 10 Cultivo principal: granadilla (ecotipo colombiano) Asociación o cultivos en parcelas circundantes: aguaymanto	10,00	42,00	10,14
Mallqui	Área: 13,25 h Altura: 1723 a 1768 msnm Temperatura: 14 °C Número de parcelas muestreadas: 10 Cultivo principal: granadilla (ecotipo colombiano) Asociación o cultivos en parcelas circundantes: Rocoto y aguaymanto.	10,00	84,00	20,29

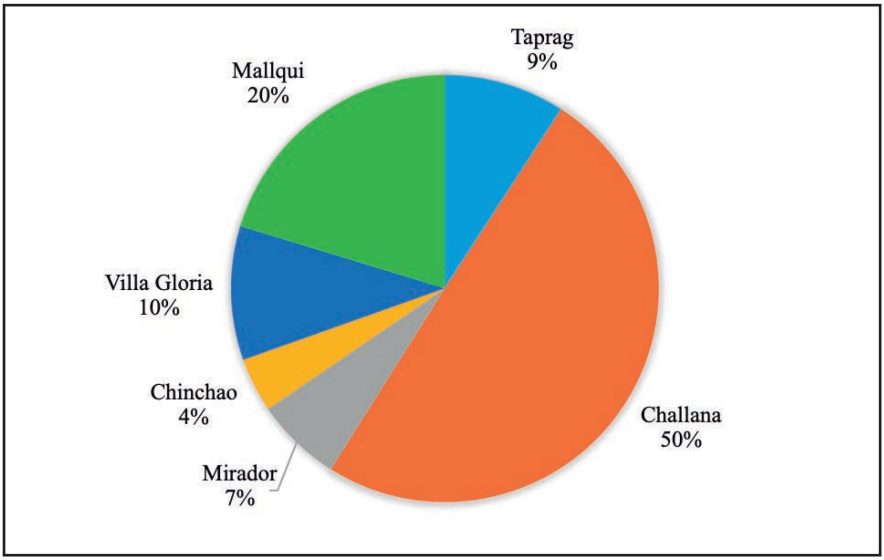
La tabla 1 proporciona información sobre diferentes lugares (Taprag, Challana, Mirador, Chinchao, Villagloria y Mallqui) donde se ha realizado muestreo de cultivos, específicamente de granadilla (ecotipo colombiano), junto con sus altitudes, número de parcelas muestreadas y el porcentaje de muestras colectadas en cada lugar.

- Taprag, se encuentra a una altitud de 2.561 a 2.594 metros sobre el nivel del mar (msnm), con un total de cinco parcelas muestreadas y se han colectado el 9,18% de las muestras.
- Challana, está a una altitud de 1.566 a 1.699 msnm, con 15 parcelas muestreadas y el 49,76% de las muestras recogidas.
- Mirador, tiene una altitud de 2.073 a 2.093 msnm, con 8 parcelas muestreadas y el 6,52% de las muestras obtenidas.
- Chinchao, se encuentra entre 1.843 y 1.890 msnm, con 7 parcelas muestreadas y el 4,11% de las muestras recogidas.
- Villagloria, tiene una altitud de 1.732 a 1.823 msnm, con 10 parcelas muestreadas y el 10,14% de las muestras colectadas.
- Mallqui, está a una altitud de 1.723 a 1.768 msnm, con 10 parcelas muestreadas y el 20,29% de las muestras recogidas.

Estos datos sugieren una variabilidad en la cantidad de parcelas infectadas con la plaga en estudio y muestreadas, además del porcentaje de muestras colectadas en cada ubicación. Además, se observa una tendencia donde las áreas con altitudes más bajas (Challana) tienden a tener un mayor número de parcelas infestadas y una mayor proporción de muestras recolectadas en comparación con las áreas de mayor altitud (Figura 8). Sin embargo, cada lugar parece tener una asociación predominante de cultivos circundantes, como aguaymanto y rocoto, junto con el cultivo principal de granadilla en cada ubicación.

Azamora sororia muestra una distribución altitudinal específica en el área de estudio, que abarca desde los 1.566 metros sobre el nivel del mar (msnm) hasta los 2.093 msnm. El análisis de los datos recolectados revela que la mayor concentración de muestras de *A. sororia* se encontró en las zonas comprendidas entre los 1.566 y los 1.699 msnm, representando el 49,76% del total de las muestras. Esto indica una preferencia de la especie por estas altitudes, posiblemente debido a condiciones climáticas, vegetativas o micro ambientales favorables que facilitan su desarrollo y reproducción. Por otro lado, el menor porcentaje de muestras, equivalente al 4,11%, se registró en las áreas situadas entre los 1.843 y los 1.890 msnm. Este menor número de registros en altitudes más elevadas sugiere que las condiciones en estas zonas podrían ser menos favorables para la especie. Factores como temperaturas más bajas, cambios en la vegetación y la disponibilidad de recursos alimentarios podrían influir en esta menor abundancia (Lozano-Povis et al. 2021). La variabilidad en la distribución altitudinal de *A. sororia* proporciona información valiosa para el manejo de esta plaga, permitiendo identificar zonas críticas y desarrollar estrategias de control más efectivas adaptadas a las condiciones específicas de cada altitud. En tanto Becker (2023), indica haber trabajado con especímenes provenientes de México, Guatemala, Costa Rica, Colombia, Venezuela, Perú, Brasil, Argentina, y señala que la especie se adapta mejor a áreas más frías. A excepción de los especímenes colectados en Lima, Perú, todos los demás provinieron de elevaciones más altas, entre 600 msnm en Turrialba, Costa Rica y 2.000 msnm en el Volcán Turrialba, también en Costa Rica, sin embargo, hace referencia que Lima, a pesar de su baja elevación, es relativamente fresca, con 18,75 ºC de temperatura media anual. Frente a este reporte, es necesario cuestionar que Becker (2023) debe ser más preciso en la descripción de la ubicación, sabiendo que el cultivo de la granadilla en Perú esta acentuada en otras regiones distinta a lo mencionado. Romero et al. (2020) indican que su centro de producción del cultivo de *Passiflora ligularis* en Perú está en los valles interandinos a altura entre los 900 a 2.700 msnm y en especial en los departamentos de La Libertad, Junín; Pasco; Ancash, Huánuco, Ayacucho, Cuzco (Urubamba) y Cajamarca.

Figura 4. Porcentaje de parcelas infectadas de *Azamora sororia*.



Descripción de daños y hábitos de la plaga: La especie que perfora los frutos del cultivo de la *Passiflora ligularis* en el bosque de conservación Carpish causa daños cuando la larva penetra el fruto mediante un pequeño orificio en la epidermis. Una vez dentro, la larva se alimenta y crea túneles de tamaño considerable, refugiándose internamente cerca de la base del fruto. Durante su fase larval, permanece dentro del fruto dañado hasta alcanzar su etapa final justo cuando el fruto alcanza su madurez fisiológica. En este punto, la larva abandona el fruto a través del mismo orificio por donde ingresó y cae al suelo para iniciar su fase de pupa.

El estado larval de la plaga se alimenta del tejido interno y porciones basales de la hoja, completando su ciclo de desarrollo larvario dentro de estos refugios antes de abandonarlos y caer al suelo para pupar. Un aspecto destacado de la plaga descrita es la diferencia en el tamaño del orificio de entrada mientras la larva está dentro del fruto (0,3 mm diámetro a 0,6 mm de diámetro), comparado con el tamaño del orificio después de que la larva ha dejado el fruto (1,2 mm diámetro a 1,7 mm de diámetro (Figuras 5-6.), que muestra la perforación inicial del fruto (0,6 mm Ø) por la larva de *Azamora sororia,* fruto abandonado por la larva (hasta 1,7 mm Ø), b) Orificio de salida de la oruga de *Azamora sororia* (Figuras 7-8).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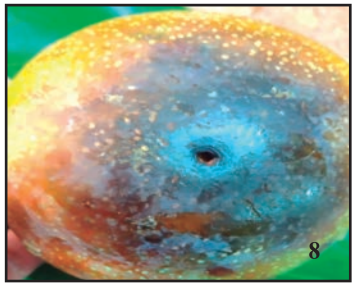

Fueron observados en promedio, hasta tres larvas presentes en cada fruto, en etapas tempranas de madurez, mientras que solo se encontraba una larva en los frutos dañados que habían alcanzado la madurez fisiológica (Figuras 9-10). Esta variación sugiere la necesidad de investigar más a fondo la posibilidad de canibalismo entre las larvas de la plaga. Podría haber una competencia entre las larvas por recursos limitados dentro del fruto, lo que podría llevarlas a consumirse mutuamente para sobrevivir. Este comportamiento de canibalismo entre las larvas podría afectar la densidad poblacional de la plaga y, por lo tanto, su capacidad para causar daños a los cultivos. Por consiguiente, investigaciones futuras deberían enfocarse en comprender más profundamente esta interacción y cómo afecta al control y manejo de la plaga. Los daños también han sido observados a nivel del pedúnculo de los frutos y ramas cercanas a los frutos, daño de taños en etapa de desarrollo (Figuras 11-12).

Los daños descritos de la especie en el presente estudio indica que este ocurre cuando la larva perfora e ingresa al fruto a través de un pequeño orificio en la epidermis. Una vez dentro se alimenta y forma túneles de tamaño considerable, refugiándose internamente entre la inserción del pedúnculo del fruto. La búsqueda bibliográfica no reveló ninguna descripción de daño causado por la especie en el cultivo de *Passiflora*. En tanto Becker (2023) hace una mención corta de que se han encontrados larvas de *Azamora* Walker, dañando a los frutos y tallos de especies de la familia Passifloraceae silvestres y cultivadas en América tropical, mas no precisa a detalle la forma de año ocasionado. Es necesario visualizar las formas de daño de otras especies dentro de esta familia. Branco et al. (2014) reporta que las larvas de la especie *Dioryctria sylvestrella* (Ratzeburg, 1840) excavan galerías bajo la corteza del tronco de *Pinus* donde se alimentan de floema y las larvas de esta especie prefieren árboles vigorosos. La especie *Ectomyelois ceratoniae* (Zeller, 1839) es perjudicial en huertos de *Punica granatum* L., la larva perfora el fruto, creando un agujero a través del cual deja excrementos de color negro. En ocasiones, especialmente durante las primeras perforaciones, también se observa la exudación de goma del fruto.

Conclusiones

El estudio confirma a *Azamora sororia* como la plaga responsable de la perforación de frutos en el cultivo de *Passiflora ligularis* dentro del bosque protegido de Carpish, evidenciando que su distribución es heterogénea y se asocia a variables altitudinales y ambientales, dado que se registra mayor abundancia en zonas de menor altitud como Challana; además, se identifican daños característicos en la estructura del fruto, lo que sugiere comportamientos alimenticios que podrían incluir competencia o canibalismo entre larvas, resaltando la importancia de profundizar en la biología y ecología de la especie para desarrollar estrategias de manejo integradas que permitan mitigar su impacto y favorecer la sostenibilidad del cultivo en una región de alta relevancia agroexportadora.

Conflicto de intereses

Los autores declaran no tener intereses financieros conocidos ni relaciones personales que pudieran haber influido en el trabajo presentado en este artículo.

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

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Las solicitudes cumplirán las siguientes condiciones:

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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.

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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.

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

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

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Gelechiidae of the Canary Islands (Spain). Part 2. Dichomeridinae, Anomologinae (= Apatetrinae auct.), Thiotrichinae (Lepidoptera: Gelechiidae)

Per Falck & Ole Karsholt

Abstract

The Gelechiidae subfamilies Dichomeridinae, Anomologinae and Thiotrichinae in the Canary Islands are revised. We recognize seven species of Dichomeridinae, five species of Anomologinae and two species of Thiotrichinae. Four species are described as new: *Dichomeris vivesi* Falck & Karsholt, sp. nov., *Helcystogramma brachmiaella* Falck & Karsholt, sp. nov., *Pseudosophronia confluella* Falck & Karsholt, sp. nov., and *Chrysoesthia diurnella* Falck & Karsholt, sp. nov. A lectotype of *Nothris castellana* Schmidt, 1941, now *Dichomeris castellana* (Schmidt, 1941), is designated. *Dichomeris castellana* (Schmidt, 1941), *Sitotroga psacasta* Meyrick, 1908, and *Polyhymno dumonti* (Hartig, 1936) are recorded as new to the Canary Islands. We also present several records of species new to single Canary Islands. *Dichomeris cisti* (Staudinger, 1859) is removed from the list of Lepidoptera in the Canary Islands. The paper is illustrated with photographs of adults and genitalia of the new species as well as of other species when relevant. Analyses of DNA barcodes show that the identifications and distinctiveness of each species as well-supported and genetically isolated.
Keywords: Lepidoptera, Gelechiidae, Dichomeridinae, Anomologinae, Thiotrichinae, new species, new records, subspecies, endemic, DNA barcodes, Canary Islands, Spain.

Gelechiidae de las Islas Canarias (España). Parte 2. Dichomeridinae, Anomologinae (= Apatetrinae auct.), Thiotrichinae
(Lepidoptera: Gelechiidae)

Resumen

Se revisan las subfamilias Dichomeridinae, Anomaloginae y Thiotrichinae de la familia Gelechiidae en las Islas Canarias. Se reconocen siete especies de Dichomeridinae, cinco especies de Anomologinae y dos especies de Thiotrichinae. Se describen cuatro especies nuevas: *Dichomeris vivesi* Falck & Karsholt, sp. nov., *Helcystogramma brachmiaella* Falck & Karsholt, sp. nov., *Pseudosophronia confluella* Falck & Karsholt, sp. nov., y *Chrysoesthia diurnella* Falck & Karsholt, sp. nov. Se designa un lectotipo de *Nothris castellana* Schmidt, 1941, ahora *Dichomeris castellana* (Schmidt, 1941). *Dichomeris castellana* (Schmidt, 1941), *Sitotroga psacasta* Meyrick, 1908 y *Polyhymno dumonti* (Hartig, 1936) se registran como nuevas para las Islas Canarias. También presentamos varios registros de especies nuevas en una sola isla de las Canarias. *Dichomeris cisti* (Staudinger, 1859) se elimina de la lista de Lepidoptera de las Islas Canarias. El artículo se ilustra con fotografías de adultos y genitalia de las nuevas especies, así como de otras especies cuando es pertinente. Los análisis de códigos de barras de ADN muestran que las identificaciones y la distinción de cada especie están bien fundamentadas y son genéticamente aisladas.
Palabras clave: Lepidoptera, Gelechiidae, Dichomeridinae, Anomologinae, Thiotrichinae, nuevas especies, nuevos registros, subespecies, endémicas, códigos de barras de ADN, Islas Canarias, España.

Introduction

This is the second part of a planned series of papers on the Gelechiidae of the Canary Islands. It follows Karsholt et al. (2013) for the higher systematics and the European checklist of Gelechiidae (Huemer & Karsholt, 2020) for the sequence of genera and species. We here deal with the subfamilies Dichomeridinae, Anomologinae and Thiotrichinae, which in these islands are represented by seven, five and two species respectively.

Dichomeridinae is a large subfamily, dominated by the species-rich genera *Dichomeris* Hübner, [1818] and *Helcystogramma* Zeller, 1877 and including a few additional small genera. The Anomologinae (formerly known as Apatetrinae, see below) falls into two almost equal-sized tribes: Anomologini and Pexicopiini, each with about 25 genera. The Thiotrichinae, which is mainly distributed in Asia, includes about 300 species in seven genera (Lee & Li, 2024, p. 8).

When revising the small South African genus *Anomologa* Meyrick, 1926 (Bidzilya et al. 2025) it became evident that it belongs to the subfamily currently known as Apatetrinae. *Anomologa* is the type of genus of the Anomologinae Meyrick, 1926, and that subfamily has priority over Apatetrinae Le Marchand, 1947, which becomes a junior synonym. The subfamily currently known as Anomologinae auct., is replaced by its oldest junior synonym Aristoteliinae Le Marchand, 1947. We plan to deal with the latter subfamily in part 3 of this series of papers dealing with the Gelechiidae of the Canary Islands (Spain).

Material and methods

For methods of collecting, preparing of genitalia slides and photographing see Falck & Karsholt (2025).

Details of all examined specimens are listed for newly described species. For other species only specimens used for DNA barcoding or for genitalia dissections are listed, as well as specimens representing new island records.

We examined the morphology of all species and the DNA barcodes from new and cryptic 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-DICHOCA at https://www.boldsystems.org. and at https://doi.org/10.5883/DS-DICHOCA.

Plant names are according to World Flora Online (2024).

Abbreviations used

AW	Collection of Andreas Werno, Nunkirchen, Germany
JS	Collection of Josef Jaroš, České Budějovice, Czechia
PF	Collection of Per Falck, Neksø, Denmark
MNCN	Collection of Antonio Vives, Museo Nacional de Ciencias Naturales, Madrid, Spain
MZH	Finnish Museum of Natural History, Helsinki, Finland
RMNH	Naturalis Biodiversity Center, Leiden, The Netherlands
SMNK	Staatliches Museum für Naturkunde Karlsruhe, Germany
WS	Collection of Willibald Schmitz, Bergisch Gladbach, Germany
ZMUC	Zoological Museum, Natural History Museum of Denmark, Copenhagen, Denmark

Checklist

Only synonyms used in literature on Gelechiidae of the Canary Islands are included. For additional synonyms see Vives Moreno (2014).

GELECHIIDAE
DICHOMERIDINAE

Dichomeris acuminatus (Staudinger, 1876)
lotella (Constant, 1893)
Dichomeris castellana (Schmidt, 1941)

Dichomeris vivesi **Falck & Karsholt, sp. nov.**
Helcystogramma convolvuli (Walsingham, 1908)
Helcystogramma brachmiaella **Falck & Karsholt, sp. nov.**
Helcystogramma lamprostoma (Zeller, 1847)
Pseudosophronia confluella **Falck & Karsholt, sp. nov.**

ANOMOLOGINAE

Anomologini

Chrysoesthia boseae (Walsingham, 1908)
Chrysoesthia diurnella **Falck & Karsholt, sp. nov.**

Pexicopiini

Platyedra subcinerea (Haworth, 1828)
vilella (Zeller, 1847)
Sitotroga psacasta Meyrick, 1908
Sitotroga cerealella (Olivier, 1789)

THIOTRICHINAE

Polyhymno dumonti (Hartig, 1936)
Palumbina guerinii (Stainton, 1857)

Results

Dichomeris Hübner, [1818]
Dichomeris Hübner, [1818]. *Zuträge Samml. exot. Schmett., 1,* 25

With about 650 species (Hobern et al. 2024) the genus *Dichomeris* is, in its current concept, the most species-rich genus within the Gelechiidae. It is moreover morphologically very diverse, and numerous genera were formerly erected to include different more or less striking species. Hobern et al. (2024) lists 83 synonyms of the genus *Dichomeris.* Most adults have segment 2 of the labial palp with a scale tuft. The genitalia are rather complex compared to most other gelechiid genera. The genus is distributed over large parts of the world. Larvae feed on herbs, bushes and trees of a number of different plant families.

Remarks: *Dichomeris cisti* (Staudinger, 1859) is listed by Vives Moreno (2014, p. 164) without exact data. It is unclear if the record is based on misidentified material or is due to a printing error. *D. cisti* should be removed from the list of Lepidoptera in the Canary Islands until its presence there is confirmed.

Dichomeris acuminatus (Staudinger, 1876)
Mesophleps (?) *acuminatus* Staudinger, 1876, in Kalchberg, *Stettin. ent. Ztg., 37,* 148
Ypsolophus lotellus Constant, 1893. *Annls Soc. ent. Fr., 62,* 398, pl. 11, fig. 7

Diagnosis: A characteristic medium-sized species (wingspan 12-14 mm) having orange-brown forewings with two blackish discal spots, sometimes with plical spots present. Labial palps have segment 2 with a large, porrect, greyish scale tuft.

Biology: The larva feeds from a slight web between the leaves of several species of Fabaceae. It has not been recorded from the Canary Islands.

Distribution in the Canary Islands, Spain: First record by Klimesch (1984, p. 166) from Gran Canaria. **New island records**: Fuerteventura, Lajares, 1 ♀, 15-18-XII-1996, leg. K. Larsen (ZMUC); Costa Calma, 45 m, 7 ♂, 11-XI-1-XII-2022, leg. P. Falck (PF); Lanzarote, Mojón Blanco, Orzola, 20 m, 1 ♂, 1 ♀, 21-X-10-XI-2019, leg. P. Falck (PF); Tenerife, Los Cristianos, 1 ♂, 10-20-III-1980, leg. J. B. Wolschrijn (ZMUC).

General distribution: Widely distributed in subtropical and tropical parts of the world. In Europe in the Mediterranean countries' northwards to southern England; Canary Islands and Madeira.

Dichomeris castellana (Schmidt, 1941) (Figures 1a, 1b, 1c, 2, 13, 13a, 14, 14a, 20)
Nothris castellana Schmidt, 1941. *Boln R. Soc. esp. Hist. nat., 38,* 37, pl. 2, fig. 4

Material examined: SPAIN, Fuerteventura, Corralejo, 1 ♂, 14-20-XII-1996, leg. K. Larsen; Lajares, 5 ♂, 1 ♀, 15-18-XII-1996, leg. K. Larsen; La Oliva, 200 m, 2 ♂, 1 ♀, 18-XII-1996, leg. K. Larsen; Vega de Río Palmas, 230 m, 4 ♂, 19-XII-1996, 1 ♂ 24-II-2019, leg. K. Larsen (all ZMUC); Lajares, 50 m, 8 ♂, 7-27-XI-2017, leg. P. Falck, DNA sample Lepid Phyl 1431PF/CILEP1430-24 (PF); Betancuria, 400 m, 13 ♂, 1 ♀, 7-27-XI-2017, leg. P. Falck, genitalia slide 4098PF (PF); Las Parcelas, 70 m, 1 ♂, 7-27-XI-2017, leg. P. Falck (PF); Caldereta, 120 m, 1 ♂, 7-27-XI-2017, leg. P. Falck (PF). Lanzarote, Urb. Famara, 55 m, 4 ♂, 1 ♀, 2-8-XI-2018, leg. C. Hviid & B. Skule (ZMUC); 2 km SW Urb. Famara, Las Laderas, 41 ♂, 3 ♀, 75 m, 2-8-XI-2018, leg. C. Hviid & B. Skule (ZMUC); Caleta de Famara, 10 m, 5 ♂, 21-X-10-XI-2019, leg. P. Falck (PF); Mojón Blanco, Orzola, 20 m, 9 ♂, 1 ♀, 21-X-10-XI-2019, leg. P. Falck, genitalia slides 4099PF, 4100PF (PF); El Golfo, 95 m, 3 ♂, 21-X-10-XI-2019, leg. P. Falck (PF); Mala, 18 m, 4 ♂, 21-X-10-XI-2019, leg. P. Falck (PF); El Boesquecillo, 610 m, 2 ♂, 21-X-10-XI-2019, leg. P. Falck, DNA sample Lepid Phyl 1432PF/CILEP1431-24 (PF). MOROCCO, 25 km S Essaouira, Sidi Kaouki, 100 m, 1 ♂, 28-III-2005, leg. O. Karsholt (ZMUC); Agadir, Sidi Toual Beach, 1 ♂, 28-I-2017, leg. C. Hviid & K. Larsen, genitalia slide 5452Karsholt (ZMUC).

Diagnosis: *D. castellana* is very variable. It is a medium-sized species (wingspan 13-15 mm) having grey forewings mottled with black, which varies from a few scales to having dark veins. Costal third of the forewing to near apex sometimes dark grey. Terminal dots can be very distinct. Labial palps have segment 2 with greyish scale tuft. It resembles in particular *Dichomeris helianthemi* (Walsingham, 1903) and it is probably not possible to distinguish the species without dissection of the genitalia or by barcoding.

DNA barcodes: We obtained a full-length DNA barcode (658 bp) from one specimen and DNA barcode fragments of 632 bp from one specimen. The barcodes fall within Barcode Index Number (BIN) BOLD: AAV6610. The maximum intraspecific p-distance is 2.00% (n=6). The nearest neighbour is *Dichomeris helianthemi* (Walsingham, 1903) with a 4.97% divergence.

Biology: Early stages and hostplant are unknown. Adults from the Canary Islands have been collected at light from late October to late February, at altitudes from 10 m to 610 m.

Distribution in the Canary Islands, Spain: **New to the Canary Islands**.

General distribution: Canary Islands (Lanzarote, Fuerteventura), Spain (mainland); Morocco (new record).

Figure 1a. Lectotype of *Nothris castellana* Schmidt, 1941 (MNCN). **1b.** Labels of the Lectotype.

Remarks: *Nothris castellana* was described from an unstated number of specimens (at least two) collected by F. Escalera in September in Montarco in the province of Madrid, Spain. The specimens were placed in the collections of the Natural History Museums of Budapest (Hungary) and Madrid (Spain) (Schmidt, 1941, pp. 37-38). Due to the kindness of Javier Gastón Gastón, Emili Requena and Dr. Amparo Blay (MNCN) (Madrid, Spain). we could examine a photograph of the male genitalia of a syntype kept in MNCN. The genitalia slide is already labelled as lectotype by Klaus Sattler, but it has not yet been published. In order to stabilize nomenclature this male specimen is here designated as the lectotype of *Nothris castellana*. It has number 57623 and is labelled "Nothris castellana Schmidt, Montarco, IX, F. Escalera" and has genitalia slide number 623c K. Sattler (Figures 14, 14a). The species has not been recorded before from outside mainland Spain.

***Dichomeris vivesi* Falck & Karsholt, sp. nov.** (Figures 3, 4, 5, 15, 15a, 21)
https://zoobank.org/2EDED3EB-DD15-4C9C-81A1-6AF0FFA27C47

Holotype ♀: SPAIN, Gran Canaria, Ayacata, 1400 m, 4-23-III-2019, leg. P. Falck (MNCN)

Paratypes: SPAIN, Gran Canaria, St. Bartolomé, leg. Pinker, abdomen missing (SMNK); Ayacata, 1400 m, 1 ♂, 4-23-III-2019, leg. P. Falck, genitalia slide 4109PF (PF); Pie de la Cuesta, 500 m, 1 ♀, 4-23-III-2019, leg. P. Falck, genitalia slide 4113PF, DNA sample Lepid Phyl 0855PF/CILEP854-21, same data but, 1 ♂, 24-X-13-XI-2020, leg. P. Falck, DNA sample Lepid Phyl 0856PF/CILEP855-21 (PF).

Diagnosis: *Dichomeris vivesi* sp. nov. is characterized by having a plical spot, two dark grey discal spots and sometimes a longitudinal, median streak. It resembles *Dichomeris juniperella* (Linnaeus, 1761), which has the discal spots more distinct and always without a median streak. In the male genitalia of *D. vivesi* sp. nov. the pointed, sub-triangular sacculus, the symmetrical juxta and the stout phallus are characteristic. They mostly resemble *D. castellana* (Schmidt, 1941), which has a shorter rounded sacculus and a longer, narrower sclerite in the phallus. In the female genitalia the shape of colliculum is characteristic.

Description Adult (Figures 3-5): Wingspan 15.5-18.5 mm. Labial palp slender, strongly upturned; segment 2 brownish, mottled with white-tipped scales, dorsally whitish, ventrally with large tuft; segment 3 brownish, laterally white. Antenna brownish grey. Head, neck and thorax brownish grey. Forewing brownish grey, mottled with darker grey scales; costa black basally; one dark grey, rather indistinct plical spot at 1/5 and two small, indistinct discal spots at 1/3 and 3/5; at costa near apex and along termen 7-8 black, distinct spots; postmedian fascia light grey, very diffuse, sometimes absent; fringe brownish grey. Hindwing grey; fringe grey.

Variation: There is some variation in the wing pattern. One or both discal spots may be diffuse or totally absent, sometimes there is a dark brownish grey, longitudinal streak from near the base to the end of the cell.

Male genitalia (Figures 15, 15a): Uncus rounded, setose. Gnathos heavily sclerotized, falcate, slightly angulated basally. Tegumen elongate. Valva simple, broadening distally, apex rounded. Sacculus sub-triangular, pointed, slightly setose. Vinculum relatively long and thin, bilobed apically. Juxta V-shaped, almost symmetrical, basally fused with vinculum, apically serrate. Phallus stout, relatively large, ventrally curved, apically spatulate; one long sclerite.

Female genitalia (Figure 21): Papillae anales pointed apically, covered with few long setae. Posterior apophysis slender, 2.5 times longer than anterior apophysis; anterior apophysis apically thickened. Antrum very broad, membranous. Ductus bursae broad. Colliculum heavily sclerotized, triangular with a sclerite and a less sclerotized elongate plate reaching corpus bursae; exit to ductus seminalis triangular, heavily sclerotized. Corpus bursae oval, membranous. Bulla seminalis rounded, membranous.

DNA barcodes: We obtained a full-length DNA barcode (658 bp) from one specimen and DNA barcode fragments of 632 bp from one specimen. The barcodes fall within Barcode Index Number (BIN) BOLD: ADI2574. The maximum intraspecific p-distance is 0.17% (n=4). The nearest neighbour is *Dichomeris juniperella* (Linnaeus, 1761) with a 6.57% divergence.

Biology: Early stages and hostplant are unknown. Adults have been collected at light in March and September, at altitudes from 800 m to 1400 m.

Distribution: Endemic to the Canary Islands, Spain and only known from the mountain areas on the island of Gran Canaria.

Etymology: The species is named after the editor of SHILAP Dr. Antonio Vives, who has been very helpful editing our manuscripts and providing permissions to collect Lepidoptera in the Canary Islands, Spain.

Helcystogramma Zeller, 1877
Helcystogramma Zeller, 1877. *Horae Soc. ent. ross., 13,* 369

A large genus with about 150 species distributed over large parts of the world. Known hostplants include Asteraceae, Convolvulaceae, Malvaceae, Poaceae and Rutaceae. Differences from the closely related genus

Brachmia Hübner, 1825 were discussed by Berggren et al. (2023, pp. 38-40).

Helcystogramma convolvuli (Walsingham, 1908)
Trichotaphe convolvuli Walsingham, 1908. *Proc. zool. Soc. Lond., 1907,* 944, pl. 51, fig. 16

Diagnosis: A characteristic medium-sized species (wingspan 11.5-14 mm) having blackish brown forewings, with black discal spots encircled orange and a yellowish sub-apical costal spot. Head and labial palps yellowish brown.

Biology: The characteristic larva feeds in rolled leaves of sweet potato *Ipomoea batatas* (L.) (Lam.) and other Convolvulaceae, sclerotizing the leaves (Malumphy, 2012, p. 149). Walsingham (1908, p. 944) found larvae in January "extremely abundant" in Santa Cruz, Tenerife on *Ipomoea quinquefolia*, a synonym of *Distimake quinquefolius* (L.) A. R. Simones & Staples, and probably an error for *Ipomoea cairica* (L.) Sweet, on which plant the larva is common in Tenerife, or *Ipomoea batatas* (Lepiforum 2008-2024).

Distribution in the Canary Islands, Spain: First record by Rebel (1892, pp. 175, 283) from Gran Canaria as "*Ceratophora sp.*". Subsequently from Tenerife (Walsingham, 1908, p. 944), La Gomera and La Palma **(**Klimesch, 1984, p. 166). **New islands record**. Fuerteventura, La Pared, Playa de la Pared, 1 ♀, 20-IX-2011, leg. A. Werno (AW); Lanzarote: Urb. Famara, 55 m, 1 ♀, 2-8-XI-2018, leg. C. Hviid & B. Skule (ZMUC).

General distribution: Widely distributed in tropical and subtropical countries world-wide. In Europe only established in the Canary Islands (Spain) and Madeira Portugal) but has occasionally been intercepted in consignments of sweet potato imported into Great Britain (Malumphy, 2012, p. 149-150; Lepiforum, 2008-2024).

***Helcystogramma brachmiaella* Falck & Karsholt, sp. nov.** (Figures 6, 7, 16, 16a, 22)
https://zoobank.org/04993F92-E1EE-41FF-981F-36346C22955C

Holotype ♂: SPAIN, La Gomera, La Calera, e. l. 5-IV-1972, *Schizogyne sericea*, leg. J. Klimesch (ZMUC).

Paratypes: SPAIN, Gran Canaria, Maspalomas, 1 ♀, 9-18-X-1967, leg. Pinker (SMNK); Puerto Rico, 100 m, 6 ♂, 26-III-8-IV-1994, leg. F. Vilhelmsen (ZMUC); Puerto Rico, 25 m, 1 ♂, 11-24-VI-2018, leg. P. Falck, same data but, 6 ♂, 1 ♀, 17-30-IX-2018, leg. P. Falck, genitalia slides 4128PF, 4131PF, DNA samples Lepid Phyl 1715PF/CILEP1714-24, 1716PF/CILEP1715-24 (PF); El Sao, 110 m, 1 ♀, 11-24-VI-2018, leg. P. Falck, same data but, 1 ♂, 17-30-IX-2018, leg. P. Falck (PF). Tenerife, El Médano, Roja, 25 m, 2 ♂, 13-IV-1998, leg. K. Larsen (ZMUC), same data but, 11 ♂, 4 ♀, 1-20-III-2017, leg. P. Falck, genitalia slide 4129PF, DNA sample Lepid Phyl 1663PF/CILEP1662-24 (PF), same data but, 1 ♀, 18-XI-8-XII-2018, leg. P. Falck (PF, MNCN); El Médano env., Montaña Roja, 25 m, 3 ♂, 27-28-IV-2003, leg. J. Jaroš (JS, ZMUC); San Isidro env., Montaña de los Riscos, 150 m, 2 ♂, 2 ♀, 2-8-V-2003, leg. J. Jaroš (JS, ZMUC); Los Cristianos, 1 ♂, 10-15-I-2000, leg. J. B. Wolschrijn (ZMUC), same data but, 5 ♂, 1 ♀, 29-XII-2003, leg. O. Karsholt (ZMUC); SW Barranco by Chayofa, 1 ♂, 30-IV-2009, leg. A. Werno (AW); Tamaimo, 640 m, 1 ♂, 7-11-I-2008, leg. K. Larsen (ZMUC); Los Gigantes, 100 m, 2 ♂, 8-11-I-2008, leg. K. Larsen (ZMUC); Los Gigantes, 100 m, 1 ♂, 1-20-III-2017, leg. P. Falck, genitalia slide 4132PF (PF); Playa Paraiso, 25 m, 1 ♂, 1-20-III-2017, leg. P. Falck (PF). La Gomera, La Calera, 1 ♀, e. l. 5-IV-1972, Schizogyne sericea, leg. J. Klimesch (ZMUC); Hermigua, 1 ♀, 14-IV-1998, leg. K. Larsen (ZMUC); La Caleta, 75 m, 2 ♂, 28-VIII-13-IX-2024, leg. P. Falck (PF); Tamargada, 380 m, 1 ♂, 28-VIII-13-IX-2024, leg. P. Falck (PF). La Palma, Los Llanos de Aridane, Barranco de las Angustias, 2 ♂, 29-30-V-2016, leg. A. Werno (AW); Los Cancajos, 15 m, 1 ♂, 17-23-I-2019, leg. P. Falck (PF); El Jesús, 650 m, 3 ♂, 1 ♀, 9-30-III-2023, leg. P. Falck, genitalia slides 4102PF, 4106PF, DNA samples Lepid Phyl 1661PF/CILEP1660-24, 1664PF/CILEP1663-24 (PF). El Hierro, Sabinosa, 100 m, 2 ♂, 1 ♀, 22-VII-3-VIII-2022, leg. P. Falck, genitalia slide 4104PF (PF); Frontera, 280 m, 1 ♂, 22-VII-3-VIII-2022, leg. P. Falck, genitalia slide 4101PF, DNA sample Lepid Phyl 1662PF/CILEP1661-24 (PF); Jinama, 1250 m, 1 ♂, 22-VII-3-VIII-2022, leg. P. Falck, genitalia slide 4130PF (PF).

Diagnosis: *Helcystogramma brachmiaella* sp. nov. is characterized by its relatively small size and the grey forewings often with three orange spots and by having clearly raised scales proximally on each segment of the antenna. In the male genitalia the trapezoid saccus with a rounded invagination posteriorly and the heavily sclerotized apical half of the phallus are characteristic. In the female genitalia the shape of segment VIII, with the middle half of the posterior margin rounded and the triangular antrum without heavily sclerotized lobes are characteristic. It resembles *Brachmia infuscatella* Rebel, 1940, which is endemic to the Azores, but that species is without orange spots and a post-median fascia in the forewing, and its genitalia are very different, making it misplaced in the genus *Brachmia*.

Description adult (Figures 6-7): Wingspan 7-9.5 mm. Labial palp slender, upturned; dark grey, yellowish ventrally and mottled with yellowish scales dorsally, segment 2 longer than segment 3. Antenna dark grey, each segment proximally with distinctly raised scales. Head, neck and thorax grey. Forewing grey, blackish basally, beneath outer discal spot and sub-apically between outer fascia and termen; stigmata black, relatively distinct; three diffuse, orange spots, one at costa near the base, one between discal spots and one just above the outer discal spot; post-median fascia yellowish white, indistinct; fringe dark grey. Hindwing grey; fringe grey. Variation: The orange spots can be very diffuse or completely absent.

Male genitalia (Figures 16, 16a): Uncus rather long, slightly widening towards rounded apex. Gnathos long and straight, apex bifid, heavily sclerotized. Tegumen elongate, laterally with rounded projection. Valva simple, slightly broadening distally, apex rounded. Saccus trapezoid, anteriorly rounded, posteriorly with rounded invagination. Phallus basally rounded, apical half relatively narrow, pointed towards apex, laterally heavily sclerotized. Vesica with numerous spinules.

Female genitalia (Figure 22): Papillae anales relatively short, apically flattened. Posterior apophysis longer than papillae anales and three times longer than anterior apophysis. Segment VIII narrow, laterally a small round hole, posterior margin rounded, anterior margin slightly concave. Antrum triangular, weakly sclerotized. Ductus bursae short, membranous, weakly spinose. Corpus bursae membranous round, spinose around exit of tube to accessory sack and posteriorly to ductus bursae. Accessory sack rounded.

DNA barcodes: We obtained full length DNA barcodes (658 bp) from four specimens and DNA barcode fragments of 629 bp and 584 bp from two specimens. *H. brachmiaella* is divided into three well-separated sub-groups comprised by specimens from Tenerife and Gran Canaria (3 specimens), El Hierro (1 specimen) and La Palma (2 specimens) respectively. While within group variation is very low, the three sub-groups are very divergent with uncorrected p distance between Tenerife + Gran Canaria and El Hierro being 4.64%, the distance between Tenerife + Gran Canaria and La Palma being 2.66% and the distance between El Hierro and La Palma being 2.72%. The barcodes fall within three Barcode Index Numbers (BIN) BOLD: AGD8570 (Tenerife and Gran Canaria), BOLD: AGD8573 (El Hierro) and BOLD: AGD8572 (La Palma). The maximum intraspecific p-distance is very high 6.56%. The nearest neighbour is an unnamed Gelechiidae species from Honduras with a 5.31% divergence. The nearest neighbour in the genus is *Helcystogramma albinervis* (Gerasimov, 1929) with a 6.19% divergence.

Biology: The larva is blackish brown with wide white stripes. It mines the fresh leaves of *Schizogyne sericea* (L. f.) DC., the frass is expelled through a circular hole, and pupation often takes place within the mine (Klimesch, 1984, p. 168). Most of the adult specimens were attracted to light and a few disturbed from the hostplant.

Distribution: Known only from the islands of Gran Canaria, Tenerife, La Gomera, La Palma and El Hierro. Probably endemic to the Canary Islands, Spain.

Etymology: The species name refers to the fact that it was hitherto known as *Brachmia* sp.

Remarks: First recorded by Klimesch (1984, p. 167-168) as *Brachmia* sp. from Gran Canaria, Tenerife and La Gomera.

Helcystogramma lamprostoma (Zeller, 1847)
Gelechia lamprostoma Zeller, 1847. *Isis, Leipzig, 1847,* 851

Diagnosis: A characteristic medium-sized species (wingspan 10-12 mm) having forewings black with reddish brown dorsum and two oblique, white fasciae in apical half.

Biology: In the Canary Islands the larva feeds on *Convolvulus althaeoides* (L.), mining the leaves. When proceeding to new leaves it makes spinning between the leaves (Klimesch, 1984, p. 165, 182, fig. 75).

Distribution in the Canary Islands, Spain: First record by Rebel (1906, p. 38) from Tenerife. Also, on Gran Canaria and La Gomera (Klimesch, 1984, p. 165). **New island record**. Fuerteventura, Betancuria, 400 m, 7-27-XI-2017, leg. P. Falck (PF).

General distribution: Spain (with Canary Islands), most Mediterranean countries and larger islands, Turkey, Middle East, India, Myanmar, Indonesia, throughout Africa from Morocco to South Africa, Cape Verde.

Pseudosophronia Corley, 2001
Pseudosophronia Corley, 2001. *Entomologist's Gaz., 52,* 214

A small genus with only two species, distributed in South Europe, North Africa and Israel. Their biology is imperfectly known.

Pseudosophronia confluella **Falck & Karsholt, sp. nov.** (Figures 8, 17, 17a, 23)
https://zoobank.org/D564E4A3-2EEB-47FB-975A-A11CC8E04DC4

Holotype ♂: SPAIN, Fuerteventura, Lajares, 130 m, 30-V-13-VI-2023, leg. P. Falck, genitalia slide 4143PF (ZMUC).

Paratypes: SPAIN, Fuerteventura, Barranco Esquinzo, 1 ♂, 15-III-15-V-2008, leg. R. Pass (ZMUC); Lajares, 130 m, 1 ♀, 1-27-XI-2017, leg. P. Falck, genitalia slide 4142PF, same data but, 3 ♂, 27-II-18-III-2018, leg. P. Falck, genitalia slide 4117PF, same data but, 15 ♂, 5 ♀, 30-V-13-VI-2023, leg. P. Falck, genitalia slide 4116PF, DNA samples Lepid Phyl 1712PF/CILEP1711-24, 1713PF/CILEP1712-24, 1714PF/CILEP1713-24 (PF, MNCN); Las Parcelas, 70 m, 1 ♂, 2 ♀, 27-II-18-III-2018, leg. P. Falck (PF); Corralejo, 10 m, 2 ♂, 27-II-18-III-2018, leg. P. Falck, same data but, 1 ♀, 11-XI-2-XII-2022, leg. P. Falck, genitalia slide 4103PF (PF); Vega de Río Palmas, 230 m, 1 ♂, 30-V-12-VI-2023, leg. P. Falck, genitalia slide 4108PF (PF); Caldereta, 120 m, 1 ♂, 7-27-XI-2017, leg. P. Falck (PF); Caleta de Fuste, 20 m, 1 ♂, 6-26-I-2020, leg. P. Falck (PF); Betancuria, 400 m, 1 ♂, 27-II-18-III-2018, leg. P. Falck (PF, MNCN); Barranco tras del Lomo, 100 m, 1 ♂, 25-26-II-2019, leg. K. Larsen (ZMUC). MOROCCO, 15 km W Tiznit, Aglou Plage, 10 m, 3 ♀, 18-III-2005, leg. O. Karsholt, genitalia slide 5454 Karsholt; 8 km S Sidi Ifni, 50 m, 1 ♂, 2 ♂, 20-III-2005, leg. O. Karsholt, genitalia slide 5453 Karsholt; 10 km N Agadir, 400 m, 1 ♂, 1 ♀, 24-IV-2013, leg. J. Tabell; Guelmim-Oued Noun, Sidi Ifni, 0-100 m, 11 ♂, 3 ♀, 5-7-III-2017, leg. C. Hviid, O. Karsholt, K. Larsen & D. Nilsson, genitalia in vial (all ZMUC).

Diagnosis: *Pseudosophronia confluella* sp. nov. is characterized by the long white streak along the costa merging with the costal strigula. It is most similar to *Pseudosophronia cosmella* (Constant, 1885), which has the costal streak and the costal strigula separated and darker grey hindwings. *P. exustellus* (Zeller, 1847) is also similar, but can be recognized by the additional white streak(s) below the white costal streak in the apical half of the wing. In the male genitalia the long pointed uncus, the spatulate projections of the vinculum and the relatively broad basal half of the phallus are characteristic. They resemble *P. cosmella* and *P. exustella*, which both have a shorter uncus, longer and pointed projections of the vinculum and a narrower phallus. In the female genitalia the long ductus bursae and the round corpus bursae are characteristic. However, it is quite similar to *P. cosmella*.

Description adult (Figure 8): Wingspan 7.5-11 mm. Labial palp slender, strongly upturned; segment 2 white, ventrally with large tuft; segment 3 white, basally dark ringed, apex dark grey, ventrally a blackish, narrow, longitudinal streak. Antenna whitish, distinctively ringed dark grey. Head white. Neck whitish. Thorax light brown. Tegula light brown, basally white. Forewing dark brown; costa black basally; along costa from the base to 4/5 a broad, white streak, apically merging with a white costal strigula; below the cell from near the base to tornus a diffuse reddish-brown streak; terminal fascia distinct, black, bordered medially with white especially near costa and tornus; fringe whitish with dark-tipped scales and a black spot apically. Hindwing whitish grey, apically slightly brownish; fringe grey, apically darker grey.

Variation: There is minor variation in the wing pattern. The costal strigula does not always reach the costa.

Male genitalia (Figures 17, 17a): Uncus pointed, laterally and apically heavily sclerotized. Socius small, elongate, setose. Gnathos basally subrectangular, postero-laterally with narrow, curved projections, heavily sclerotized. Tegumen elongate, anterior margin inwardly curved. Valva simple, broadening distally, apex rounded. Vinculum large, V-shaped with spatulate projection. Saccus sub-triangular. Phallus as long as valva, curved basally and in the middle, very narrow in apical half.

Female genitalia (Figure 23): Papillae anales relatively long, pointed apically. Posterior apophysis long, slender, twice as long as anterior apophysis. Segment VIII with posterior margin convex, rounded; anterior margin medially V-shaped. Antrum cup-shaped, membranous covered with micro-spines. Ductus bursae slender, membranous. Corpus bursae membranous round.

DNA barcodes: We obtained full length DNA barcodes (658 bp) from two specimens and DNA barcode fragments of 638 bp from one specimen. The barcodes fall within Barcode Index Number (BIN) BOLD: AGK4509. The maximum intraspecific p-distance is 0.32% (n=3). The nearest neighbour is *Pseudosophronia cosmella* (Constant, 1885) with a 6.09% divergence.

Biology: Early stages and hostplant are unknown. Adults have been collected at light in January-March, June and September, at altitudes from 10 m to 130 m, in Morocco until April and up to 400 m.

Distribution: Known only from the islands of Fuerteventura, Spain and from the West coast of Morocco.

Etymology: The species is named after the confluent white longitudinal costal streak and the costal strigula.

Chrysoesthia Hübner, [1825]
Chrysoesthia Hübner, [1825]. *Verz. bekannter Schmett.,* 422

The genus includes about 25 mostly small, often colourful species, distributed in the Palaearctic, Nearctic and Afrotropical regions. Their larvae are leaf-miners of Amaranthaceae and Caryophyllaceae.

Chrysoesthia boseae (Walsingham, 1908)
Chrysopora boseae Walsingham, 1908. *Proc. zool. Soc. Lond., 1907,* 931, pl. 51, fig. 7

Material examined: SPAIN, Gran Canaria, Los Tilos de Moya, 500 m, 8 ♂, 5 ♀, 11-24-VI-2018, leg. P. Falck, DNA sample Lepid Phyl 1666PF/CILEP1665-24 (PF). Tenerife, Puerto de la Cruz, 200 m, 9 ♂, 8 ♀, larvae 18-XI-8-XII-2018, leg. P. Falck, genitalia slides 4119PF, 4137PF, DNA samples Lepid Phyl 1459PF/CILEP1458-24, 1460PF/CILEP1458-24 (PF). La Gomera, Hermigua, 250 m, 1 ♀, 9-29-III2024, leg. P. Falck, genitalia slide 4140PF, DNA sample Lepid Phyl 1667PF/CILEP1666-24 (PF). La Palma, Las Pajaros, 350 m, 7 ♂, 9-30-III-2023, leg. P. Falck, genitalia slides 4118PF, 4139PF, 4141PF, DNA samples Lepid Phyl 1457PF/CILEP1456-24, 1458PF/CILEP1457-24 (PF).

Diagnosis: A relatively small species (wingspan 7.5-9 mm) having blackish forewings, with an inner orange fascia, orange dots at dorsum and at the end of the cell and two yellowish dots on costa and one at tornus.

DNA barcodes: We obtained full length DNA barcodes (658 bp) from two specimens and DNA barcode fragments of 549 bp, 560 bp, 563 bp and 595 bp from four specimens. The barcodes fall within Barcode Index Numbers (BIN) BOLD: ADL6012 (Gran Canaria and Tenerife), BOLD: AGE7629 (La Gomera) and BOLD: AFS2681 (La Palma). The maximum intraspecific p-distance is 2.25% (n=8). The nearest neighbour is *Chrysoesthia verrucosa* Tokár, 1999 with a 7.66% divergence.

Biology: The larva mines the leaves of *Bosea yervamora* L. (Amaranthaceae) making blotch-mines. Adults are easily disturbed from bushes of the host-plant during the daytime.

Distribution in the Canary Islands, Spain: Described by Walsingham (1908, p. 931) from Tenerife as "*Chrysophora bosae* sp. n.". Subsequently recorded from La Gomera (Klimesch, 1984, p. 148) and El Hierro (Rebel, 1935, p. 17). **New island records**. Gran Canaria and La Palma, see under material examined.

General distribution: Endemic to the Canary Islands.

***Chrysoesthia diurnella* Falck & Karsholt, sp. nov.** (Figures 9, 10, 18, 18a, 24, 24a)
https://zoobank.org/2228A2D5-394A-449A-B857-21482C74719D

Holotype ♀: SPAIN, Lanzarote, Mojón Blanco, Orzola, 10 m, 21-X-10-XI-2019, genitalia slide 4138PF, leg. P. Falck (ZMUC).

Paratypes: SPAIN, Fuerteventura, Corralejo, 10 m, 29 ♂, 6 ♀, 6-26-I-2020, leg. P. Falck, genitalia slide 4110PF, 4112PF, 4133PF, 4135PF, DNA sample Lepid Phyl 1663PF/CILEP1662-24 (PF). Lanzarote, Mojón Blanco, Orzola, 10 m, 24 ♂, 26 ♀, 21-X-10-XI-2019, leg. P. Falck, genitalia slide 4111PF, 4114PF, 4115PF, 4134PF, 4136PF, DNA samples Lepid Phyl 0331PF/CILEP330-19, 0332PF/CILEP331-19, 0333PF/CILEP332-19, same data but 1 larva on *Atriplex halimus* L., 5-25-XI-2024, leg. P. Falck (PF, MNCN). MOROCCO, Guelmim-Oued Noun, 8 km S Sidi Ifni, 50 m, 1 ♂, 20-III-2005, leg. O. Karsholt; Guelmim-

Oued Noun, Sidi Ifni, sea level, 1 ♂, 5-7-III-2017, leg. C. Hviid, O. Karsholt, K. Larsen & D. Nilsson; 5 km SSW, Mirleft, N29.53821 W10.05780, 20 m, 3 ♂, 28-IV-2013, leg. J. Tabell, genitalia slide 4134ZMPF (all ZMUC).

Diagnosis: *Chrysoesthia diurnella* sp. nov. resembles *C. gaditella* (Staudinger, 1859), *C. aletris* (Walsingham, 1919), *C. halymella* (Amsel, 1935) and *C. atriplicella* (Amsel, 1939) and it is not possible to separate it from these without dissection of the genitalia or barcoding. In the male genitalia of *C. diurnella* sp. nov. the relatively fewer number of both the smaller and larger cornuti and the apical part of the phallus covered with one larger and few very small teeth are characteristic. In the female genitalia the relatively long anterior apophysis is characteristic.

Description. Male (Figures 9, 10): Wingspan 6.2-7.5 mm. Labial palp cream white, slender and slightly upturned. Antenna cream white distinctively ringed dark grey. Head cream white. Neck, thorax and tegula yellowish white. Forewing cream-white mottled with dark grey; at ¼ a dark grey costal spot, at ½ and ¾ two relatively broad, diffuse, dark grey fasciae; three yellowish brown spots, one beyond the inner costal dark spot, one dorso-laterally at the inner fascia and one at the end of the cell; apically from tornus to apex dark grey; fringe whitish with dark-tipped scales. Hindwing light grey; fringe grey. Female: As in male, but with less dark grey mottling and a more distinct wing pattern.

Male genitalia (Figures 18, 18a): Uncus rounded, setose. Gnathos weakly sclerotized, round, covered with small spines. Tegumen elongate. Valva sub-triangular. Sacculus trapezoidal, laterally with a row of comb-like denticles. Phallus straight, as long as the valva, apical third covered with about 15 very small and three larger teeth, basally a group of 7-12 small cornuti, towards apex a row of 5-6 larger cornuti.

Female genitalia (Figures 24, 24a): Papillae anales elliptical, heavily sclerotized with numerous bristles. Posterior apophysis very short, slightly longer than anterior apophysis. Segment VIII very short and wide, with protruding anterior margin. Ostium circular, hardly visible. Ductus bursae membranous. Corpus bursae elongate, membranous.

DNA barcodes: We obtained a full-length DNA barcode (658 bp) from one specimen and DNA barcode fragments of 623bp, 632 bp, 634 bp from three specimens. The barcodes fall within Barcode Index Number (BIN) BOLD: AEC2486. The maximum intraspecific p-distance is 1.62% (n=4). The nearest neighbour is an unnamed Gelechiidae species from Egypt with a 3.58% divergence. The minimum divergence from *Chrysoesthia gaditella* (Staudinger, 1859) is 7.28%.

Biology: The larva mines the leaves of *Atriplex halimus* L. (Amaranthaceae). Adults fly actively around bushes of the hostplant during the daytime.

Distribution: Known only from the islands of Fuerteventura and Lanzarote, Spain and Morocco.

Etymology: The species is named after its day flying habit.

Remarks: *Chrysoesthia diurnella* sp. n. belongs to a complex of closely related species: *C. gaditella* (Staudinger, 1859), *C. aletris* (Walsingham, 1919), *C. halymella* (Amsel, 1935) and *C. atriplicella* (Amsel, 1939) (Huemer & Karsholt 2020, p. 124; Lepiforum 2008-2024). We consider at least *C. atriplicella* to be a synonym of *C. gaditella*, but a formal synonymization is beyond the scope of this paper. For comparison the genitalia of both sexes of *C. gaditella* are figured (Figures 19, 19a, 25).

Platyedra Meyrick, 1895
Platyedra Meyrick, 1895. *Handbk Br. Lepid.,* 605

The single species is widely distributed, probably due to introduction from mainland Europe. The larva feeds in seed-heads of different Malvaceae.

Platyedra subcinerea (Haworth, 1828)
Recurvaria subcinerea Haworth, 1828. *Lepid. Br., 4,* 548
Gelechia vilella Zeller, 1847. *Isis von Oken, 1847,* 845

Diagnosis: A relatively large species (wingspan 17-19 mm) having brownish forewings, with a blackish, indistinct discal spot surrounded by a whitish ring and a characteristic black dot on dorsum near the base.

Biology: The larva lives in seeds and flowers of *Malva sylvestris* L. and occasionally *Alcea rosea* L. (Gregersen & Karsholt, 2022). In the Canary Islands there is only one record of *Malva sylvestris* from Fuerteventura (Canary Islands Biodiversity Database, 2024). Probably *P. subcinerea* lives in other *Malva* species present on the islands.

Distribution in the Canary Islands, Spain: First record from Tenerife by (Walsingham, 1908, pp. 941-942) as "*Platyedra vilella* Z." Subsequently from Gran Canaria and La Gomera (Klimesch, 1984, p. 165) and La Palma (Báez & Martín, 2001, p. 238). **New island records**. Fuerteventura, Lajares, 2 ♂, 15-18-XII-1996, leg. K. Larsen (ZMUC); Lanzarote: La Casita de Femes, 2 ♂, 1-II-1994, leg. J. P. Baungaard (ZMUC).

General distribution: See under the description of the genus.

Sitotroga Heinemann, 1870
Sitotroga Heinemann, 1870. *Schmett. Dtl. Schweiz* (2) *2* (1), 287

A small, but widely distributed genus with eight species (Hobern et al. 2024). The larva of *S. cerealella* is a pest on stored grain (Poaceae).

Sitotroga psacasta Meyrick, 1908 (Figure 11)
Paltodora psacasta Meyrick, 1908. *Proc. zool. Soc. Lond. 1908,* 723

Material examined: SPAIN, Gran Canaria, Maspalomas, 1 ♀, 2-IV-1994, leg. P. Grotenfelt (MZH); Puerto Rico, 100 m, 3 ♂, 26-III-8-IV-1994, leg. F. Vilhelmsen; Bco. De Arguineguin, 21-VII-1-VIII, 1995, leg. K. Larsen; Maspalomas, Presa de Chamoriscán, 300 m, 1 ♂, 27-VII-1-VIII-1995, leg. K. Larsen; 1.3 km N Mogan, 430 m, 4 ♂, 3-8-XI-2014, leg. B. Skule; 4 km NNE Mogan, Lugar del Pie de La Questa, 570 m, 2 ♂, 4-XI-2014, leg. B. Skule; 3.5 km NE Mogan, Barranco Mogan, 430 m, 2 ♂, 3-8-XI-2014, leg. B. Skule; El Doctoral, 350 m, 9 ♂, 4 ♀, 9-12-V-2018, leg. K. Larsen (all ZMUC); Pie de la Cuesta, 500 m, 2 ♂, 2 ♀, 11-24-VI-2018, leg. P. Falck (PF); Puerto Rico, 50 m, 2 ♂, 17-30-IX-2018, leg. P. Falck (PF); Teror, 550 m, 2 ♂, 24-X-13-XI-2020, leg. P. Falck (PF); Los Tilos de Moya, 500 m, 1 ♂, 11-24-VI-2018, leg. P. Falck (PF); Barranquillo de Andrés, 700 m, 1 ♂, 11-24-VI-2018, leg. P. Falck (PF). Tenerife, Las Montanas de Anaga, El Bailadero, 700 m, 1 ♂, 21-22-IV-1998, leg. K. Larsen (ZMUC); Casas Los Menores, 300 m, 11-I-1998, leg. K. Larsen (ZMUC); El Cabuquero, 200 m, 13-IV-1998, leg. K. Larsen (ZMUC); Armeníme, 50 m, 13 ♂, 2 ♀, 25-XI-2-XII-2012, leg. P. Falck, same data but, 1 ♂, 3-9-III-2013, leg. P. Falck (PF); Tamaimo, 550 m, 2 ♂, 2 ♀, 8-22-XI-2016, leg. P. Falck (PF); Los Gigantes, 100 m, 5 ♂, 4 ♀, 8-22-XI-2016, leg. P. Falck (PF); Los Roques, 160 m, 1 ♂, 18-XI-8-XII-2018, leg. P. Falck (PF). La Gomera, Hermigua, El Convento, 650 m, 1 ♂, 30-III-5-IV-2008, leg. W. Losert (WS); Hermigua, 1 ♂, 18-25-IV-2014, leg. W. Losert (WS); Hermigua, 170 m, 1 ♂, 1-8-I-2023, leg. P. Falck, DNA sample Lepid Phyl 1717PF/CILEP1716-24 (PF). La Palma, El Paso, Casa Tabares, 400 m, 1 ♂, 22-III-2008, leg. H. van der Wolf (RMNH).

Diagnosis: A medium sized species (wingspan 11-15 mm) having yellowish forewings, with a dark brown wing-pattern forming almost two outwardly oblique fasciae. Outer discal and plical spots distinct.

DNA barcodes: We obtained a full length DNA barcode (658 bp) from one specimen. The barcode falls within Barcode Index Number (BIN) BOLD: ADF3395. The nearest neighbour is a *Sitotroga* sp. from Australia with a 2.50% divergence.

Biology: Early stages and hostplant are unknown.

Distribution in the Canary Islands, Spain: **New to the Canary Islands**.

General distribution: Canary Islands, South Europe, South Africa.

Sitotroga cerealella (Olivier, 1789)
Alucita cerealella Olivier, 1789. *Encycl. Méth. Hist. nat., 4*(1), 121

Diagnosis: A medium sized species (wingspan 13-14 mm) having pointed brown forewings, with a black outer discal spot and black plical spots sometimes forming a diffuse plical streak.

Biology: The larva is a known pest on stored cereals and legumes such as barley, rye, oats, maize, wheat, rice, millet, buckwheat and bamboo (Gregersen & Karsholt, 2022, p. 191).

Distribution in the Canary Islands, Spain: First recorded from Tenerife by Rebel & Rogenhofer (1894, p. 89). Subsequently from Gran Canaria (Chrétien, 1908, p. 362) and La Palma (Klimesch, 1984, p. 164). **New island record**. La Gomera, Guarimiar area, 1 ♂, 1-III-2001, leg. A. Werno (AW).

General distribution: Almost cosmopolitan.

Polyhymno Chambers, 1874
Polyhymno Chambers, 1874. *Can. Ent., 6,* 246

A genus of 45 species, half of which occur in the Afrotropical region, with the remainder distributed in the Nearctic, Neotropical, Oriental and South-western Palaearctic regions. Known hostplants belong to the Fabaceae (Lee & Li, 2024, p. 77).

Polyhymno dumonti (Hartig, 1936) (Figure 12)
Stigmatoptera dumonti Hartig, 1936. *Z. öst. EntVer., 21,* 45, pl. 2, fig. 11, pl. 3, figs 11a-d.

Material examined: SPAIN, Fuerteventura, Barranco Esquinozo, 1 ♂, 3-I-25-II-2008, leg. R. Pass, genitalia slide 4132ZMPF (ZMUC), Corralejo, 10 m, 1 ♀, 7-27-XI-2017, leg. P. Falck (PF).

Diagnosis: A medium sized species (wingspan 11 mm) having light brown forewings, with three shining white longitudinal lines, the middle splitting towards apex and two white sub-apical spots.

Biology: Early stages and hostplant are unknown. Both specimens were attracted to light.

Distribution in the Canary Islands, Spain: **New to the Canary Islands**.

General distribution: Canary Islands; from Sudan across North Africa to Tunisia; Israel.

Palumbina Rondani, 1876
Palumbina Rondani, 1876. *Boll. Soc. ent. ital., 8,* 22

The 27 known species of this genus are mainly distributed in the Oriental region, with a few occurring in Australia. Only *P. guerinii* occurs in Europe and Africa. Known larvae are leaf miners on Anacardiaceae, Fagaceae and Hamamelidaceae (Lee & Li, 2024, pp 12, 55).

Palumbina guerinii (Stainton, [1857])
Stathmopoda guerinii Stainton, [1857]. *Entomologist's Annu., 1858,* 152, pl., fig. 5

Diagnosis: A very characteristic, medium sized, narrow-winged species (wingspan 9-13 mm) having greyish brown forewings, with two cream-white outwardly oblique fasciae and two short and one longer longitudinal streak.

Biology: The larva is a leaf-miner on *Pistacia* species. It has not been found in the Canary Islands.

Distribution in the Canary Islands, Spain: First record from Tenerife by Klimesch (1984, p. 160). Subsequently from Gran Canaria (Báez & Martín, 2001, p. 238).

General distribution: Throughout the Mediterranean countries from Turkey to Morocco and the Canary Islands; Kenya.

Discussion

With only 7 species of Dichomeridinae, 5 species of Anomologinae and 2 species of Thiotrichinae, the three subfamilies of Gelechiidae dealt with in this paper show a low diversity in the Canary Islands. Only three species from these subfamilies are endemic to the islands, *Dichomeris vivesi* sp. nov., *Helcystogramma brachmiaella* sp. nov. and *Chrysoesthia boseae* (Walsingham, 1908) and none of them has radiated there into species-groups. With the description of four new species and three additional species for the fauna of the Canary Islands, the present paper still represents a remarkable addition to the Lepidoptera from these islands.

The most recent checklist of Canary Island Lepidoptera (Vives Moreno, 2014) lists 5 species of Dichomeridinae, 4 species of Anomologinae (as Apatetrinae) and 1 species of Thiotrichinae. Among the five listed Dichomeridinae one species, *Helcystogramma mercedella* (Walsingham, 1908) was dealt with by us as *Aproaerema mercedella* Walsingham, 1908 in the subfamily Anacampsinae (Falck & Karsholt, 2025), and another species, *Dichomeris cisti* (Staudinger, 1859), as referred to earlier in this paper is removed from the list of Lepidoptera in the Canary Islands. Moreover, *Epidola stigma* Staudinger, 1859, which is listed by Vives Moreno (2014) in Apatetrinae, is removed to the Aristoteliinae and will be dealt with in the next part of this series (Falck & Karsholt, in press). This leaves 7 species correctly recorded from the Canary Islands in 2014, and the present contribution thus represents an increase of 100 % for these three subfamilies, which is comparable with what we found for the Anacampsinae (Falck & Karsholt, 2025).

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Conflict of Interest

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

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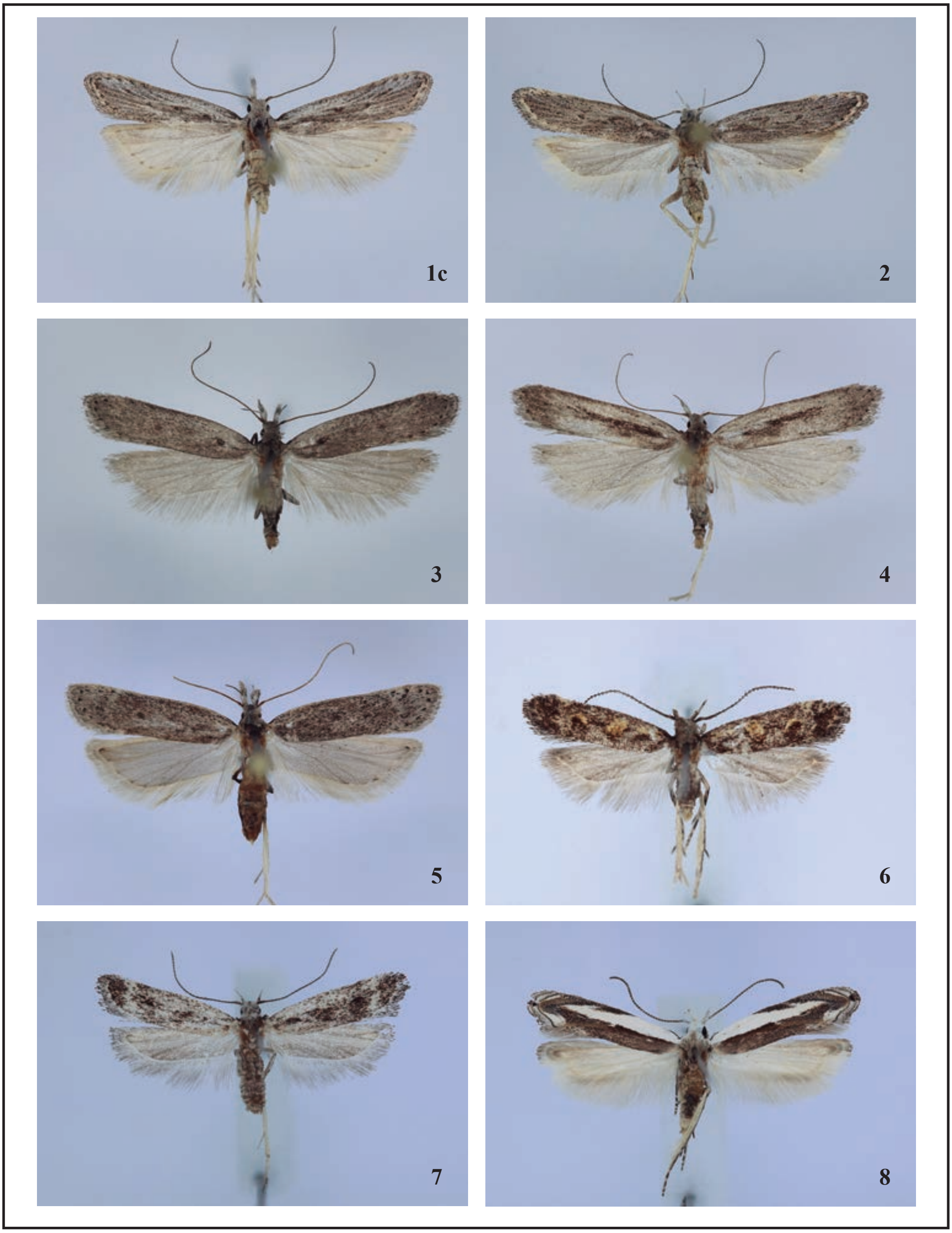
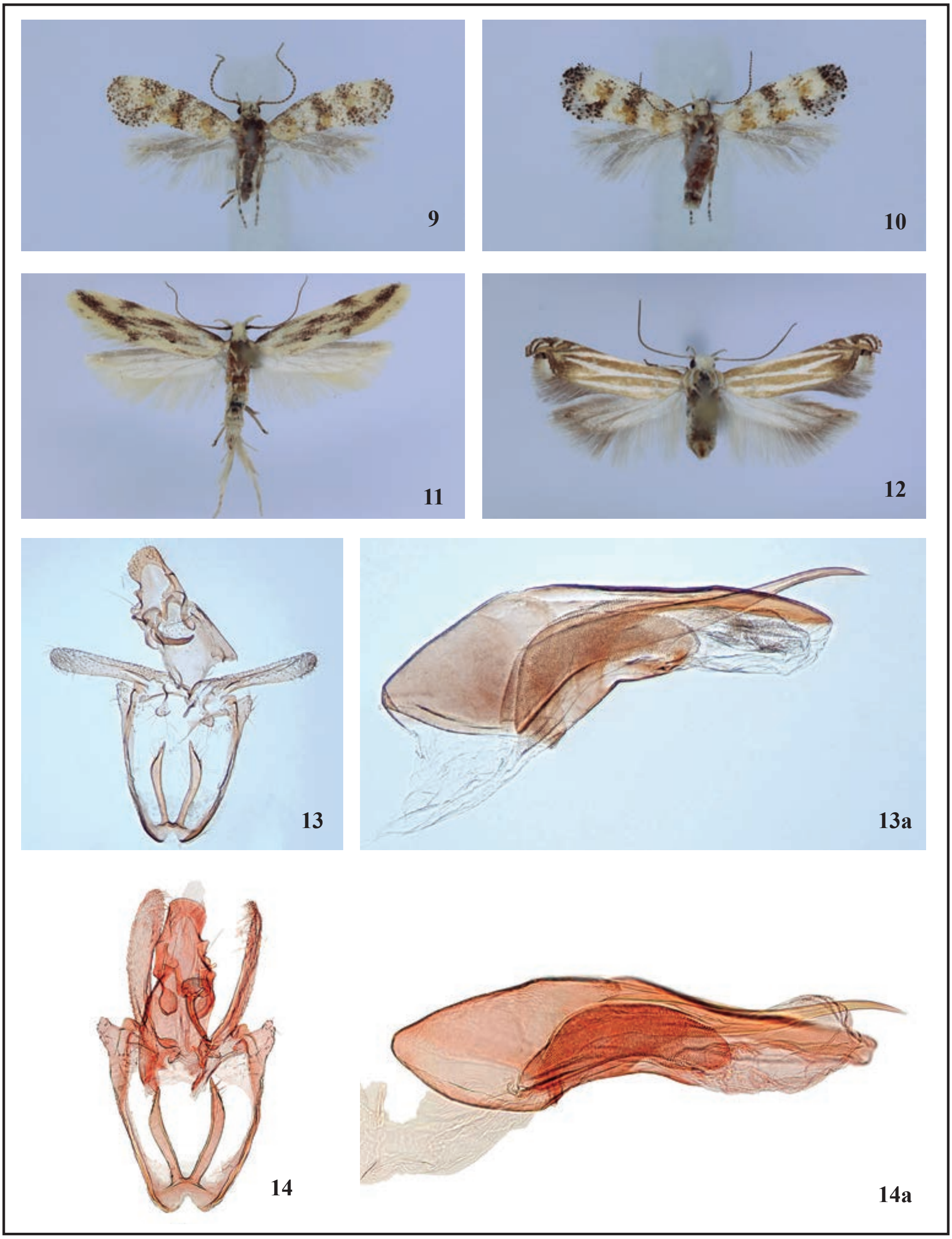
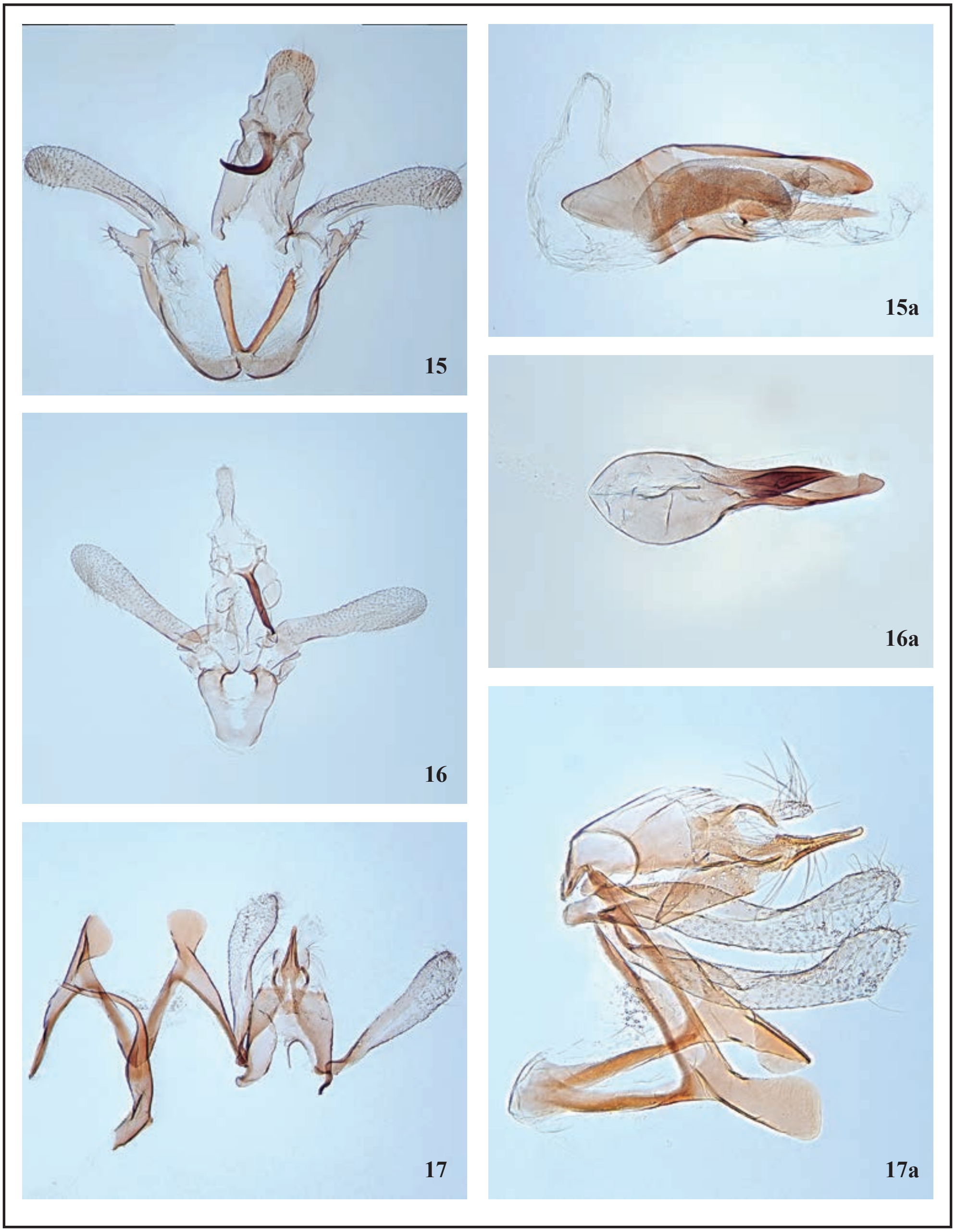
Figures 1c-8. 1c. *Dichomeris castellana* (Schmidt, 1941), ♂, Lanzarote, 15 mm. **2.** *Dichomeris castellana* (Schmidt, 1941), ♀, Lanzarote, 14 mm. **3.** *Dichomeris vivesi* Falck & Karsholt, sp. nov., ♂, Gran Canaria, 18.5 mm. **4.** *Dichomeris vivesi* Falck & Karsholt, sp. nov., ♂, Gran Canaria, 16 mm. **5.** *Dichomeris vivesi* Falck & Karsholt, sp. nov., ♀, Gran Canaria, 17.5 mm. **6.** *Helcystogramma brachmiaella* Falck & Karsholt, sp. nov., ♂, Gran Canaria, 7.5 mm. **7.** *Helcystogramma brachmiaella* Falck & Karsholt, sp. nov., ♀, El Hierro, 9 mm. **8.** *Pseudosophronia confluella* Falck & Karsholt, sp. nov., ♂, Fuerteventura, 10 mm.



Figures 9-14a. 9. *Chrysoesthia diurnella* Falck & Karsholt, sp. nov., ♂, Lanzarote, 6.5 mm. **10.** *Chrysoesthia diurnella* Falck & Karsholt, sp. nov., ♀, Lanzarote, 6.5 mm. **11.** *Sitotroga psacasta* (Meyrick, 1908), ♀, La Gomera, 14.5 mm. **12.** *Polyhymno dumonti* (Hartig, 1936), ♀, Fuerteventura, 12 mm. **13.** *Dichomeris castellana* (Schmidt, 1941), ♂, Lanzarote, GP4098PF. **13a.** *Dichomeris castellana* (Schmidt, 1941), ♂, phallus, Lanzarote, GP4099PF. **14.** *Dichomeris castellana* (Schmidt, 1941), lectotype, ♂, Montarco, Spain, GP623c K. Sattler (57523) **14a.** *Dichomeris castellana* (Schmidt, 1941), lectotype, ♂, phallus, Montarco, Spain, GP623c (57623)



Figures 15-17a. 15. *Dichomeris vivesi* Falck & Karsholt, sp. nov., ♂, Gran Canaria, GP4109PF. **15a.** *Dichomeris vivesi* Falck & Karsholt, sp. nov., ♂, phallus, Gran Canaria, GP4109PF. **16.** *Helcystogramma brachmiaella* Falck & Karsholt, sp. nov., ♂, Tenerife, GP4132PF. **16a.** *Helcystogramma brachmiaella* Falck & Karsholt, sp. nov., ♂, phallus, Tenerife, GP4129PF. **17.** *Pseudosophronia confluella* Falck & Karsholt, sp. nov., ♂, Fuerteventura, GP4108PF. **17a.** *Pseudosophronia confluella* Falck & Karsholt, sp. nov., ♂, lateral view, Fuerteventura, GP4117PF.



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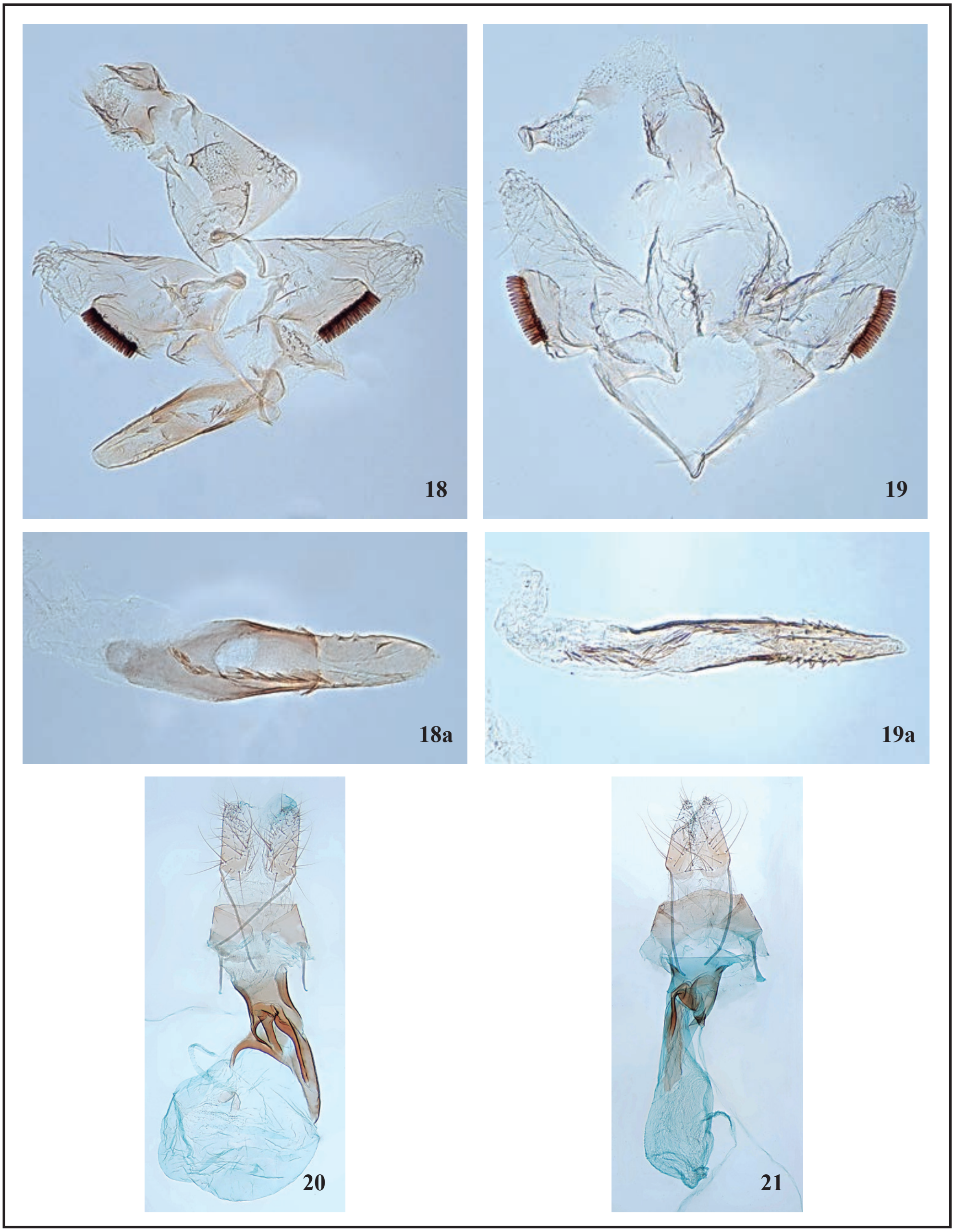

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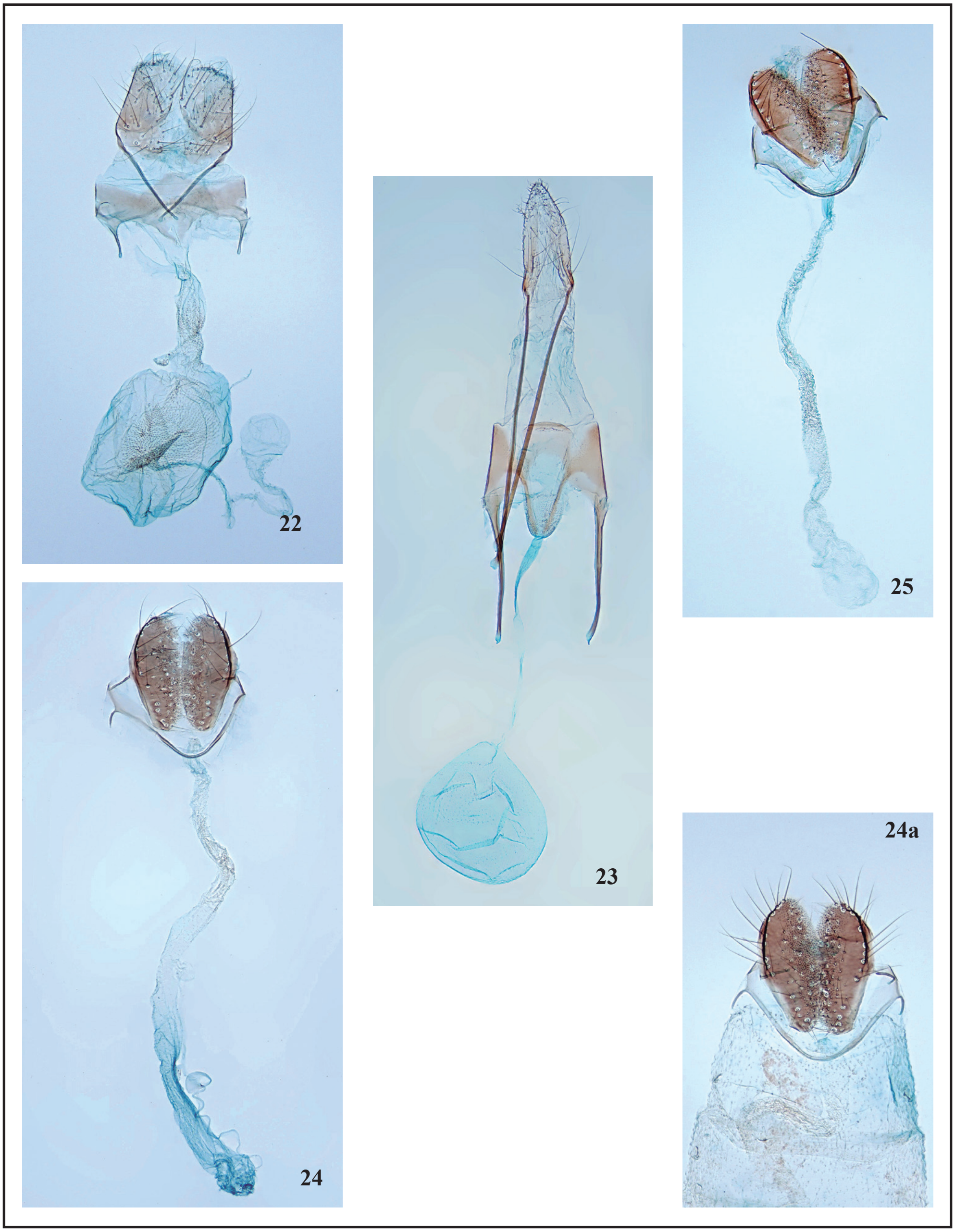

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The first authentic record of *Citripestis eutraphera* (Meyrick, 1935) on *Mangifera indica* L. in Pakistan (Lepidoptera: Pyralidae)

Muhammad Faheem Qasir, Muhammad Ramzan, Sajid Ghafoor, Shafqat Saeed, Muhammad Ghous, Waheed Ali Panhwar, Waqar Majeed, Manel Ben Ali & Amor Hedfi

Abstract

This is the first report on the occurrence of *Citripestis eutraphera* (Meyrick, 1935) (Lepidoptera: Pyralidae) from the Pakistani mainland causing extensive damage to mature and young mango fruits and leaves. Frequent surveillance in the district of Multan's mango-growing areas showed that reports of *Citripestis eutraphera* incidence on *Mangifera indica* L. had been made in recent years. This notorious pest may soon harm producing mangoes and other fruits. This data will be useful in developing sustainable management strategies to combat the mango pest in the country and its neighbouring countries.
Keywords: Lepidoptera, Pyralidae, *Citripestis eutraphera, Mangifera indica,* first record, Pakistan.

Primer registro auténtico de *Citripestis eutraphera* **(Meyrick, 1935) sobre el** *Mangifera indica* **L. en Pakistán (Lepidoptyera: Pyralidae)**

Resumen

Este es el primer informe sobre la aparición de *Citripestis eutraphera* (Meyrick, 1935) (Lepidoptera: Pyralidae) en el territorio continental pakistaní, que causa grandes daños en frutos y hojas maduros y jóvenes de mango. La vigilancia frecuente en las zonas de cultivo de mango del distrito de Multan mostró que en los últimos años se habían recibido informes sobre la incidencia de *Citripestis eutraphera* en *Mangifera indica* L. Esta notoria plaga puede dañar pronto la producción de mangos y otras frutas. Estos datos serán útiles para desarrollar estrategias de gestión sostenibles para combatir la plaga del mango en el país y en sus países vecinos.
Palabras clave: Lepidoptera, Pyralidae, *Citripestis eutraphera*, *Mangifera indica*, primer registro, Pakistán.

Introduction

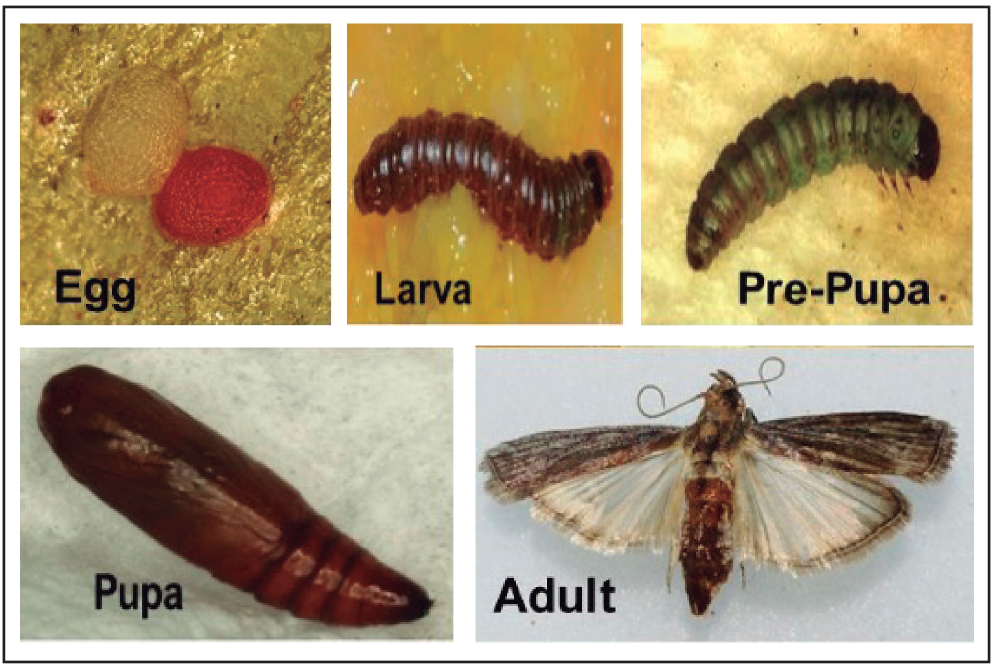
Mangifera indica L. is a member of the Anacardiaceae family. It is a tropical fruit that is native to the Indo-Burma region and is highly consumed by people (Majeed et al. 2024). Mangoes are produced and exported in large quantities by several countries, including Pakistan, Iran, Thailand, the Philippines, China, India, Egypt, Brazil, Mexico, Nigeria, Saudi Arabia, and Indonesia (Memon, 2016; Ullah et al. 2018). Due to the high consumption rate of *M. indica*, there is a significant demand for it. Because *M. indica* is a tasty fruit with a high consumption rate, there is a huge demand for it. Although only about 5% of the world's mango crop is currently exported, Pakistan has the potential to triple its mango exports. Since just around 5% of the world's mango crop is now exported, Pakistan has the potential to raise exports of mangos by three times. Pakistan is the 6th largest mango producer (Malik et al. 2018; Jing et al. 2020), and exports over

100,000 tonnes of mangoes, valued at approximately $100 million (Murtaza et al. 2021; Khan et al. 2023), which may increase dramatically.

Mangoes are primarily cultivated in the provinces of Sindh and Punjab in Pakistan. Mangoes are mostly farmed in the provinces of Sindh and Punjab in Pakistan. The mango output in Pakistan decreased by a significant 50% last year Mango output in Pakistan fell by a significant 50% last year (Zahid et al. 2023; Chandio et al. 2024). Farmers were optimistic about a bumper crop of mangoes in 2022, but their hopes were dashed when production in Pakistan declined sharply. Farmers had high hopes for a bumper crop of mangoes in 2022, but their hopes were dashed when production in Pakistan fell sharply. There are several factors contributing to the decline in mango production, with insect pests being the most significant. The several factors involved in declining mango production but among them, insect pests are the top one. Insect pests have had a major impact on *M. indica* production, despite a 110% growth in volume of exports between 2014 and 2021. Pakistan has the highest mango output in the world; however, by using good agricultural techniques to improve the quality of its mangos, it might increase its exports. To raise mangoes' market, share internationally and enhance their quality, a few issues must be resolved. The high production could be achieved by protecting the mangoes from insect infestation, particularly borers, which not only affect the photosynthetic system but also injure the fruits that become unfit for human consumption resulting in the rejection of the whole consignment. Mangoes must be protected from pests to keep their superior quality and visually pleasing look. The agricultural practices should be adopted by mango growers at small or large scales resulting increase in mango production and beneficial for the economy.

In 2019-2020, a survey was conducted in Multan (30.2º N and 71.4º E), Punjab, Pakistan, to know the problems faced by mango farmers in boosting mango production. There were several issues faced by mango growers in Multan, but among them, was a borer that was unidentified and caused high infestation in mango orchards. There was needed to identify it at the species level. To achieve this, infested fruits were collected from the fields and brought to the laboratory, where they were placed in plastic containers to facilitate the completion of the larvae's life cycle until they reached adulthood. For this purpose, the infested fruits collected from the field were brought to the laboratory and kept in plastic containers to allow the larvae to complete their life cycle till adult emergence. The identified insect was *Citripestis eutraphera* (Meyrick, 1935), and different stages are shown in Figure 1.

Figure 1. Different stages of *Citripestis eutraphera*.

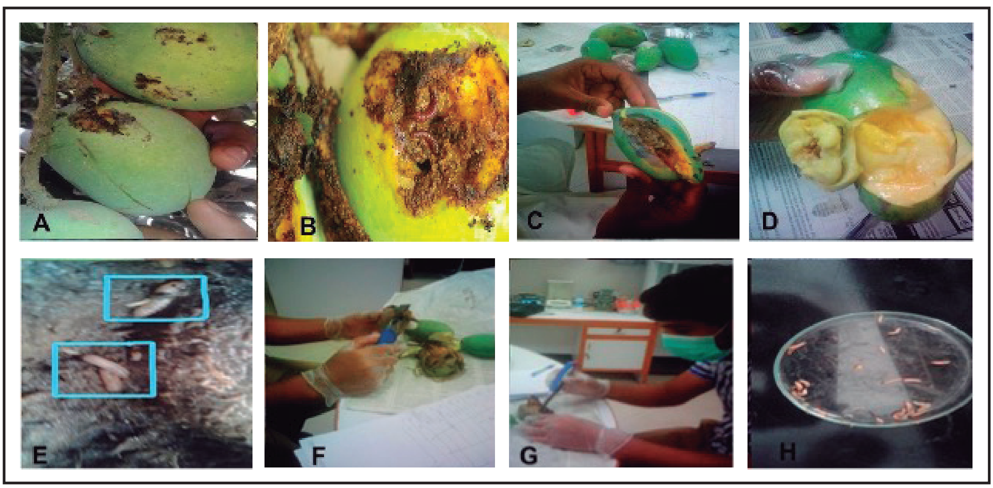


There were five larval instars. The larvae entered the fruits by making a hole and the first two instars fed on the fruit pulp, while later instars fed on the seeds. Additionally, newly hatched larvae also feed on the soft leaves and petioles of mangoes. To move between fruits, the larvae utilized silk threads created during feeding, and they either pupated inside the fruits or fell onto the soil near the tree trunk for pupation. Larvae move between fruits with the help of silk threads made by larvae during feeding and larvae pupate inside the fruits or fall on the soil for pupation near the tree trunk. A similar mode of damage was observed in both ex-situ and situ. Further research is necessary to develop effective pest management strategies and control the pest population on other crops. Further studies are needed to manage this pest and control the pest population on other crops.

Discussion and Conclusion

This is the first record from Pakistan, while it has been reported from neighboring countries like India in 1991 (Bhumannavar, 1991; Hiremath et al. 2017), and Indonesia in 1981 (Kalshoven, 1981). It has become a major pest of mango, cashew apples, and nuts with 12-15% yield losses (Bhumannavar, 1991; Jacob et al. 2004; Reddy, 2016; Singh et al. 2021; Reddy et al. 2022) in Indian states (Jayanthi et al. 2014; Soumya et al. 2016). This destructive pest poses a significant threat to various agricultural and horticultural crops in Pakistan. Without proper control measures, it could lead to substantial economic losses for the nation. This destructive pest can attack other agricultural and horticultural crops in Pakistan and if proper control measures are not adopted against this then it will become a serious issue with huge economic losses for the Pakistani nation. The mode of damage that occurs by larvae of *C. eutraphera* and *Bactocera* spp. can easily be confused, especially when they co-exist in single cropping systems, as the larvae are very similar at the initial stage. *C. eutraphera* is undoubtedly a serious threat to the mango industry in South and Southeast Asia and also in the Northern Territory of Australia. When sensitive leaves were supplied to the larvae in the lab, they bonded, ate the leaves, and eventually matured. The mango is pierced by larvae at the point where the fruit and the fruit stem alight. They started by scraping the outside of the mango fruit and creating frass before going inside and creating galleries. Excreta and frass were layered over the bore holes. According to the survey, the average damage percentage (%) caused by the insect in every mango field was rated between 90% and 100% (Figure 2).

Figure 2. *Citripestis eutraphera*. **A-D.** Mango fruits infested with larvae and larval frass. **E** larvae crawling on fruit skin after whole damage. **F-G** Collection of larvae and damage percentage record. **H** collected larvae.



Mango growers in Pakistan face a threat to their production costs because of the existence of *C. eutraphera* (Meyrick). The import and export of mango can be badly affected by the infestation of this notorious pest in Pakistan. Knowing what pests are present in a crop is a crucial first step in developing effective management strategies, hence it is necessary to record their presence in the nation. The most atrisk groups will undoubtedly include home gardeners and small-scale farmers as many of them could not have the tools needed to deal with this pest. Therefore, it is essential to conduct urgent research, including studies into alternate control measures. These tactics might involve the use of pheromone traps for mass catching and monitoring, the utilization of native predators and parasitoids for natural management, and the significance of hygiene in reducing infestation levels. The following recommendations are made based on this paper: research institutions should work with other local or international organizations to develop and train growers and extension officers in environmentally friendly pest management techniques, which may involve importing or recruiting native enemies. Establishing local and regional systems for pest invasion alerts will also be crucial to prevent farmers from being caught off guard when a new pest invades their crop and causes such a significant loss in productivity. The information in this book should be used to comprehend why *C. eutraphera* (Meyrick), an invasive foreign fruit and shoot borer, is present in Pakistan.

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Conflicts 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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Una nueva especie del género *Chiasmia* Hübner, [1823] de la isla de Sámar y otras tres más del género *Entomopteryx* Guenée, 1857 de las islas de Mindoro, Sámar y Negros de Filipinas (Lepidoptera: Geometridae, Ennominae)

Andrés Expósito-Hermosa

Resumen

Se describen *Chiasmia delacallei* sp. nov., *Entomopteryx cifuentesi* sp. nov., *Entomopteryx torresi* sp. nov. y *Entomopteryx fernandezi*, sp. nov. de Filipinas. Se incluyen imágenes de los adultos y de la genitalia de los machos.
Palabras clave: Lepidoptera, Ennominae, Macariini, Lithinini, *Chiasmia, Entomopteryx,* Filipinas.

A new species of the genus *Chiasmia* Hübner, [1823] from the island of Sámar and three more of the genus *Entomopteryx* Guenée, 1857 from the islands of Mindoro, Sámar and Negros in the Philippines (Lepidoptera: Geometridae, Ennominae)

Abstract

Chiasmia delacallei sp. nov., *Entomopteryx cifuentesi* sp. nov., *Entomopteryx torresi* sp. nov. and *Entomopteryx fernandezi* sp. nov. are described from the Philippines. Images of adults and genitalia of the males are included.
Keywords: Lepidoptera, Ennominae, Macariini, Lithinini, *Chiasmia, Entomopteryx,* Philippines.

Abreviaturas utilizadas

AEH: Colección Andrés Expósito Hermosa. Móstoles (Madrid), ESPAÑA.

Sistemática

***Chiasmia delacallei* Expósito, sp. nov.** (Figuras 1-2, 9)
https://zoobank.org/B0AA65CD-6969-484D-AF7B-95B8AAB176D4

Holotipo ♂, Filipinas, Mt. Capoto, a 600 m, isla de Sámar, X-2005 (colector local). Paratipo: Filipinas. Mt. Capoto 600 m, isla de Sámar, 1 ♂, X-2005 (colector local), genitalia AEH 3523. El holotipo, así como, el paratipo quedan depositados en la colección del autor en Móstoles, Madrid (España).

Cabeza, tórax y abdomen de color marrón claro. En cada segmento del abdomen existen manchitas irregulares marrones (no visibles en el reverso) que dan la apariencia de una doble serie de puntos. Las antenas no son bipectinadas. La chaetosema es perfectamente visible. Los dos ejemplares analizados, de la nueva especie, presentan una expansión alar de 27 y 28 mm respectivamente. El fondo alar es preponderantemente de color marrón claro, con bandas inclinadas algo más oscuras (tono acentuado en las posteriores). Las alas tienen un reticulado con numerosas cuadrículas de color gris claro y un espolvoreado con numerosos puntos oscuros. En general, el modelo de sus alas recuerda a las del género *Phalacra* Walker, 1866 de Drepanidae, con sus, ya citadas, bandas inclinadas. Además, un visible punto apical en cada ala. Las alas anteriores son algo falcatadas y las posteriores con un visible tallo en su zona central. El reverso es similar, pero con algunas zonas de tono ocre y más claro que en el anverso.

La hembra es desconocida.

Genitalia ♂ (Figura 9): Uncus con los característicos cuernos (horns) y subapical esclerito (sclerite). Gnathos con zona proximal redondeada. En la valva: tanto la costa como el sacculus se hallan perfectamente desarrollados y muy separados. Aedeagus con su zona proximal más delgada, la vesica es más compleja y tiene un proceso con forma digital. El 8º esternito es bilobulado con el lado derecho más reducido y hendidura centrar poco profunda.

Distribución: La nueva especie, se halla difundida por la isla de Sámar en Filipinas

Etimología: Se dedica esta nueva especie al Profesor Dr. José Amador De La Calle Pascual y se la denomina, por este motivo, como *delacallei*

Entomopteryx cifuentesi **Expósito, sp. nov.** (Figuras 3-4, 10)
https://zoobank.org/E65D393D-8699-4437-A574-0FB214E03651

Holotipo ♂, Filipinas, Monte Halcón, a 1.000 m. isla de Mindoro, VII/VIII-2008 colector local, genitalia AEH 3514. El holotipo queda depositado en la colección del autor en Móstoles, Madrid (España).

Tanto esta *Entomopteryx* Guenée, 1857 de Lithinini, como las que seguidamente se describen, muestran morfología cercana a las ya conocidas: *E. combusta* (Warren, 1893), *E. amputata* Guenée, 1857 y *E. statheuta* (Prout, 1932) (Holloway, 1993 [1994]; Parsons et al. 1999). Esta nueva especie tiene una expansión alar de 25 mm, su fondo alar es de color ocre amarillento y está salpicado de infinidad de manchitas de tono ferruginoso. Cabeza, tórax y abdomen del mismo color. El termen de las alas anteriores, por su parte central, es ligeramente convexo. Banda postmediana ferruginosa, con un diminuto punto blanco cerca de la costa. Punto negro discal. En las alas posteriores la banda mediana es bastante recta, con un ribete blanco externo y un pequeño trazo en la zona apical: La banda postmediana es paralela al termen, sin el ribeteado blando y con suaves ondulaciones. Reverso semejante al anverso, pero el tono amarillento es más pálido.

La hembra es desconocida.

Genitalia ♂ (Figura 10): Uncus delgado, dilatado y aplastado en su parte distal. Gnathos con largos brazos laterales, en su zona de confluencia es de forma triangular y con una serie de pequeñas espinas (vista frontal). Transtilla dilatada. Cristae presente. Valvas de apariencia débil, aunque la costa es algo más fuerte y dilatada en su zona distal. Aedeagus con forma de media luna y la vesica puntiaguda dotada de alrededor de quince cornuti.

Distribución: Conocida de la isla de Mindoro, en Filipinas.

Etimología: Se dedica esta nueva especie al Dr. Julio Cifuentes Colmenero y se la denomina, por este motivo, como *cifuentesi.*

Entomopteryx torresi **Expósito, sp. nov.** (Figuras 5-6, 11)
https://zoobank.org/4D5C8E22-BADC-4761-9074-0DBAF498E0A4

Holotipo ♂, Filipinas, Mt. Capoto, a 600 m, isla de Sámar, X-2003 colector local, genitalia AEH 3515. El holotipo queda depositado en la colección del autor en Móstoles, Madrid (España).

La nueva especie tiene una expansión alar de 26 mm y se asemeja a *cifuentesi*, pero la banda postmediana de las alas posteriores tiene los segmentos más quebrados y el termen de las alas posteriores con más crestas.

La hembra es desconocida.

Genitalia ♂ (Figura 11): El uncus es más largo y fino que en *cifuentesi*, en el gnathos guarnición de espinas más puntiagudas (vista lateral). Transtilla y cristae menos marcadas. Aedeagus (invertido) más débil con bastante más cornuti que en *cifuentesi*, y la vesica es más roma.

Distribución: Conocida de la isla de Sámar, Filipinas.

Etimología: Se dedica esta nueva especie, a mi buen amigo José Luis Torres Méndez y se la denomina, por este motivo, como *torresi*.

Entomopteryx fernandezi **Expósito, sp. nov.** (Figuras 7-8, 12)
https://zoobank.org/4D5C8E22-BADC-4761-9074-0DBAF498E0A4

Holotipo ♂, Filipinas, Monte Canlaón, Isla de Negros, 1-6-XI-2005, colector local, genitalia AEH 3516. El holotipo queda depositado en la colección del autor en Móstoles, Madrid (España).

La nueva especie es semejante a las dos anteriores, pero se separa de ellas inmediatamente por fondo alar rojo oscuro. De 30 mm de expansión alar. Las líneas se asemejan más a *torresi*. Reverso de las alas sin el fondo ocre.

La hembra es desconocida.

Genitalia ♂ (Figura 12): Uncus más grueso que en las especies anteriores. La parte triangular de gnathos es menor. La transtilla es mayor y cristae más débil que en *cifuentesi*. Aedeagus (invertido) semejante a *cifuentesi*, pero con mayor número de cornuti, aunque estos, más cortos.

Distribución: Conocida de la isla de Negros, Filipinas.

Etimología: Se dedica esta nueva especie a mi buen amigo Eliseo Fernández Vidal y se la denomina, por este motivo, como *fernandezi*.

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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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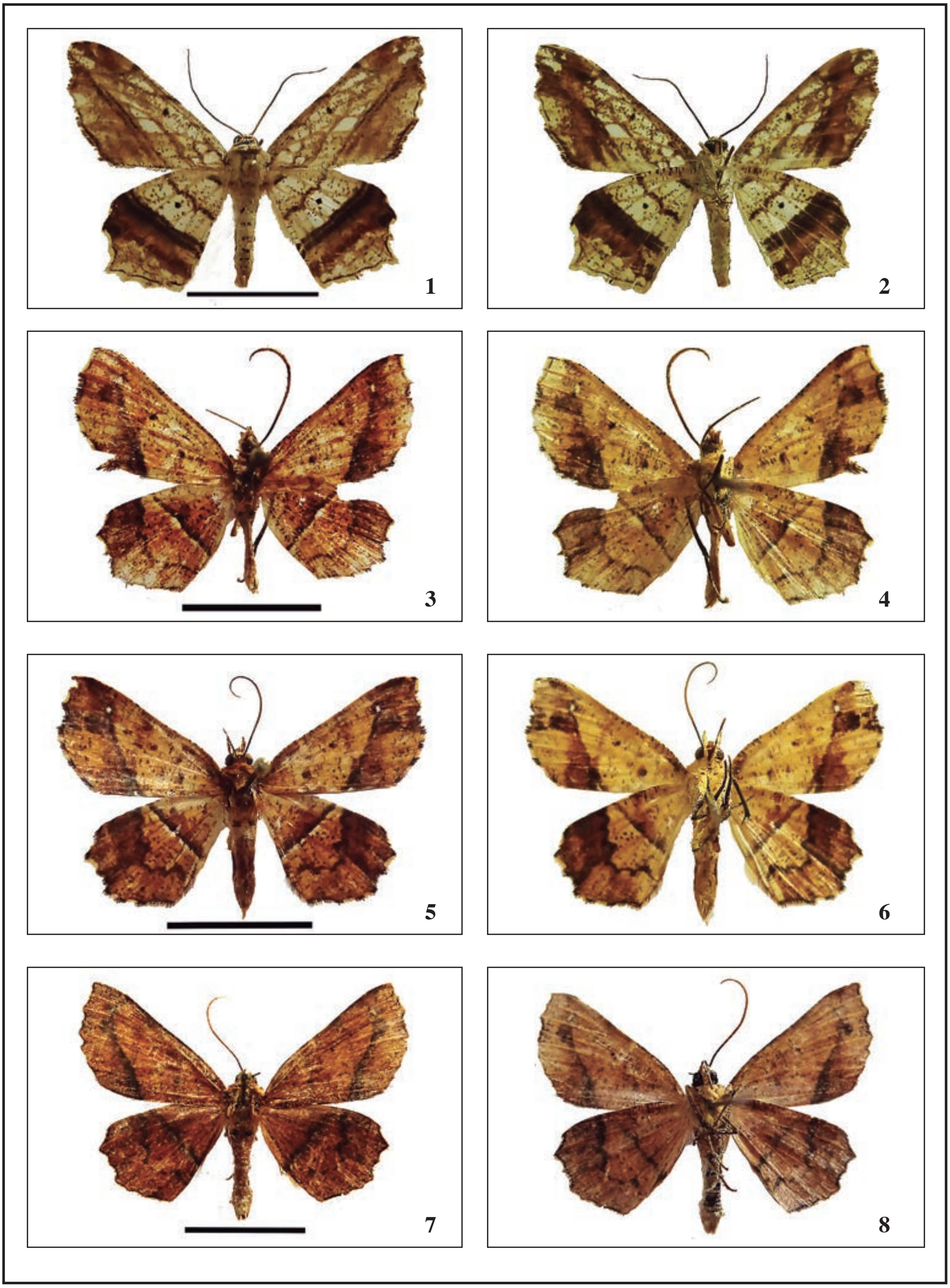
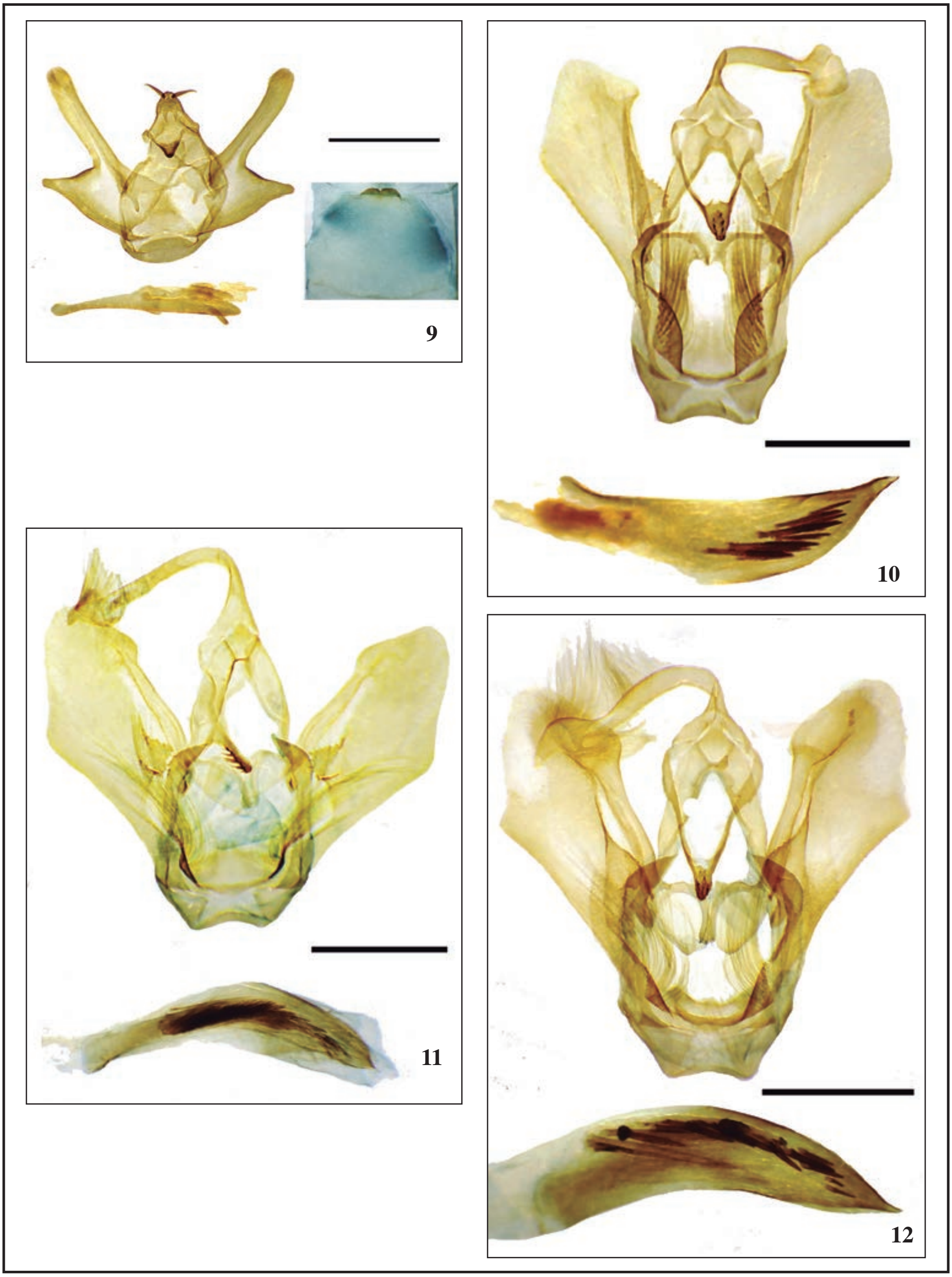
Figuras 1-8. 1-2. *Chiasmia delacallei* Expósito, sp. nov. Holotipo ♂. **1.** Anverso. **2.** Reverso. **3-4.** *Entomopteryx cifuentesi* Expósito, sp. nov. Holotipo ♂. **3.** Anverso. **4.** Reverso. **5-6.** *Entomopteryx torresi* Expósito, sp. nov. Holotipo ♂. **5.** Anverso. **6.** Reverso. **7-8.** *Entomopteryx fernandezi* Expósito, sp. nov. Holotipo ♂. **7.** Anverso. **8.** Reverso. (escala 1 cm)



Figuras 9-12. 9. *Chiasmia delacallei* Expósito, sp. nov., genitalia ♂, paratipo preparación AEH 3523. **10.** *Entomopteryx cifuentesi* Expósito, sp. nov., genitalia ♂, preparación AEH 3514. **11.** *Entomopteryx torresi* Expósito, sp. nov. Holotipo ♂, genitalia ♂, preparación AEH 3515. **12.** *Entomopteryx fernandezi* Expósito, sp. nov., Holotipo ♂, genitalia ♂.preparación AEH 3516. (escala 1 mm)



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New species of Pterophoridae from the Philippines (Insecta: Lepidoptera)

Petr Ya. Ustjuzhanin & Vasily N. Kovtunovich

Abstract

Three new species from the Philippines are described: *Nippoptilia jakobi* Ustjuzhanin & Kovtunovich sp. nov.; *Hellinsia zurilinae* Ustjuzhanin & Kovtunovich sp. nov.; *Pterophorus aurora* Ustjuzhanin & Kovtunovich sp. nov. One species, *Asiaephorus sythoffi* (Snellen, 1903), is recorded from the Philippines for the first time.
Keywords: Insecta, Lepidoptera, Pterophoridae, new species, new records, biodiversity, Mindanao, Luzon, Philippine Islands.

Nuevas especies de Pterophoridae de Filipinas
(Insecta: Lepidoptera)

Resumen

Se describen tres nuevas especies de Filipinas: *Nippoptilia jakobi* Ustjuzhanin & Kovtunovich sp. nov.; *Hellinsia zurilinae* Ustjuzhanin & Kovtunovich sp. nov.; *Pterophorus aurora* Ustjuzhanin & Kovtunovich sp. nov. Una especie, *Asiaephorus sythoffi* (Snellen, 1903), se registra por primera vez en Filipinas.
Palabras clave: Insecta, Lepidoptera, Pterophoridae, nuevas especies, nuevos registros, biodiversidad, Mindanao, Luzón, Filipinas.

Introduction

The island country of the Philippines is in the western part of the Pacific Ocean and includes more than 7,000 islands. The nature of the Philippines is rich, diverse, with mangrove forests, and evergreen, tiered rainforests harbouring numerous endemic plant species. The fauna belongs to the Indo-Malay zoogeographic region, exhibiting a high diversity of vertebrate species, many of which are also endemic. However, many plant and animal species are now threatened with extinction due to heavy water pollution and intensive deforestation.

The fauna of Pterophoridae in the Philippines is still very poorly studied. To date, there is only one relevant study (Gielis, 2003), which provides an overview of 22 Pterophoridae species, of which seven were described as new to science. The present study employed a limited sample of Pterophoridae from the islands of Mindanao and Luzon, the Philippines (Figures1-2), collected by Dr Omelko. The processing of this material identified eight species of Pterophoridae, including three species new to science and one species new to the fauna of the Philippines.

Materials and methods

The Pterophoridae species were collected during nighttime and twilight hours using light traps. The studied specimens are deposited in the collection of the Zoological Institute, St. Petersburg, Russia (ZISP) and in the Collection of P. Ustjuzhanin and V. Kovtunovich (Novosibirsk and Moscow, Russia, CUK). The holotypes of the new species are deposited in the collection of Zoological Institute, St. Petersburg, Russia (ZISP).

Figures 1-2. Biotopes. **1.** Philippines, Mindanao, Mount Apo Natural Park. **2.** Philippines, Luzon, Aurora Memorial National Park. Photo M. Omelko.

Results

New species description

Nippoptilia jakobi Ustjuzhanin & Kovtunovich, sp. nov. (Figures 3-4)
https://zoobank.org/2785EEA6-C3AE-44AC-AE57-4F61A4D3F2F1

Type material: Holotype ♂, Philippines, Mindanao, Mount Apo Natural Park, 26-I-2024, M. M. Omelko leg. (ZISP, gen.pr. Nr. 2016)

Description: External characters. Head, thorax and tegulae dark brown. Labial palpi thin, almost straight, projected forward, with alternating brown and yellow scales, 1.5 times longer than longitudinal eye diameter. Antennae dark brown, with alternating white longitudinal strokes. Wingspan 14 mm. Fore wings brown, with areas of light yellowish spots. Thin yellow band on first lobe distally. Deep cut on top of second lobe, fringe inside it bright yellow. Fringe along outer edge of fore wing yellowish gray, with dark brown portions of elongated scales. Fringe inside cleft grey, with alternating black scales. Hind wings unicolorous, dark brown. Dark scales on top of third blade forming triangle. Hind legs light brown, shining, spurs very long, with dark brown scales at base.

Male genitalia: Tegumen two-lobed. Valves symmetric, broad basally, narrowed apically, with dense cluster of spines. Apical valves with one long spine. Saccus arched. Aedeagus long, curved with sharp bends, twice as long as valve.

Diagnosis: In the male genitalia, the species is like *Nippoptilia regalis* Fletcher, 1909 in two-lobed tegumen, but it differs in valves broadened basally and strongly curved aedeagus. The new species is also like *N. regalis* in wing coloration.

Distribution: Philippines, Mindanao.

Flight period: January.

Etymology: The species is named in honour of Galina Yurievna Yakobi (Novosibirsk, Russia), doctor of otoneurology, a highly esteemed specialist. She committed herself to the alleviation of pain and suffering of many people.

Hellinsia zurilinae Ustjuzhanin & Kovtunovich, sp. nov. (Figures 5-6)
https://zoobank.org/0F197598-C1C0-4C3B-946E-AD3BC20E36CA

Type material: Holotype ♂, Philippines, Mindanao, Mount Apo Natural Park, 28-I-2024, M. M. Omelko leg. (ZISP, gen.pr. Nr. 2017.)

Description: External characters. Head, thorax and tegulae bright white. Collar between head and thorax with bright red hairs. Labial palpi straight, pointed apically, slightly smaller than longitudinal eye diameter.

Antennae light coloured, with alternating narrow transverse brown scales. Wingspan 14 mm. Fore wings bright white. Costal edge darkened with brown scales. Distinct narrow band of dark brown scales above cleft of first lobe. Two small elongated strokes in distal and apical parts of first lobe. Irregularly shaped dark brown spot at cleft base. Light gray fringe inside cleft and along outer edge of fore wing. Hind wings unicolorous, gray, noticeably darker than fore wings, with grey fringe. Hind legs pale yellow with portions of brown scales at spur bases.

Male genitalia: Valves asymmetric, left valve wider than right one, slightly narrowed apically. Saccular process on left valve forked, unequal in length and width. Broad process slightly shorter than narrow one. Saccular process on right valve bulbous, basally wide and oval, smoothly narrowing distally. The upper half of the right valve of the holotype is destroyed.

Female genitalia: unknown.

Diagnosis: In the male genitalia, the new species is similar to *Hellinsia madecasseus* (Bigot, 1964) in asymmetric shape of valve, sinuous aedeagus and arcuate saccus, but it differs in the presence of fork-shaped saccular process on the left valve and bulb-shaped saccular process on the right one. *H. madecasseus* has saccular process on the left valve.

Distribution: Philippines, Mindanao.

Flight period: January.

Etymology: The species is named in honour of Valentina Olegovna Zurilina, amateur entomologist from Chelyabinsk, expert on butterflies and moths, excellent collector of high- quality materials, in gratitude for our long-standing cooperation.

***Pterophorus aurora* Ustjuzhanin & Kovtunovich, sp. nov.** (Figures 7-8)
https://zoobank.org/CB87CF7C-ED9D-40DC-A1C3-9D91405943E5

Type material: Holotype ♂, Philippines, Luzon, Aurora Memorial National Park, 18-II-2024, M.M. Omelko leg. (ZISP, gen.pr. Nr. 2018)

Description: External characters. Head, thorax and tegulae with densely appressed white scales. Labial palpi white, straight, pointed apically, slightly shorter than longitudinal eye diameter. Antennae thin, yellowish white. Wingspan 20 mm. Fore wings white, with areas of small dark spots. Cluster of small black spots on white fringe at cleft base. On both lobes of fore wings, black spots in middle and distal parts. Hind wings white. Small black portions of scales on first and second lobes. Fringe on both wings long, white or grayish white. Hind legs unicolorous, white.

Male genitalia: Valves asymmetric, narrow, slightly widened in middle part, narrowed apically. Fork-shaped saccular process on left valve, both processes on it of equal length, in middle part of valve. Saccular process on right valve in form of claw-shaped process, pointed. Anellus arms asymmetric, right arm distinctly wider and slightly longer than left one. Uncus thin, smoothly curved in middle part, pointed apically. Aedeagus short, almost straight, twice shorter than valve, narrowed distally.

Female genitalia: Unknown.

Diagnosis: The new species is similar to *Pterophorus vikhrevi* Ustjuzhanin et Kovtunovich, 2015 in wing coloration and dark spots arrangement, but it differs in smaller wingspan and different structure of male genitalia. In the male genitalia, the species is similar to *Pterophorus ceylonicus* Ustjuzhanin & Kovtunovich, 2015 in the shape of valve, uncus and aedeagus, but it differs in the saccular process structure. The left saccular process of *P. ceylonicus* has two processes of unequal length, while in the new species, they are equal in length; the right saccular process of *P. ceylonicus* is curved, while in the new species, it is straight. The shape of anellus arms is also different; in the new species, the right arm is slightly longer than the left one, while in *P. ceylonicus,* it is considerably longer; moreover, in *P. ceylonicus,* the anellus left arm is apically pointed, while in the new species, it is rounded.

Distribution: Philippines, Luzon.

Flight period: February.

Etymology: The name is toponymic. Aurora is a memorial national park located in the Sierra Madre Mountain range, in the central part of Luzon Island.

Platyptilia farfarella Zeller, 1867

Material examined: PHILIPPINES, Mindanao, Mount Apo Natural Park, 1 ♂, 3 ♀, 28-31-I-2024, M. M. Omelko leg. (ZISP, CUK); Mindanao, Mount Kitanglad Range Natural Park, 1 ♀, 02-II-2024, M. M. Omelko leg. (ZISP); Luzon, Aurora Memorial National Park, 1 ♀, 16-II-2024, M. M. Omelko leg. (CUK).

Asiaephorus sythoffi (Snellen, 1903)

Material examined: PHILIPPINES, Mindanao, Mount Kitanglad Range Natural Park, 1 ♂, 05-II-2024, M. M. Omelko leg. (CUK).

Remark: The first record from the Philippines.

Sphenarches anisodactylus (Walker, 1864)

Material examined: PHILIPPINES, Mindanao, Mount Apo Natural Park, 1 ♀, 28-I-2024, M. M. Omelko leg. (CUK).

Adaina microdactyla (Hübner, [1813])

Material examined: PHILIPPINES, Mindanao, Mount Apo Natural Park, 18 ex., 26-I-08-II-2024, M. M. Omelko leg. (ZISP, CUK).

Adaina microdactoides Gielis, 2003

Material examined: PHILIPPINES, Mindanao, Mount Apo Natural Park, 1 ♂, 29-I-2024; 3 ♂, 3 ♀, 04-06-II-2024, M. M. Omelko leg. (ZISP, CUK).

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Conflict of Interest

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

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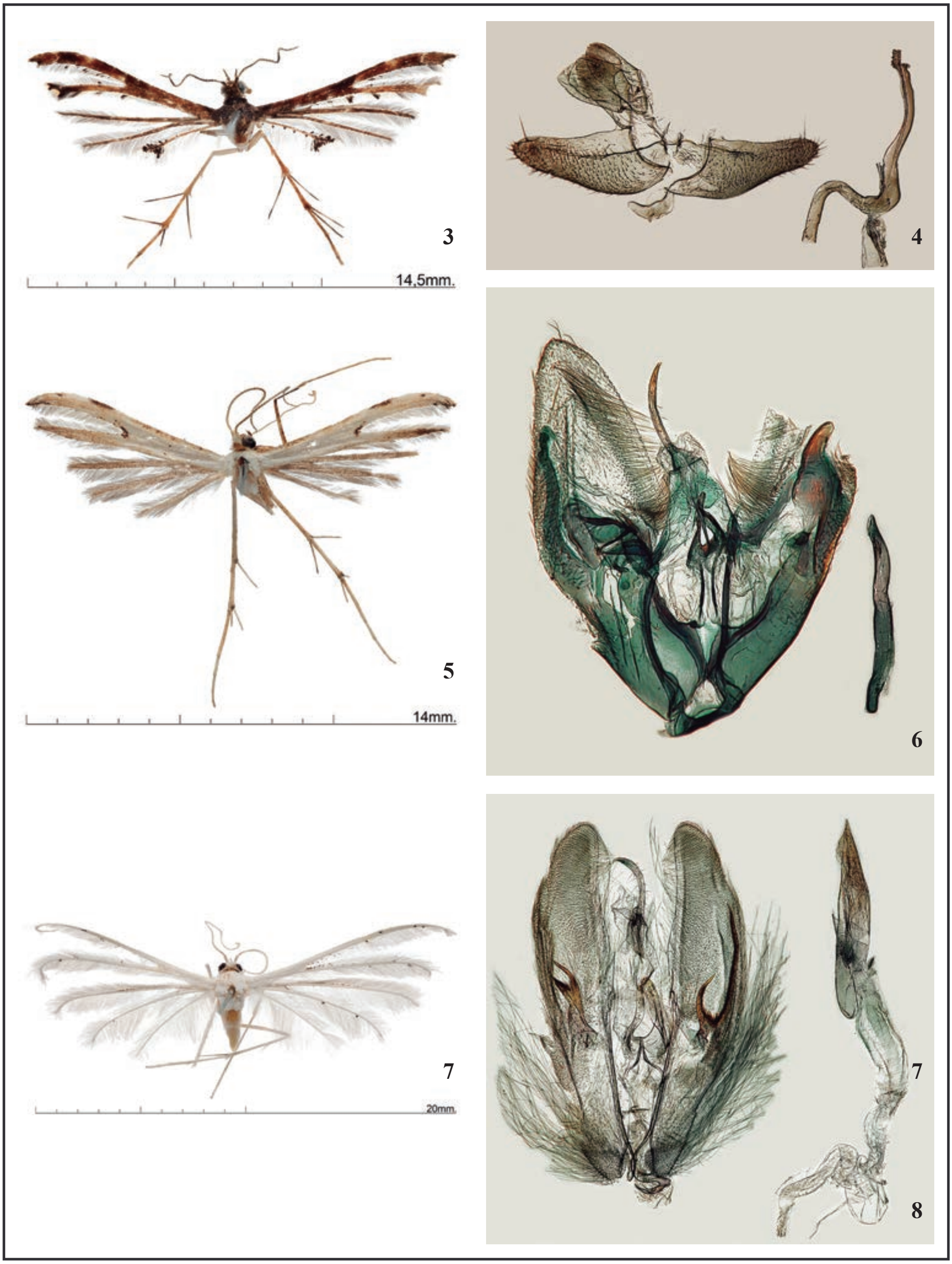
Figures 3-8. 3-4. *Nippoptilia jakobi* Ustjuzhanin & Kovtunovich, sp. nov. **3.** Adult (Holotype, ZISP). **4.** Male genitalia (Holotype, ZISP, 2016). **5-6.** *Hellinsia zurilinae* Ustjuzhanin & Kovtunovich, sp. nov. **5**. Adult (Holotype, ZISP). **6.** Male genitalia (Holotype, ZISP, 2017). **7-8.** *Pterophorus aurora* Ustjuzhanin & Kovtunovich, sp. nov. **7.** Adult (Holotype, ZISP). **8.** Male genitalia (Holotype, ZISP, 2018).



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A cryptic species of *Eupithecia sardoa* Dietze, 1910, in Spain: *Eupithecia iberica* Lévêque, Skou, Tautel & Ranki, sp. nov. (Lepidoptera: Geometridae, Larentiinae, Eupitheciini)

Antoine Lévêque, Peder Skou, Claude Tautel & Timo Ranki

Abstract

The authors describe a new species, cryptic of *Eupithecia sardoa* Dietze, 1910, revealed by genetic studies. *Eupithecia iberica* sp. nov. was discovered in Spain (Ibiza and southern Andalusia). The species is described, and the male and female genitalia are presented. The new species is very close to *Eupithecia sardoa*, with which it is compared. The holotype is preserved in the collection of the second author and paratypes are distributed among several collections, including that of the Museo Nacional de Ciencias Naturales (Madrid, Spain). The authors take this opportunity to review the history of the discovery of *Eupithecia sardoa* and what is currently knowledge about this species. The two Mediterranean taxa *iberica* sp. nov. and *sardoa* belong to a group of related species associated with *Juniperus*.
Keywords: Lepidoptera, Geometridae, Larentiinae, Eupitheciini, *Eupithecia*, new species, Andalusia, Balearic Islands, Ibiza, Spain, Corse, France, Sardinia, Italy.

Una especie críptica de *Eupithecia sardoa* Dietze, 1910, en España: *Eupithecia iberica* Lévêque, Skou, Tautel & Ranki, sp. nov. (Lepidoptera: Geometridae, Larentiinae, Eupitheciini)

Resumen

Los autores describen una nueva especie, críptica de *Eupithecia sardoa* Dietze, 1910, revelada por estudios genéticos. *Eupithecia iberica* sp. nov. fue descubierta en España (Ibiza y sur de Andalucía). Se describe la especie y se presentan la genitalia del macho y de la hembra. La nueva especie está muy próxima a *Eupithecia sardoa*, con la que se compara. El holotipo se conserva en la colección del segundo autor y los paratipos están distribuidos en varias colecciones, entre ellas la del Museo Nacional de Ciencias Naturales (Madrid, España). Los autores aprovechan esta oportunidad para repasar la historia del descubrimiento de *Eupithecia sardoa* y lo que se sabe actualmente de esta especie. Los dos taxones mediterráneos *iberica* sp. nov. y *sardoa* pertenecen a un grupo de especies afines asociadas a los *Juniperus*.
Palabras clave: Lepidoptera, Geometridae, Larentiinae, Eupitheciini, *Eupithecia*, nueva especie, Andalucía, Islas Baleares, Ibiza, España, Córcega, Francia, Cerdeña, Italia.

Une espèce cryptique d'*Eupithecia sardoa* Dietze, 1910, en Espagne: *Eupithecia iberica* Lévêque, Skou, Tautel & Ranki, sp. nov. (Lepidoptera: Geometridae, Larentiinae, Eupitheciini)

Résumé

Les auteurs décrivent une nouvelle espèce, cryptique d'*Eupithecia sardoa* Dietze, 1910, révélée par des études génétiques. *Eupithecia iberica* sp. nov. a été découverte en Espagne (Ibiza et sud de l'Andalousie). L'espèce est décrite et les genitalia mâles et femelles sont présentés. La nouvelle espèce est très proche d'*Eupithecia sardoa*, avec laquelle elle est comparée. L'holotype est conservé dans la collection du deuxième auteur et les paratypes sont répartis au sein de plusieurs collections, dont celle du Museo Nacional de Ciencias Naturales (Madrid, Espagne). Les auteurs profitent de l'occasion pour faire le point sur l'histoire de la découverte d'*Eupithecia sardoa* et sur ce que l'on connaît actuellement de cette espèce. Les deux taxa méditerranéens *iberica* sp. nov. et *sardoa* appartiennent à un groupe d'espèces apparentées associées aux *Juniperus*.
Mots-clés: Lepidoptera, Geometridae, Larentiinae, Eupitheciini, *Eupithecia*, nouvelle espèce, Andalousie, îles Baléares, Ibiza, Espagne, Corse, France, Sardaigne, Italie.

Introduction

Many Lepidoptera specimens were collected during the "Our Planet Reviewed in Corsica 2019-2021" project, a multi-year scientific programme to explore biodiversity led by the Muséum National d'Histoire Naturelle in Paris (France), in partnership with the Collectivité de Corse and the Office Français de la Biodiversité, and in which the first author participated (Touroult et al. 2023). These specimens included several *Eupithecia* captured in Malaise traps and preserved in alcohol. Following DNA barcodes checks on these Pug Moths, the first author was surprised to find that several *Eupithecia* from the Balearic Islands (Ibiza, Spain), taken by the second author, then identified as *sardoa* in BOLD, differed by more than 6% from those found in Corsica (France) and whose sequences did not match to any others known in this same database moreover. From then on, the hypothesis of the existence of two different species hitherto confused under the name *sardoa* emerged.

DNA barcodes analysis, based on study material available as part of a project led by our Finnish colleague Pasi Sihvonen, also made it possible to highlight that several other specimens, captured by the fourth author in the extreme south of Spain, in Tarifa, initially also attributed to *Eupithecia sardoa*, belonged to the same species as those of Ibiza, distinct from that encountered in Corsica. The second author had previously to the record made by the fourth author found two specimens at the same locality. He has further found two specimens at another locality more to the west and finally he had been given two specimens from a third locality. These six specimens, which were not barcoded, have also previously been attributed to *Eupithecia sardoa*.

After a thorough study of external (habitus) and internal (male and female genitalia) characteristics, in addition to that of DNA barcodes, we can conclude that these *Eupithecia* from Spain form a new European taxon that we present and describe below. Its closeness to *E. sardoa*, particularly through the presence of dentate antennae in the male, has allowed us to take a new look at these two Mediterranean taxa associated with *Juniperus*.

Material and methods

ABBREVIATIONS USED

BIN	Barcode Index Number
BOLD	Barcode of Life Data System (www.boldsystems.org)
CTC	Collection of Claude Tautel, Champagnac-le-Vieux, France
FMNH	Finnish Museum of Natural History, Helsinki, Finland
LPRC	La Planète Revisitée en Corse ("Our Planet Reviewed in Corsica")
MNCN	Museo Nacional de Ciencias Naturales, Madrid, Spain
MNHN	Muséum National d'Histoire Naturelle, Paris, France
NHMUK	Natural History Museum, London, United Kingdom
PSC	Collection of Peder Skou, Ollerup, Denmark
SNSB-ZSM	Staatlichen Naturwissenschaftlichen Sammlungen Bayerns - Zoologische Staatssammlung München, Munich, Germany
TRC	Collection of Timo Ranki, Schoenfels, Luxemburg

Study material

The specimens studied, belonging to the new species described below, were attracted by light on the island of Ibiza by the second author and in mainland Spain by the second and fourth authors. The second author has used light traps in both Ibiza and mainland Spain, equipped with 8-Watt superactinic light tubes. The light traps used by the fourth author in Tarifa were automatic traps with 2 W LED strips. These specimens were pinned, spread and preserved dry. The Corsican specimens, studied for comparison, were collected either by light trap (vertical light sheet illuminated by a 125 W mercury vapour bulb, by the third author, or the same light traps as Ibiza and mainland Spain, by the second author), then pinned, spread and preserved dry, or by Malaise Traps and, in the latter case, preserved in alcohol.

The abdomens of the dissected specimens were treated using a KOH solution in a water bath, to soften the tissues, dissolve the fats and extract the genitalia. The abdominal segments and genitalia were cleaned in water, dehydrated in alcohol, coloured with Chlorazol Black then mounted between slide and coverslip in Euparal®.

Photos of adult specimens were taken with a Nikon D7000 camera or a Nikon D800E camera, equipped with an AF-S Micro-Nikkor 105 mm f/2.8 lens. Photos of genitalia slides were taken with a Canon EOS 6D camera, combined with an MP-E 65 mm Macro f/2.8 lens and mounted on a semi-automatic Cognisys Rail macro StackShot device controlled by Helicon Remote software. The photographs were combined using Helicon Focus 6 software and processed using Adobe Photoshop CS6.

Molecular data and phylogenetic inference

The data relating to fourteen specimens (and associated sequences), initially determined to be *sardoa*, on which we are basing our study and description of the new species have been brought together in a dataset specially created for the occasion in BOLD. Entitled “Study of Eupithecia sardoa complex”, this dataset bears the code DS-SARDOA03 and will be made public at the time of publication of this article. It includes ten specimens of *sardoa* and four specimens of the new species (Tables 1 and 2).

Table 1. Details of specimens included in the dataset DS-SARDOA03.

Specimen	Locality	Collector	Date	Sex	Institution storing
LPRC2022-0234	Corsica, Haute-Corse, Ostriconi	LPRC	13–22-X-2020*	-	MNHN
LPRC2022-0237	Corsica, Haute-Corse, Ostriconi	LPRC	13–22-X-2020*	-	MNHN
LPRC2022-0245	Corsica, Haute-Corse, Ostriconi	LPRC	13–22-X-2020*	-	MNHN
LPRC2022-0321	Corsica, Haute-Corse, Ostriconi	LPRC	13–22-X-2020*	-	MNHN
LPRC2022-0336	Corsica, Haute-Corse, Ostriconi	LPRC	13–22-X-2020*	♀	MNHN
LPRC2022-0337	Corsica, Haute-Corse, Ostriconi	LPRC	13–22-X-2020*	-	MNHN
LPRC2022-0338	Corsica, Haute-Corse, Ostriconi	LPRC	13–22-X-2020*	♂	MNHN
BC-CT-MNHN0003	Corsica, Haute-Corse, Marina di Pinarello	Cl. Tautel	27-X-2022	♂	CTC
BC-CT-MNHN0004	Corsica, Haute-Corse, Marina di Pinarello	Cl. Tautel	27-X-2022	♂	CTC
BC ZSM Lep 106582	Sardinia, Province of Sassari, Stagno di Platamona	P. Skou	23-V-2004	♂	SNSB-ZSM
BC ZSM Lep 106682	Balearic Island, Ibiza, Cala d’Hort	P. Skou	3–4-X-2018	♂	SNSB-ZSM
BC ZSM Lep 113000	Balearic Island, Ibiza, Cala d’Hort	P. Skou	3–4-X-2018	♂	PSC
BC ZSM Lep 113509	Balearic Island, Ibiza, Sant Llorenç de Balàfia	P. Skou	5-X-2018	♀	PSC
Sihvonen1574	Andalucía, Tarifa, Punta Paloma	T. Ranki	14-IV-2021	♀	TRC

Note: * Collected by a Malaise Trap.

Table 2. Details of sequences included in the dataset DS-SARDOA03.

Specimen	Sequence	Bases [Ambiguous]	Marker	%GC	BIN URI
LPRC2022-0234	LPRCL1474-22	654 [0n]	COI-5P	32.1	BOLD:AFA0192
LPRC2022-0237	LPRCL1477-22	653 [0n]	COI-5P	32.0	BOLD:AFA0192
LPRC2022-0245	LPRCL1485-22	654 [0n]	COI-5P	32.1	BOLD:AFA0192
LPRC2022-0321	LPRCL1561-22	652 [0n]	COI-5P	32.1	BOLD:AFA0192
LPRC2022-0336	LPRCL1576-22	652 [0n]	COI-5P	32.2	BOLD:AFA0192
LPRC2022-0337	LPRCL1577-22	651 [0n]	COI-5P	32.3	BOLD:AFA0192
LPRC2022-0338	LPRCL1578-22	654 [0n]	COI-5P	32.1	BOLD:AFA0192
BC-CT-MNHN0003	LPRCL2256-23	653 [0n]	COI-5P	32.0	BOLD:AFA0192
BC-CT-MNHN0004	LPRCL2257-23	654 [0n]	COI-5P	32.0	BOLD:AFA0192
BC ZSM Lep 106582	GWOTZ333-19	658 [250n]	COI-5P	20.4	-
BC ZSM Lep 106682	GWOUB701-19	658 [0n]	COI-5P	31.6	BOLD:ADZ9010
BC ZSM Lep 113000	GWOUH084-21	638 [0n]	COI-5P	32.3	BOLD:ADZ9010
BC ZSM Lep 113509	GWOUI023-21	658 [0n]	COI-5P	31.6	BOLD:ADZ9010
Sihvonen1574	MIXED004-24	632 [4n]	COI-5P	32.3	BOLD:ADZ9010

DNA was extracted from one or two legs of seven dry specimens (BC-CT-MNHN0003 and -0004; BC ZSM Lep 106582, -106682, -113000 and -113509; Sihvonen1574) and of seven specimens conserved in alcohol after to have collected by a Malaise trap (LPRC2022-0232, -0237, -0245, -0321, -0336, -0337 and -0338).

DNA extraction, amplification and sequencing for the nine Corsican specimens of *sardoa* were carried out by the CCDB's Team (Canadian Centre for DNA Barcoding, hosted by the Center Genomics at the University of Guelph, Ontario, Canada). Legs were placed in a 96-well plate and shipped for processing at the CCDB. The plate was processed using the SEQUEL (Pacific Biosciences, USA) high-throughput NGS pipeline for large numbers of samples, as described in Hebert et al. (2018). After quality control and validation, consensus sequences produced by the SEQUEL platform were uploaded to the BOLD (Ratnasingham & Hebert, 2007) where both specimen- and sequence-data are managed.

Our colleagues Axel Hausmann and Pasi Sihvonen kindly gave us access in BOLD to their data and sequences relating respectively to the three specimens from Ibiza and the specimen from Tarifa, all four pre-identified as *sardoa* but actually corresponding to the new species. Thanks to Axel Hausmann, we also had access in BOLD to a sequence of a specimen of *sardoa* from a Sardinian locality close to the type-locality of this species.

In order to obtain a broader overview, we also used 229 additional sequences available in BOLD (Table 3), bringing the total number of sequences taken into account to 243. So, a comparative genetic analysis of several European and North American *Eupithecia* species associated with *Juniperus* and belonging to the *interruptofasciata* species-group was carried out. The gene analysed is the mitochondrial gene coding for the cytochrome oxidase subunit I (COI - DNA Barcode).

Table 3. Details of the additional data from BOLD considered in our molecular analysis.

Species and total number of specimens	Locality	Number of sequences
E. interruptofasciata (3)*	Canada, British Columbia	2
	Canada, Ontario	1

E. niphadophilata (107)*	USA, Alaska	2
	Canada, British Columbia	82
	Canada, Alberta	6
	Canada, Ontario	17
E. pusillata (90)	Canada, British Columbia	1
	Greenland	1
	Norway	8
	Finland	16
	United Kingdom, England, Lancashire	1
	France, Indre-et-Loire	32
	Germany, Bavaria	3
	Austria	9
	Italy (Piedmont, South Tyrol, Abruzzo and Calabria)	11
	Spain, Aragon	1
	North Macedonia	2
	Armenia	2
	Russia, Altai	3
E. conquesta (4)	Cyprus	4
E. phoeniceata (9)	United Kingdom, England	4
	Portugal	3
	Italy, Sicily	2
E. oxycedrata (16)	France, Alpes-Maritimes	1
	France, Corsica	7
	Italy, Abruzzo	1
	Croatia	1
	Spain, Comunidad Valenciana	1
	Portugal	4
	Marocco	1

Note: * Identified as such in BOLD.

The 243 sequences, exported from BOLD in a FASTA file, were processed with MEGA11 software (Tamura et al. 2021). The sequences were aligned by MUSCLE. Two trees were constructed using the “Phylogeny” function in MEGA11. For the first (Figure 65), the evolutionary history was inferred using the Neighbor-Joining method (Saitou & Nei, 1987) and the evolutionary distances were computed using the p-distance method (Nei & Kumar, 2000); all ambiguous positions were removed for each sequence pair (pairwise deletion option). For the second tree (Figure 64), the evolutionary history was inferred by using the Maximum Likelihood method and Kimura 2-parameter model (Kimura, 1980). In the two cases, the analysis involved 243 nucleotide sequences, codon positions included were 1^{st}+2^{nd}+3^{rd}+Noncoding and there was a total of 668 positions in the final dataset.

We also examined the BINs associated with the sequences analysed above. The Barcode Index Number System (Ratnasingham & Hebert, 2013), available in BOLD, clusters sequences using well established algorithms to produce operational taxonomic units that closely correspond to species. BINs are based on the divergence patterns of DNA barcodes. In Lepidoptera, there is generally a good congruence between BINs and the morphological delimitation of species, although this is not always the case, since there are species that share the same DNA barcode and, conversely, species within which there is genetic structuring into two or more BINs. These situations require more in-depth study, as they may reveal the existence, in the first case of synonymies that have not yet been established and, in the second case of twin species that have not yet been described or have yet to be rehabilitated.

Results

Taxonomy

***Eupithecia iberica* Lévêque, Skou, Tautel & Ranki, sp. nov.** (Figures 1-8, 17-20, 23-24)
https://zoobank.org/00F23CE2-8F82-4CB5-89AE-127A8FCE97EB

Holotype ♀: SPAIN, Balearic Islands, Ibiza, Sant Llorenç de Balàfia, 39.03ºN-1.47º E, 120 m, 5-X-2018, leg. Peder Skou, Sample ID BOLD: BC ZSM Lep 113509, in PSC.

Paratypes: SPAIN, Balearic Islands, Ibiza, 1.2 km ENE Cala d'Hort, 38.89ºN-1.23ºE, 100 m, 1 ♂, 3-4-X-2018, leg. Peder Skou, in MNCN; idem, 1 ♂, Sample ID BOLD: BC ZSM Lep 113000, in PSC; idem, 1 ♂, Sample ID BOLD: BC ZSM Lep 106682, in SNSB-ZSM; idem, 1 ♀, prep. gen. Cl. Tautel nº E306, in CTC (Figures 1-2, 17-18, 33, 37); idem, 1 ♂, prep. gen. Cl. Tautel nº E307, in CTC (Figures 3-4, 23-24, 44, 47, 59); Ibiza, 4.2 km SW Sant Rafel, Puig des Fornàs, 220 m, 1 ♂ and 1 ♀, 30-III-3-IV-2016, leg. Peder Skou, in PSC; Ibiza, Coll de sa Creu, 170 m, 1 ♂ and 4 ♀, 1-X-2018, leg. Peder Skou, in PSC. Andalucía, Cádiz, Tarifa, Punta Paloma, 36º3'55" N - 5º42'16"W, 40 m, 1 ♀, 14-15-IV-2021, leg. Timo Ranki, in MNCN; idem, 1 ♀, prep. gen. A. Lévêque n° AL40, in MNHN (Figures 5-6, 20, 31, 38); idem, 1 ♂, prep. gen. A. Lévêque nº AL41, in MNHN (Figures 7-8, 29, 43, 48-49, 55); idem, 1 ♀, Sample ID BOLD: Sivhonen1574, in TRC; idem, 1 ♀, 14-15-X-2021, prep. gen. Cl. Tautel nº E308, in CTC (Figures 19, 32); idem, 1 ♂ and 3 ♀, 3-V-2022, in TRC; idem, 1 ♂, 4-X-2022, in TRC; Cádiz, 8 km NW Tarifa, Punta Paloma, 10 m, 1 ♂ and 1 ♀, 12-13-IV-2007, leg. Peder Skou, in PSC; Andalucía, Huelva, 14 km SE Mazagón, Playa del Rompeculos, 20 m, 2 ♀, 20-IV-2007, leg. Peder Skou, in PSC; Andalucía, Cádiz, Novo Sancti Petri, 10 m, 1 ♂ and 1 ♀, 4-7-III-2005, leg. Bjarne Skule, in PSC.

Description: Forewing length: (8) 9-10 mm. Wingspan: (15) 16-17,5 (19) mm. Head: Antennae deeply dentate in the male (Figure 29), filiform in the female; first segment (scape) grey-beige; flagellum grey-beige interspersed with brown on top, uniformly light brown below. Labial palpi grey, with the lighter end (grey-beige). Frons grey-beige, light, with a few darker grey scales. Vertex almost uniformly light grey-beige. Thorax: Thoracic collar, tegulae, mesothorax and metathorax light grey-beige. A blackish transverse band crosses the anterior parts of the tegulae and the mesothorax. Legs grey-beige; articles of tarsus (tarsomeres) of the fore-, middle- and hind-legs with the light end, giving the tarsi a finely ringed appearance; hindtibia with two pairs of spurs, one medial, the other distal; tibia of the middle-legs with only one pair of spurs, distal; no spurs on the fore-legs. Abdomen: Upper side light grey, with the second tergum darker, blackish. Underparts lighter, grey-beige. Presence of small brownish to blackish scales on the sides. Sternum A8 shaped like an elongated triangle, with apex bifurcated and proximal margin slightly concave (Figures 47B, 49).

Forewing (upper side): Elongated, with a rather acute apex; the male has narrower wings than the female. Ground colour light grey-beige, with darker areas, greyish brown. Discal spot rather rounded (especially in male), quite small, black. Basal, antemedial and medial lines inconspicuous. Dark brown to blackish dashes, more or less elongated, on the veins M1, M2, M3 and CuA2, and between CuA2 and the vein A, in the post-medial area; a dark brown to blackish dash also along the bottom edge of the cell (in continuity, or almost, with the dash on CuA2). Terminal area with two elongated browns to blackish dashes near apex. A beige apical streak rather quite conspicuous. The wavy line faintly sinuate, pale, light grey-beige, contrasting with the darker ground of the terminal area. The terminal line dark brown, finely interrupted by beige at the veins. Fringe chequered greyish brown and beige. Hindwing (upper side): Ground colour light grey-beige, almost everywhere slightly paler than the forewing, except near the anal margin and the terminal area. Basal area dark and transverse lines conspicuous only near the anal margin. The pale wavy line invisible. Discal spot small, rounded, greyish brown. Terminal line and fringe as on forewing. Under side of wings: Quite uniform light grey-beige, almost with no pattern except for the highlighting of the veins in the post-medial area, and an apparent dark grey to blackish discal spot. A lighter subterminal band, bending towards the costa below the apex. Terminal line and fringe as on the upper side. Variation: Low. The ground colour is more or less light. The dark dashes on the veins and near apex of the forewing are more or less strongly marked. The discal spots are more or less marked; the one on the hindwing is sometimes barely visible. The specimens from Tarifa seem to have a little more contrast and could be a little smaller than those from Ibiza. The spring specimens seem in average a little bigger than the autumn specimens.

Male genitalia (Figures 43-44, 61): Uncus hook-like and pointed apically, biapical, with the tip deeply bifid. Valva relatively broad; costa sclerotized almost until the apex; sacculus sclerotized, ending in a broad point; lateral margin of the valva slightly convex below the apex then slightly concave just above the point. Aedeagus (Figures 56, 59, 63): vesica small, half the length of the coecum and as wide as this latter, opens in the axis of the coecum, without angle; vesica with two elongated cornuti (one 2.1 to 2.4 times longer than the other) and two sclerotized area (one small, almost as wide as it is long, at the base of the vesica, and the other just above, elongated, almost as long as the smallest cornutus); the longest cornutus forms an angle of around 90º to the smallest when the vesica is everted.

Female genitalia (Figures 31-33, 41): Papillae anales relatively oval and rather large. Apophyses pointed, the anterior a little longer than the height of the tergum A8. The anterior margin of the tergum A8 is sclerotized, relatively straight. Colliculum absent. Ductus bursae long, rather narrow, with a regular width (only slightly wider in its posterior part), sclerotized; no longitudinal striations and no row of minute spines running up the side of the ductus bursae, in its anterior part (Figures 37-38). Corpus bursae small, rather narrow, with a crown of little but strong spines in its centre.

Etymology: The specific epithet "*iberica*" refers to the territory from which the new species is described, that of the Iberian and related peoples, who lived in particular in the coastal regions of the east and south of the Iberian Peninsula, but also in the Balearic Islands.

Diagnosis and related species: Very similar to *Eupithecia sardoa* Dietze, 1910 and also closed to *E. pusillata* ([Denis & Schiffermüller], 1775), *E. oxycedrata* (Rambur, 1833) and *E. ericeata* (Rambur, 1833).

In males, the dentate antennae can be used to distinguish *sardoa* and the new species from the three others.

Compared to *sardoa*, the new species seems to be distinguished by its relatively small size, in average slightly lower than that of *sardoa* (wingspan: (16) 17-20 (21) mm) but be careful with the smallest specimens of *sardoa* and some *iberica* sp. nov. specimens a little larger than average. On the upper side, the discal spots seem more marked than in *sardoa*, especially on the hindwings; the light apical streak is more conspicuous than in *sardoa* (in which it may even be absent, or barely visible, in some specimens) (cf. criterion a on Figures 17, 19 and 23); in the extension of the apical streak, a light oblique band is clearly visible in the new species, reaching the inner edge of the forewing, such a band not being so clearly delimited in *sardoa* (cf. criterion b on Figures 17, 19 and 23); the difference in contrast between the forewings and the hindwings seem generally more pronounced in *sardoa* than in the new species; the dark dash situated between the veins CuA2 and A is less elongated than in *sardoa* (in which this dash extends, almost always continuously, to the medial and antemedial lines) (cf. criterion c on Figures 17, 19 and 23). On the underside of forewing, the lighter subterminal band, bending towards the costa below the apex, is absent in *sardoa* (compare Figures 18, 20 and 24 with Figures 22 and 26, criterion d). The sternum A8 is more elongated than in *sardoa* (cf. Figure 47B, and compare Figure 54 and 55).

The genitalia are very similar to those of *sardoa*. In the male genitalia, the ratio between the length of the coecum and that of the vesica is 2 in the new species but about 1.8 in *sardoa*. The longest cornuti is less elongated than in *sardoa*; it is 2.1 to 2.4 times longer than the smallest, in the new species, against 2.5 to 2.8 in *sardoa* (compare Figures 56-57). The female genitalia of the new species have a wider, less elongated ductus bursae and a less spiny corpus bursae than those of *sardoa*. The ductus bursae of *sardoa* female genitalia have one more twist than that of the new species, and it has longitudinal striations in its anterior part, with a row of minute spines running up the side from the spiny crown of the corpus bursae (no striations or row of spines in the new species) (compare Figures 37-38 with Figures 39-40). The basal part of the corpus bursae without spines distinguishes *sardoa* and the new species from the three others close species (*pusillata*, *ericeata* and *oxycedrata*).

Genetic data: The initial information that we have gathered using the tools directly available in BOLD show, on the one hand, that the nine Corsican sequences of *sardoa* studied are grouped together in the same BIN (BOLD:AFA0192) and, on the other hand, that the four Spanish sequences of *iberica* sp. nov. are clustered in a different BIN (BOLD:ADZ9010), an interesting result that supports our morphological analysis and the specific separation of the two taxa.

The unrooted Neighbour Joining tree constructed with MEGA11 after phylogenetic inference (Figure 65) shows that the populations of the *sardoa* complex in the broad sense are united in the same clade but are structured into two genetically well differentiated clusters, one grouping individuals originating from Corsica and Sardinia (true *sardoa*) and the other individuals from Ibiza and Tarifa (*iberica* sp. nov.). The patristic distances corresponding to this tree are given in Table 4.

The unrooted Maximum Likelihood tree obtained with MEGA11 after phylogenetic inference (Figure 64) and the associated patristic distances provided in Table 5 show very similar results. We find the same clade bringing together two genetically distinct groups corresponding to *sardoa* and the new species. The main difference between these two trees is the branching of the *oxycedrata* clade, which does not appear to be very robust, as indicated by the absence of a Bootstrap value associated with this node in the Neighbour Joining tree.

Table 4. Pairwise patristic distances between sequences associated to the Neighbour Joining tree of the figure 65. The analyse involved 243 nucleotide sequences. Codon positions included were 1st+2nd+3rd+Noncoding. All ambiguous positions were removed for each sequence pair (pairwise deletion option). There was a total of 668 positions in the final dataset. Evolutionary analyses were conducted in MEGA11. The mean divergences (%) among members associated with Junipers of the *Eupithecia interruptofasciata* species group are given in bold. The minimum (%) and maximum (%) are given in square brackets. The number of comparisons on which these distances are calculated is given in brackets. The BINs corresponding to the different species are indicated for each one in the first column. Intraspecific distances are shown in grey cells and interspecific distances in the other cells.

	niph / inte	**pusi**	**conq**	**phoe**	**oxyc**	**iber**	**sard**
niphadophilata / *interruptofasciata* BOLD:AAA3835	**0.42** [0.00 – 1.23] (n = 5,995)						
pusillata BOLD:ABZ6329	**2.60** [2.14 – 3.20] (n = 9,900)	**0.24** [0.00 – 1.45] (n = 4,005)					
conquesta BOLD:AFC0556	**5.32** [5.29 – 5.55] (n = 440)	**5.92** [5.48 – 6.30] (n = 360)	**0.00** [0.00 – 0.01] (n = 6)				
phoeniceata BOLD:AAF6413	**5.72** [5.59 – 6.14] (n = 990)	**6.32** [5.77 – 6.89] (n = 810)	**4.39** [4.28 – 4.59] (n = 36)	**0.49** [0.01 – 0.61] (n = 36)			
oxycedrata BOLD:AAB4293	**5.44** [5.30 – 5.85] (n = 1,760)	**6.05** [5.49 – 6.61] (n = 1,440)	**5.40** [5.28 – 5.59] (n = 64)	**5.80** [5.57 – 6.18] (n = 144)	**0.36** [0.00 – 0.91] (n = 120)		
iberica sp. nov. BOLD:ADZ9010	**7.06** [7.02 – 7.32] (n = 440)	**7.67** [7.21 – 8.08] (n = 360)	**7.03** [7.00 – 7.06] (n = 16)	**7.43** [7.29 – 7.65] (n = 36)	**6.37** [6.23 – 6.58] (n = 64)	**0.11** [0.02 – 0.21] (n = 6)	
sardoa BOLD:AFA0192	**6.91** [6.76 – 7.26] (n = 1,100)	**7.52** [6.95 – 8.01] (n = 900)	**6.87** [6.74 – 7.00] (n = 40)	**7.27** [7.04 – 7.59] (n = 90)	**6.22** [5.97 – 6.52] (n = 160)	**6.54** [6.40 – 6.70] (n = 40)	**0.39** [0.00 – 0.96] (n = 45)

Table 5. Pairwise patristic distances between sequences associated to the Maximum Likelihood tree of the figure 64. Analyses were conducted using the Kimura 2-parameter model. The analyse involved 243 nucleotide sequences. Codon positions included were 1st+2nd+3rd+Noncoding. There was a total of 668 positions in the final dataset. Evolutionary analyses were conducted in MEGA11. The mean divergences (%) among members associated with Junipers of the *Eupithecia interruptofasciata* species group are given in bold. The minimum (%) and maximum (%) are given in square brackets. The number of comparisons on which these distances are calculated is given in brackets. The BINs corresponding to the different species are indicated for each one in the first column. Intraspecific distances are shown in grey cells and interspecific distances in the other cells.

	niph / inte	**pusi**	**conq**	**phoe**	**oxyc**	**iber**	**sard**
niphadophilata / *interruptofasciata* BOLD:AAA3835	**0.43** [0.00 – 1.40] (n = 5,995)						
pusillata BOLD:ABZ6329	**3.21** [2.47 – 4.49] (n = 9,900)	**0.56** [0.00 – 2.61] (n = 4,005)					
conquesta BOLD:AFC0556	**6.82** [6.56 – 7.19] (n = 440)	**7.36** [6.89 – 8.27] (n = 360)	**0.00** [0.00 – 0.00] (n = 6)				
phoeniceata BOLD:AAF6413	**6.83** [6.41 – 7.35] (n = 990)	**7.37** [6.74 – 8.43] (n = 810)	**4.65** [4.50 – 4.80] (n = 36)	**0.42** [0.00 – 0.61] (n = 36)			
oxycedrata BOLD:AAB4293	**6.61** [6.14 – 7.38] (n = 1,760)	**7.15** [6.47 – 8.46] (n = 1,440)	**6.79** [6.58 – 7.19] (n = 64)	**6.79** [6.43 – 7.35] (n = 144)	**0.25** [0.00 – 0.76] (n = 120)		
iberica sp. nov. BOLD:ADZ9010	**9.00** [8.62 – 9.41] (n = 440)	**9.54** [8.95 – 10.49] (n = 360)	**9.18** [9.06 – 9.21] (n = 16)	**9.18** [8.91 – 9.37] (n = 36)	**7.79** [7.46 – 8.22] (n = 64)	**0.08** [0.00 – 0.15] (n = 6)	
sardoa BOLD:AFA0192	**8.89** [8.42 – 9.85] (n = 1,100)	**9.43** [8.75 – 10.93] (n = 900)	**9.06** [8.86 – 9.66] (n = 40)	**9.07** [8.72 – 9.82] (n = 90)	**7.67** [7.26 – 8.67] (n = 160)	**6.29** [5.98 – 6.93] (n = 40)	**0.34** [0.00 – 0.95] (n = 45)

The mean evolutionary divergence of the DNA barcodes of *sardoa* and *iberica* sp. nov. is more than 6% (see Tables 4 and 5), which is:

– far greater than the intraspecific genetic variability observed within *sardoa* (less than 0.4% on average) and *iberica* sp. nov. (0.1% on average).
– a divergence greater than the mean genetic distance noted between the DNA barcodes of *conquesta* and *phoeniceata*, for example, two valid species recently distinguished by Tabell et al. (2024) and now well established in specific rank.
– a much higher divergence (at least twice as great) than the mean distance measured between the DNA barcodes of *pusillata* and the *niphadophilata* / *interruptofasciata* complex.

In addition, it is notable that the minimum genetic distance between *iberica* sp. nov. and any of the other species studied here is always greater than the minimum distances observed between this latter and the other species (see Tables 4 and 5).

These genetic results corroborate those obtained from the morpho-anatomical study of the specimens and support our conclusion to separate the *sardoa* populations into two distinct species, one inhabiting mainly Sardinia, Sicily, the Italian western coast and Corsica (*sardoa*) and the other inhabiting the Balearic Islands and southern Spain (*iberica* sp. nov.).

Biology and distribution

Biology: This new species seems to have two generations (as *E. sardoa*), the first in early spring (particularly from the end of March until early May, with a peak in abundance around mid-April) and the second in early autumn (first half of October), according to the few data we have in the current state of our knowledge (Figures 66 and 67A). It is associated with sandy Mediterranean scrubs in which *Juniperus* are found, particularly *Juniperus* sp. *cf.* group *phoenicea* (Figure 74) and/or *J. macrocarpa* (Figures 71-

72), which could be its food plants, but the first stages are unknown. The sites where the new species were observed have slightly different habitats, but what they have in common is the presence of *Juniperus*. On the island of Ibiza, the species can be found until inland (Figure 69 for example), at altitudes of over two hundred meters, according to the observations we are aware of. The three localities known so far in mainland Spain are dunes or sandy places directly to the coast in ten to forty meters altitude (Figure 70 for example), which resembles the habitats in which *sardoa* occurs; it is interesting to note that these three sites coincide with the distribution of endemic association *Rhamno oleoidis*-*Juniperetum macrocarpae* Rivas-Martínez, 1965, along the Atlantic coast of Andalusia, where the largest populations of *J. macrocarpa* of the Iberian Peninsula are found (Diez-Garretas et al., 2022, p. 398 [figures 1 and 2], 401-402).

E. iberica sp. nov. does not appear to coexist with *sardoa*, which appears as a strictly coastal species, this latter growing on *J. macrocarpa*, a particular *Juniperus* adapted to coastal sandy sites (see below).

Distribution (Figure 68): Only known today from Ibiza (Figure 68B) and southernmost mainland Spain west of Tarifa (Figure 68C). It should be noted that the Spanish specimens from Punta Paloma, west of Tarifa, is located in the Strait of Gibraltar, on the Atlantic coast. In addition, there may have been or could have been some populations along the Spanish Mediterranean coast but if there were favourable habitats there in the past, then they have probably been destroyed (there seem to be very few potentially suitable places left today, based on a quick examination of satellite photos of this coast). There is a potential site with protected coastal dunes near Marbella (Andalusia, between Málaga and Gibraltar); unfortunately, the fourth author wasn't managed to get there at the right time (he only tried at the beginning of December without success, perhaps it was already too late in the year). It would also be interesting to look for the new species in the stabilised coastal dunes of the Albufera Natural Park, close to El Saler beach, south of Valencia, where *Juniperus macrocarpa* sub-association (*Phillyreo angustifoliae-Rhamnetum angustifoliae juniperetosum macrocarpae* Costa & Mansanet, 1981) occupies the dunes affected by sea air (see Diez-Garretas et al. 2022, p. 400 [figure 4] and 402).

Francesc Vallhonrat collected one male and two females of an *Eupithecia* that he identified as *sardoa* in Ibiza at the end of March 2011. These observations were published by Vallhonrat et al. (2011, p. 71), enabling them to confirm the presence of *sardoa* in the Balearic Islands (see below) and to add this species to the Ibiza's fauna. With the hindsight we today have, thanks to the fact that we have had access to true *sardoa* from Corsica, we can conclude that these specimens from Ibiza collected by Vallhonrat in 2011 most probably do in fact belong to *iberica* sp. nov., but this would require re-examining these specimens, which unfortunately were not figured in Vallhonrat's paper, to know for sure. We reproduce here the collection data associated with these three specimens from Ibiza: Forn des Saig, Santa Eulària des Riu, alt. 240 m, 26-III-2011, 1 ♀; Puig des Fornàs, Sant Rafel, alt. 220 m, 27-III-2011, 1 ♀; Puig de Cas Jai, Santa Agnès de Corona, alt. 220 m, 28-III-2011, 1 ♂ (all Vallhonrat *leg.*). These three sites are located in the interior of the island, not on the coast, which seems consistent with the second author's observation at Sant Llorenç de Bàlafia.

We were unable to examine the specimens associated with the Majorcan citations of *Eupithecia sardoa*: Riddiford (2002, p. 56, according to Barry Goater) and Mironov (2003, p. 144, also according to Barry Goater's data); this Majorcan record is however represented by a question mark on the map proposed by Mironov on page 143. Redondo et al. (2009, p. 235), treat the species *E. sardoa* in their work relating to the Geometrid moths of the Iberian-Balearic area on the sole basis of these two previous bibliographical references for Mallorca, which could therefore in all likelihood in fact concern the new species (in which case *E. sardoa* would be to exclude from the Iberian-Balearic fauna), without us being able to affirm it however (see also below); it should be noted indeed that the coastal dune habitat at this site seems to correspond fairly well to those where *sardoa* flies in Corsica or Italy.

Discussion

The tribe Eupithecinii comprises almost 1,900 species in the World and includes forty-seven genera, the largest of which is *Eupithecia* Curtis, 1825, that is also the most species-rich of the family Geometridae, with nearly 1,500 species (Mironov, 2014, p. 105). This high level of diversity continues to grow thanks to regular descriptions of new species, including in Europe, as for example the description of *Eupithecia gypsophilata* from Spain by Skou et al. (2017).

The *interruptofasciata* species group was introduced by Bolte (1990) after examining two North

American species (*E. interruptofasciata* Packard, 1873, and *E. niphadophilata* (Dyar, 1904)) and one European species (*E. pusillata*), all three associated with Juniper trees. According to Mironov (2003) and Mironov & Galsworthy (2014), this group included twenty-three species at that time: fourteen in Europe (*cocciferata* Millière, 1864, *abbreviata* Stephens, 1831, *lentiscata* Mabille, 1869, *dodoneata* Guenée, [1858], *reisserata* Pinker, 1976, *massiliata* Dardoin & Millière, 1865, *extremata* (Fabricius, 1787), *scopariata* (Rambur, 1833), *pusillata*, *sardoa*, *ericeata*, *phoeniceata* (Rambur, 1834), *oxycedrata* and *rosmarinata* Dardoin & Millière, 1865), two in northern Africa (*rusicadaria* Dietze, 1910, and *rhoisata* Chrétien, 1917), at least five in Asia (*dubiosa* Dietze, 1910, recently discovered also in Europa on the island of Samos (Müller et al. 2019, p. 547), *maerkerata* Schütze, 1938, *kozlovi* Viidalepp, 1973, *exrubicunda* Inoue, 1988, and *masuii* Inoue, 1980) and, so, two in northern America (*interruptofasciata* and *niphadophilata*). Very recently, an additional and unexpected species was described in this species group by Tabell et al. (2024): *Eupithecia conquesta* Tabell & Junnilainen, 2024, from Cyprus, close to *E. phoeniceata* and *E. oxycedrata*.

The discovery of *E. iberica* sp. nov. was just as surprising as that of *E. conquesta*, especially as they both concern the same species group and, within that, the same set of Pug moths associated with *Juniperus* (we can make the hypothesis indeed that *conquesta* is dependent on the Juniper trees as its sister species *phoeniceata*).

A few years ago, this group of species had already provided a surprise when the presence of *E. pusillata* was detected for the first time in Canada (in and around Vancouver) thanks the DNA barcodes (deWaard, 2010), whereas this Euro-Siberian Pug moth - which is widespread throughout Europe, including Iceland, and reaches the Kamchatka and the Sakhalin Island, in Asia - had previously only been known, in North America, from south-west Greenland (Mironov, 2003). This late discovery is probably partly explained by the fact that *E. pusillata*, *E. interruptofasciata* and *E. niphadophilata* form a complex of three particularly similar species, which are very difficult to identify on the basis of their wing patterns. This is often the case with the Pug moths in general. Therefore, examination of the male 8th sternite and genitalia, the female genitalia or DNA barcodes may prove decisive in making a reliable identification.

The relatively substantial differences noted by Tabell et al. (2024) between the male and female genitalia of *conquesta* and *phoeniceata* appear sufficient for a reliable determination of these two species with very similar wing patterns. It is quite surprising to see that the differences we described above between the male and female genitalia of *sardoa* and *iberica* sp. nov., two species that are also very similar in appearance, are more tenuous than those between *conquesta* and *phoeniceata*, even though the genetic divergence of DNA barcodes is much higher between *sardoa* and *iberica* sp. nov. than between *conquesta* and *phoeniceata*.

About *Eupithecia sardoa* Dietze, 1910

The history of the discovery and knowledge of *E. sardoa*

The first to reveal the existence of *Eupithecia sardoa* is its author Dietze (1910, pl. 77, fig. 703 and 704; 1913, p. 151). This latter describes the moth at the end of the part he devotes to Rambur's *Eupithecia oxycedrata*, assuming the species to be new, although he is not entirely sure, since he precedes the mention "spec. nov." with a question mark. Dietze had two specimens labelled "Sassari", which he figures in two black and white photographs in his book. These two Sardinian specimens were very likely bought from a French naturalist and insects' seller, Mr M. Damry († 1903), then based in Sardinia, who captured them most likely in 1896 and sold them to Dietze under the name *oxycedrata*. Indeed, the NHMUK has nine male specimens of *E. sardoa*, from the Charles Oberthür's collection, labelled with the little more detail, as follows: "Ile de Sardaigne - Sassari - Damry 1896". These specimens must have been caught on a beach near Sassari, as Damry (1897, p. 130) reported in his short note about his Lepidoptera hunts in Sardinia: «*Eupithecia oxycedrata* au bord de la mer en avril, sur le genévrier oxycèdre» (= "*Eupithecia oxycedrata* by the sea in April, on a juniper tree"). Since 1870, Dietze had been in possession of four other specimens from a consignment sent by Mabille, specimens that this latter had determined as *oxycedrata* and which he had caught in Corsica (these Corsican specimens most probably come from Porto-Vecchio, see below). On carefully examination of the three males he had of the six specimens in his collection, Dietze was astonished by the dentate antennae of these three individuals, whereas, according to him, neither *oxycedrata* nor any other known *Eupithecia* showed this characteristic. This discovery of dentate antennae in the male, an unusual phenomenon within this genus, enabled him to characterize and describe this species, which he compared to the taxon *euxinata* Bohatsch, 1893. This author described his *euxinata* as a variety of *oxycedrata* (then valid at subspecific rank after the International Code of Zoological Nomenclature). However, Dietze (1910, pl. 77, fig. 701 and 702; 1913, p. 151) indicated that *euxinata* - that he deals with just before *sardoa* in his book - was not a form of *oxycedrata*, following so the opinion of Petersen (1909, pp. 273-274). Although Dietze thought he was dealing with a new species, he did not exclude the possibility that his *sardoa* might be a form of *euxinata* (in which he had noticed that the antennae were slightly notched). *Eupithecia euxinata* was synonymized with *E. ericeata* by Mironov (2003, p. 144), following a hypothesis that Petersen (1909, p. 274) had already put forward in his time.

Despite the mention by Dietze (1913, p. 151) of the presence of the species in Corsica based on the specimens sent to him by Mabille, Herbulot (1961, pp. 121-123) does not include *E. sardoa* in his list of Geometridae of France. But a few years later, after having taken note of it and intrigued by this passage dealing with Mabille's captures in Corsica in the description of *sardoa* given by Dietze, Claude Herbulot (1968, pp. 245-246) became interested in these Corsican specimens. Paul Mabille (1835 - † 1923) was a great explorer of the Corsican lepidofauna, following in the footsteps of his uncle Pierre Rambur (1801-† 1870). Claude Herbulot bought the collections of these two lepidopterists at the sale of the Léon Lhomme's collection, which included them, in 1953; they are now conserved with his own at the SNSB-ZSM in Munich. In the Mabille's collection that he owned, Claude Herbulot was so able to find three other male specimens of *sardoa*, whose one labelled "Porto-Vecchio" and the two others still labelled "*oxycedrata*". Herbulot was then able to confirm their belonging to *sardoa*. Indeed, these three males, very similar to each other, had dentate antennae and perfectly matched the description given by Dietze. The third author fondly remembers, during his visits, how Claude Herbulot liked to show him his three specimens of *sardoa*, which he considered to be one of the jewels in his collection, so little was known about this moth until the 2000s. Moreover, Herbulot prepared the genitalia of one of them and found that they differed profoundly from those of *oxycedrata*, finding that they were closer to those of *sobrinata* (taxon today considered as synonym of *pusillata*) and *ericeata*. Thus, Claude Herbulot confirmed the integration of this barely known species into the fauna of France.

In this paper published in *Alexanor*, Herbulot (1968, p. 246) included one assertion that today must be cast into doubt. Indeed, Herbulot cited Bitinski-Salz (1934, p. 167), that reported the presence of *E. sardoa* in the interior of Sardinia on the Mount Limbara (where the species would be common in mid-May at an altitude of 1,000 m) and at Aritzo (also at 1,000 m), according Sterneck, but this is most certainly a confusion with *oxycedrata*, as *sardoa* is strictly coastal. During the spring 2002 then in May 2004, in Sardinia, the second author has observed numerous adult moths in several coastal localities:

–Platamona Lido (8 km east of Porto Torres, prov. of Sassari), alt. 5 m, 30-III-2002, two specimens.

–Stagno de Platamona (6 km east of Porto Torres, prov. of Sassari), alt. 5 m, 13-V-2004, fifteen specimens, and 23-V-2004, six specimens.

–Capo Pecora (6 km north of Buggerru, prov. of South Sardinia), alt. 50 m, 15-V-2004, one specimen.

–Portixeddu (5 km north of Buggerru, prov. of South Sardinia), alt. 10 m, 17-V-2004, seventeen specimens.

In 1914, Wagner described a new *Eupithecia* from Tunisia (at originally in the genus *Tephroclystia*, a synonym of *Eupithecia*): *E. peterseni* (Wagner, 1914), which he compared to *E. oxycedrata*. He had obtained the adults in early September thanks to a breeding of caterpillars collected during the previous April month by beating an isolated Juniper tree on a beach in Hammam Lif, a seaside resort near Tunis, the appearance of these caterpillars strongly recalling that of the caterpillars of *sobrinata* (i. e. our *pusillata*). This species *peterseni* was synonymized with *E. sardoa* by Mironov (2003, p. 143).

It was only since Mironov (2003) that the moth finally became better known, especially with regard to its genitalia, because the representation proposed, for the first time, by Wiltshire (1985, p. 169, fig. G) only concerned the female and was a drawing that is not very faithful to reality.

Eupithecia sardoa was discovered on the Tuscan coast in 2000 (nine specimens), and again collected in 2001 (twenty specimens), by using Malaise traps, in the Parco Regionale della Maremma (Dapporto & Strumia, 2004, pp. 170, 178), a place situated just opposite the Bastia area, separated from the eastern Corsican coast by the Tuscan Archipelago. Nappini & Dapporto (2009, pp. 180, 186, 192) also reported the presence of this species several times during a light trapping campaign that they carried out in the same park every month of the year between December 1999 and February 2004; the species was thus observed during the months of March, April, May and October. Still on the Tuscan coast, but about 150 km further north, near Pisa, the species was discovered in November 2004 in the Riserva di San Rossore, situated in the Parco Regionale di Migliarino-San Rossore-Massaciuccoli, during a trapping campaign carried out between June and November 2004 in a retrodunal station using an automatic light trap fitted with 8 W actinic tube (Dapporto et al. 2005, pp. 23, 25-27, 32, 42). Further south, in the central coastal part of the Italian peninsula, Grassi et al. (2007: 134; fig. 5 and 15), for their part, publish for the first time the presence of *E. sardoa* on the Lazio coast on the basis of old captures (eight specimens collected in 1977 and another in 1979) but also more recent observations (four specimens in 2004 and two in 2005) in the Parco Nationale del Circeo; these authors report the presence of the species during the months of February, March, May, September, October, November and December. While Mironov (2003, p. 144) reported only one generation, in May (according to Tunisian mentions), these different Italian papers show that the species is bivoltine on the west coast of the Italian peninsula, with a first generation in spring and the second in autumn.

At the same time, *E. sardoa* was also reported as new for the Sicilian fauna by Parenzan et al. (2006, p. 64), on the basis of several specimens identified by Axel Hausmann and collected in the Riserva naturale di Vendicari, in the south-east of the island, in January and September 1998, April 1999, November 2000, January and March 2001. These collecting dates show that the species is also bivoltine in Sicily. The second author has found himself two individuals in Sicily, 6.5 km east of Pozzallo, Santa Maria del Focallo, at an altitude of 5 m, on 20 and 21 September 2014; he also has three other Sicilian specimens in his collection, collected 5 km east of Pozzallo, at an altitude of 3 m, on 8 December 2019 (leg. D. Nilsson, C. Hviid & B. Skule).

Although the species had not been mentioned in Corsica since Mabille's historic captures in the 19th century, Jean-Claude Petit was the first to rediscover *sardoa* on the island in 2016 (pers. comm.). He is also the first to observe the first stages (which have never been the subject of a publication in a journal until now), along with its food plant, and to breed the species. Furthermore, the second author discovered one somewhat worn female of *sardoa* during light trapping carried out on 14 May 2017 at Sorbo-Ocagnano along a beach on the east coast, in a site rich in Junipers located as the crow flies some twenty kilometres south of Bastia. This same day, he also found around thirty caterpillars while beating the Junipers on the site, which enabled him to breed the species. At the same place (Figures 76-78), on 12 May 2022, Daniel Morel encountered the moth in large numbers (twenty adults and two caterpillars) and was able to take photos of it in vivo for the first time (Figure 79), which he posted on the *Artemisiae* website devoted to the Lepidoptera of France (Oreina, 2024, online). The third author visited the same Corsican site on 27 October 2022 where he was able to collect both the caterpillars at different stages and the moth simultaneously, which proves that the species is also bivoltine in Corsica, as it is mainland Italy and Sicily. Again, in this sandy site of Sorbo-Ocagnano, two caterpillars were found and photographed by Daniel Morel on 8 January 2023 while beating Juniper trees (*Artemisiae* Website). On 9 October 2023, this latter found *sardoa* in very large numbers during the autumn generation (Figures 80, 82-84), always in the same coastal site, in particular by scouring the dunes with his headlamp (pers. comm.). The following day, he discovered the species at another new site on the east coast, in Aléria (one female, Figure 81, genitalia examined; pers. comm. and *Artemisiae* website).

At the same time, the species was discovered for the first time on the west coast of Corsica, at Palasca, in the Ostriconi dunes to the south-west of the "Désert des Agriates", thanks to the trapping campaign carried out as part of the multidisciplinary "Our Planet Reviewed" mission. Several Malaise traps were installed at this site in October 2020 (Figure 75). The moths collected were stored in alcohol until this material was studied by barcoding in 2022, revealing the presence of *sardoa* in this sector of the island. In addition, the DNA barcodes obtained, which differed from those available for Ibiza (previously associated with *sardoa*) and which did not match any others known, have enabled us to highlight the existence of the cryptic species *iberica* sp. nov. described here.

Summary of current knowledge of *E. sardoa*

Biology: The species seems to fly in two generations. The first runs from the beginning of February (in Lazio), or even from the end of January (in Sicily) to the end of May. The peak of the greatest number of specimens encountered for this spring generation is around mid-May in Corsica and Sardinia. The second runs from mid-September (in the Lazio), or even from early September (in Tunisia) to around mid-December (in Sicily and Lazio). In Corsica, the autumn generation was observed in October; the large number of individuals seen during this month (particularly during the first fortnight) suggests that October would represent the peak of the flight period of this second generation in Corsica. In summer, neither the adult moth nor the caterpillars seem present (the species is probably in the pupa stage at this time of year).

The phenology (Figures 66 and 67B) of the species is not simple to understand. In Corsica, the presence of caterpillars has mentioned in May, October and January (at the same time as the adults in May and October but not in January); according to the data available, the month of May seems to be a peak in abundance for both adults and caterpillars on this island. In Sicily, adults were observed in early December (2019) and late January (1998 and 2001), a short gap of only about six to seven weeks. Considering all the data available to us throughout its range, adults have been observed from the beginning of September to the end of May. How many generations are there really? Does this number vary according to geographical area? Could there be just one generation between September and May, with emergence staggered over time? Are the Sicilian adults at the end of January the last late arrivals of an autumn generation or the very first of a spring generation? The best hypothesis we can come up with, given the current state of knowledge, is that there are two generations, one in spring and the other in autumn, both spread out over a fairly long period of time (nine to ten weeks at least), with staggered emergence and a possible overlap during the winter.

The absence of autumn data in Sardinia is probably due to a lack of surveys in favourable sites at this time of year. There is no reason why the moth should not fly in autumn in Sardinia.

The eggs are not known, but the other stages have been observed. The caterpillars start life as greenish larvae, later turning green, pinkish brown or brown with a thin white lateral line. According to the rearing carried out by the third author, the light-brown pupa has a dark green underside, is housed in a small silky cocoon in the sand and can remain alive for at least one year if the conditions for emergence are not met.

E. sardoa is strictly adapted to *Juniperus macrocarpa* Sm., 1813 (= *J. oxycedrus* subsp. *macrocarpa* (Sm.) Ball, 1877), a coastal shrub found on dunes and sandy beaches mostly along the Mediterranean coasts but also along the Atlantic coasts of Spain and the Marocco beyond the Strait of Gibraltar. The habitat of *E. sardoa* (Figures 76-78) corresponds to the habitat type of community interest 2250* "Coastal dunes with *Juniperus* spp." of the Council Directive 92/43/EEC of 21 May 1992 (Annex 1). This is a priority habitat of the Directive. More precisely, the habitat of *sardoa* corresponds to the subtype 2250-1 (Corine Biotopes code 16.271 and EUNIS code N1-B21 [previously B1.631], "Dune prickly juniper thickets"). From a phytosociological point of view, this habitat corresponds in Corsica to the association *Asparago acutifolii-Juniperetum macrocarpae* (Molin. et Ro. Molin.) O. Bolòs, 1962. Due to the strong ecological constraints it undergoes (exposure to wind and sea spray, dryness of the substrate), this habitat does not show any dynamics towards a forest stage and generally corresponds to specialized permanent vegetation, most often presenting a subprimary character, in balance with the environmental conditions (Bensettti et al. 2004, p. 333). This habitat is localized and presents a high sensitivity to human impacts such as tourism (wild camping, trampling, motorized vehicle traffic) and urbanization; it is also threatened by the coastal erosion, forest fires or pollutions. The *Juniperus macrocarpa* tree, characteristic of this habitat, is a plant protected in Corsica.

Remark: The species *Eupithecia oxycedrata* is abundant in hilly or mountainous sites, and is related to *Juniperus oxycedrus* L., 1753 (= *J. oxycedrus* subsp. *oxycedrus* L., 1753), but is also found, in smaller numbers, on the coastal sites; for example, Daniel Morel found in May 2022 a female of *oxycedrata* (genitalia examined) on the same day and at the same site where he observed *sardoa*, the caterpillar of *oxycedrata* can therefore also live on *J. macrocarpa*.

Distribution (Figure 68): *E. sardoa* is a Central Mediterranean species; it is a Thyrrenian species, but not strictly. It is found very locally on the coasts of Corsica, Sardinia, Tuscany, Lazio, Sicily and North Africa where the species has been found in Tunisia. As far as we currently know, its range and that of *iberica* sp. nov. do not appear to overlap. Thus, *sardoa* and *iberica* sp. nov. seem to be two closely related species occupying the same ecological niche but in geographically distinct distribution areas (allopatry) and are therefore likely two vicariant species.

In the Balearic Islands, *E. sardoa* has been reported from Mallorca, on the northeast coast of the island, in the Parc Natural de s'Albufera, which is home to dune habitats. This mention, prior to 1998, published by Riddiford (2002, p. 56) as new for Spain, provides from Barry Goater. It is also based on Barry Goater's observation that Mironov (2003, p. 144) refers to the presence of the species on this island, although he displays a question mark on the map he proposes for this species (p. 143). These two bibliographical references were later taken up by Redondo et al. (2009, p. 235), who show on the map that they propose two distinct points, not even located in the Park of s'Albufera, even though these two mentions a priori refer to the same observation by Barry Goater in this park. Few years ago, the second author asked Mironov why he had put a question mark over Mallorca, since Barry Goater had dissected the specimen, and Mironov replied that the reason was he had not been able to see this specimen for himself. Today, the collection of Barry Goater, died in the summer of 2022, is conserved in the Natural History Museum of Denmark in Copenhagen. In addition, Martin Honey has visited and collected in Mallorca several times and has got the species there. In an email to the second author, Martin Honey wrote: "Mallorca, Parc Natural de s'Albufera, Es Comú, 22-X-2003 (M. R. Honey and N. J. Riddiford) - confirmed by genitalia". We haven't had the possibility to examine these Mallorcan specimens. So, this site, which would be the most westerly locality of the range of *sardoa*, can no longer be confirmed without going back to the specimens because of the discovery and description here of *iberica* sp. nov., a sister species, quite similar in appearance and with close genitalia, found on the neighbouring island of Ibiza. So, it's not unreasonable to think that the species that flies in Mallorca might be *iberica* sp. nov., and not *sardoa*, both species can occur in the same type of coastal sandy habitats, but we can't say so here without further investigation.

The specimens collected in Ibiza and identified as *sardoa* in 2011 by Francesc Vallhonrat most probably belong to the new species *iberica* (see above).

Conclusion

It was unexpected to discover a new species of *Eupithecia* in Europe and, moreover, a sister species to *sardoa*, which we have only known better for a few years. Molecular analyses were particularly helpful in identifying this new taxon, as *sardoa* and *iberica* sp. nov. are morphologically very similar. However, after a thorough re-examination of the habitus and genitalia, we were able to highlight some diagnostic characters, particularly in the genitalia.

It was equally unexpected that this discovery should come at the same time as that of another new species, in the same species group, but in Cyprus, another Mediterranean island.

This recent description of *conquesta* and that of *iberica* sp. nov. here bear witness to the important speciation mechanism at work in the Mediterranean basin within the genus *Eupithecia*. The limited range of other known species, such as *E. sardoa*, *E. poecilata* Püngeler, 1888 (endemic to Corsica and Sardinia), *E. lentiscata* Mabille, 1869, or *E. dubiosa* Dietze, 1910, also supports this conclusion.

With this discovery, the island of Ibiza continues to surprise us, following the recent descriptions of the endemic species *Epirrhoe balearia* Fischer, 2011, and *Peribatodes ebusaria* Vallhonrat, 2012.

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Conflict of Interest

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

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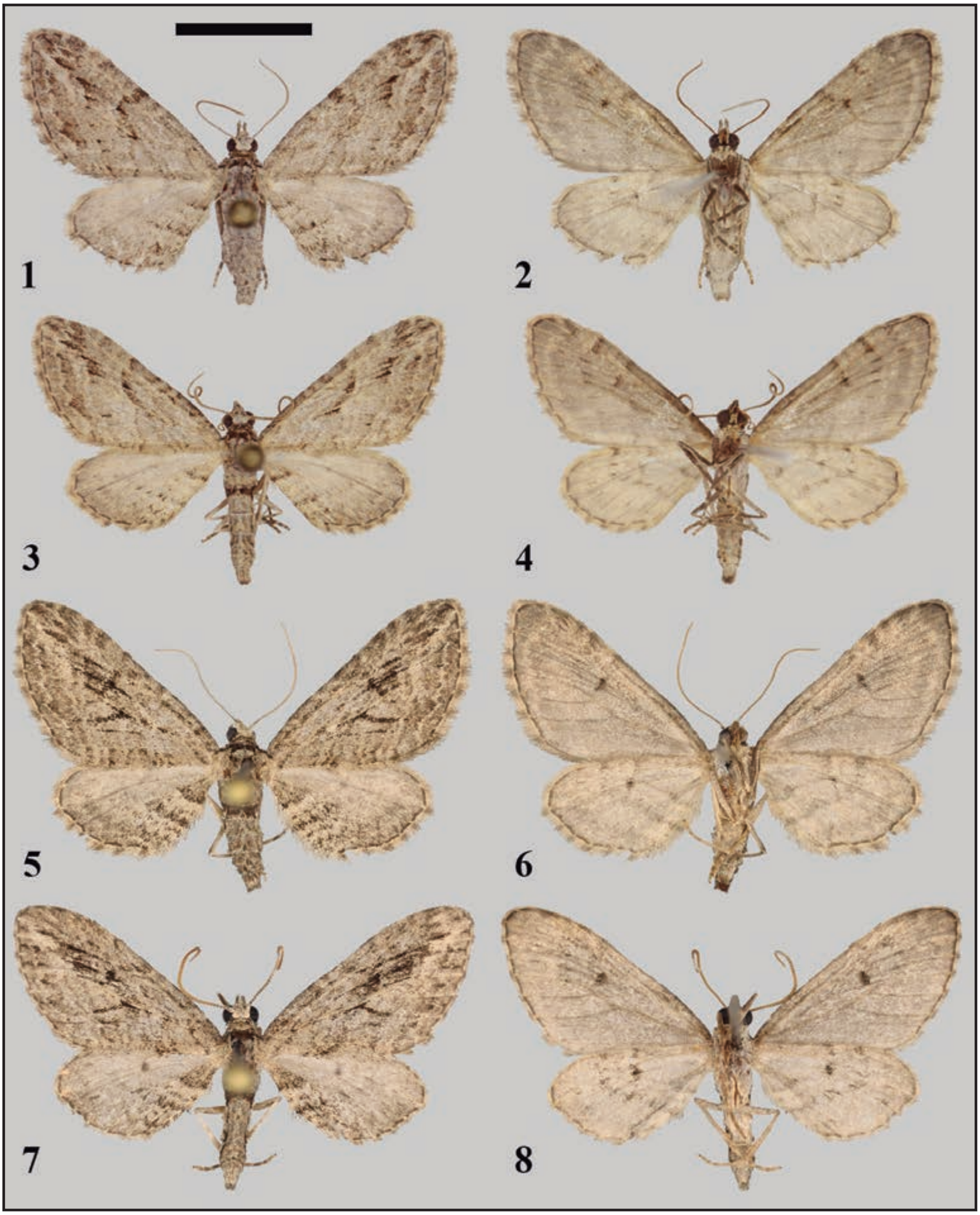
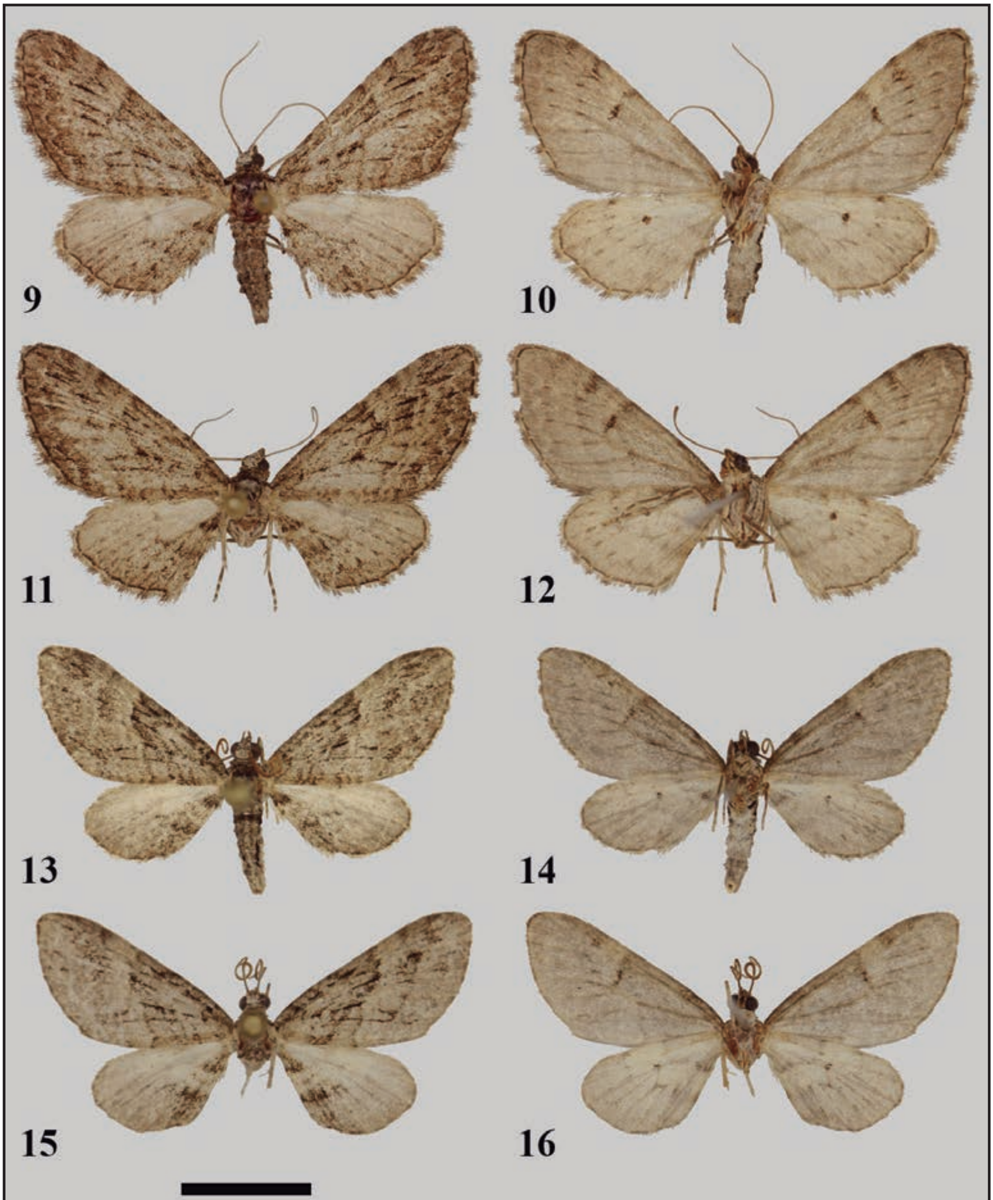
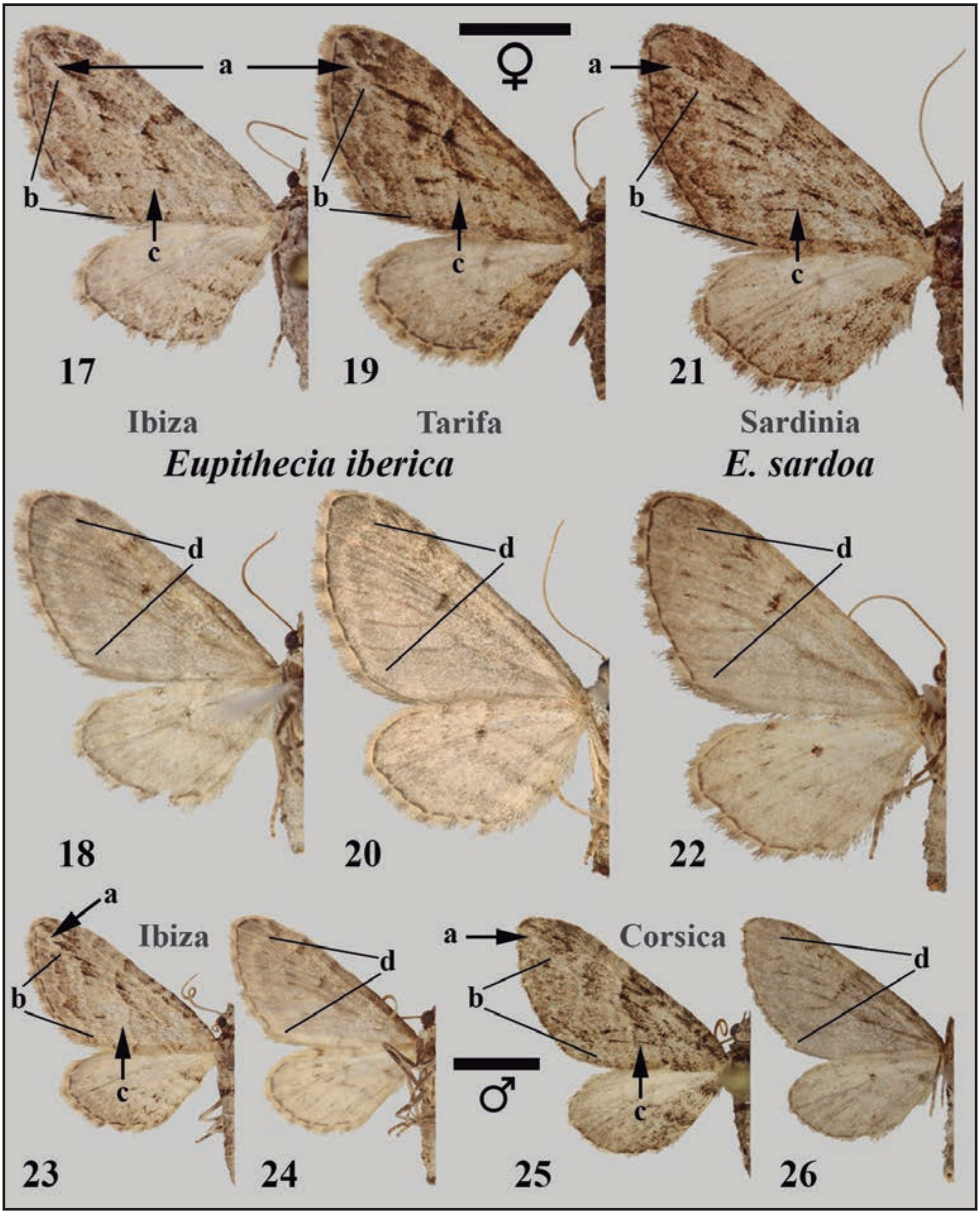
Figures 1-8. *Eupithecia iberica* sp. nov., paratypes. **1-2.** Female, upper and under sides, Ibiza. **3-4.** Male, upper and under sides, Ibiza. **5-6.** Female, upper and under sides, Tarifa. **7-8.** Male, upper and under sides, Tarifa. Scale bar: 0.5 cm (Photos 1-4: Cl. Tautel; 5-8: A. Lévêque).



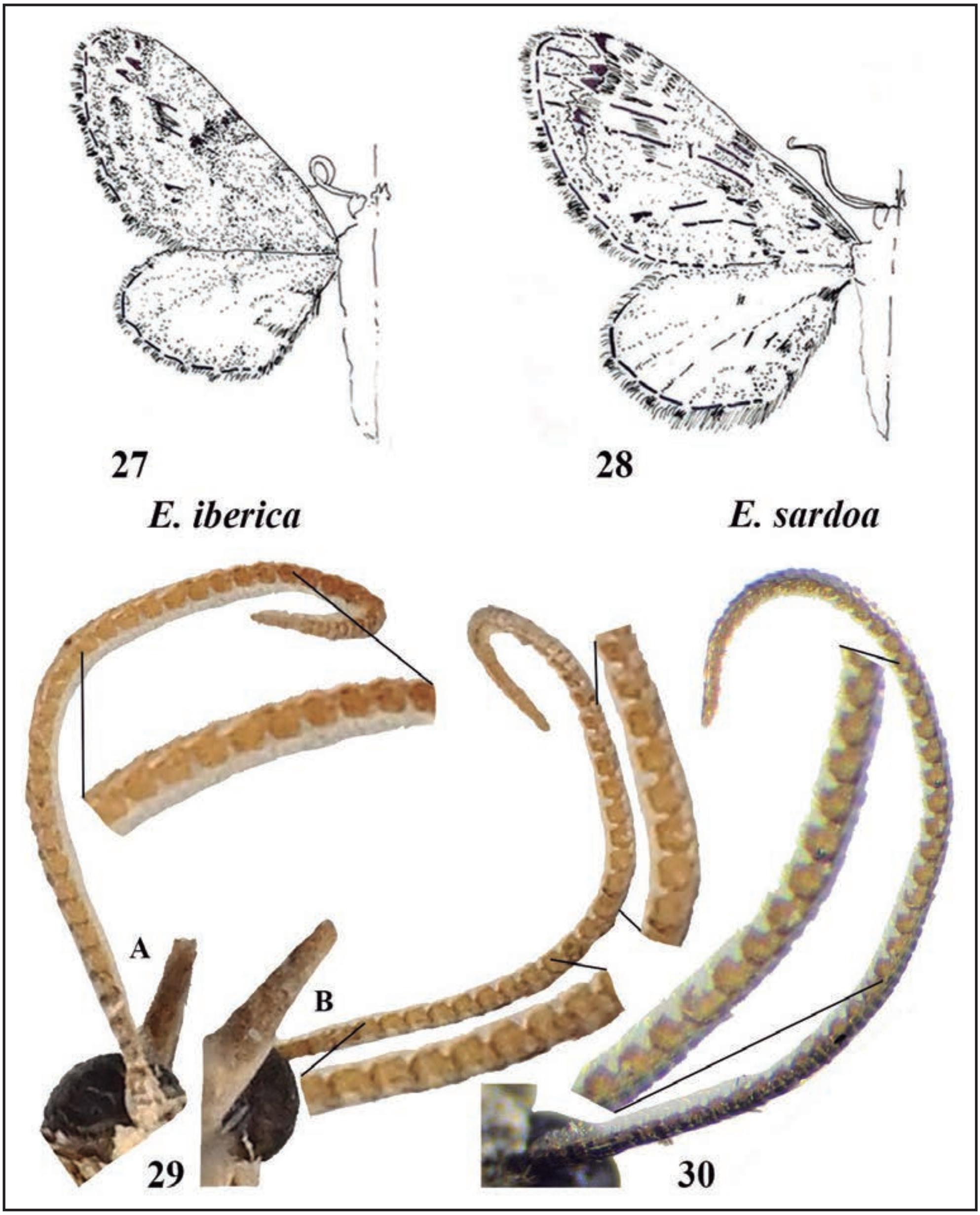
Figures 9-16. *Eupithecia sardoa* Dietze, 1910. **9-10.** Female, upper and under sides, Sardinia, Stagno de Platomona, 23-V-2004, P. Skou leg., slide Cl. Tautel E309. **11-12.** Female, upper and under sides, Sardinia, Stagno de Platomona, 13-V-2004, P. Skou leg., slide Cl. Tautel E200. **13-14.** Male, upper and under sides, Corsica, barcoded specimen nº BC-CT-MNHN0004. **15-16.** Male, upper and under sides, Corsica, barcoded specimen nº BC-CT-MNHN0003. Scale bar: 0.5 cm (All photos: Cl. Tautel).



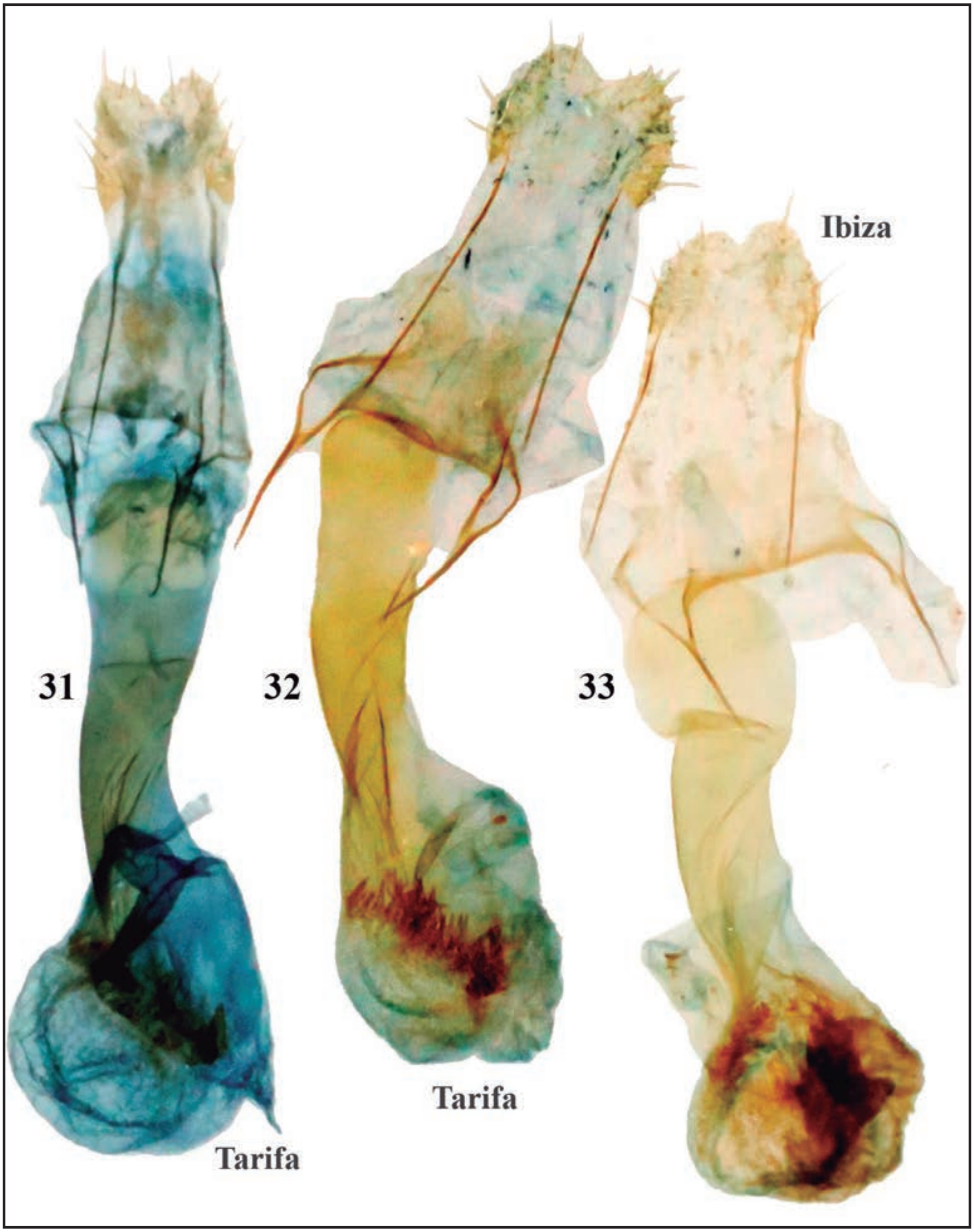
Figures 17-26. Comparison of the habitus of *E. sardoa* Dietze, 1910, and *E. iberica* sp. nov., and highlighting of the main distinctive characters: **a**, apical streak; **b**, light oblique band in the extension of the apical streak; **c**, dark dash between the veins CuA2 and A; **d**, curved subterminal light band on the underside. **17-18.** Same specimen as figures 1-2. **19.** Tarifa, X-2021. **20.** Same specimen as figure 6. **21-22.** Same specimen as figures 9-10. **23-24.** Same specimen as figures 3-4. **25-26.** Same specimen as figures 13-14. Scale bars: 0.3 cm (photo 19: Cl. Tautel).



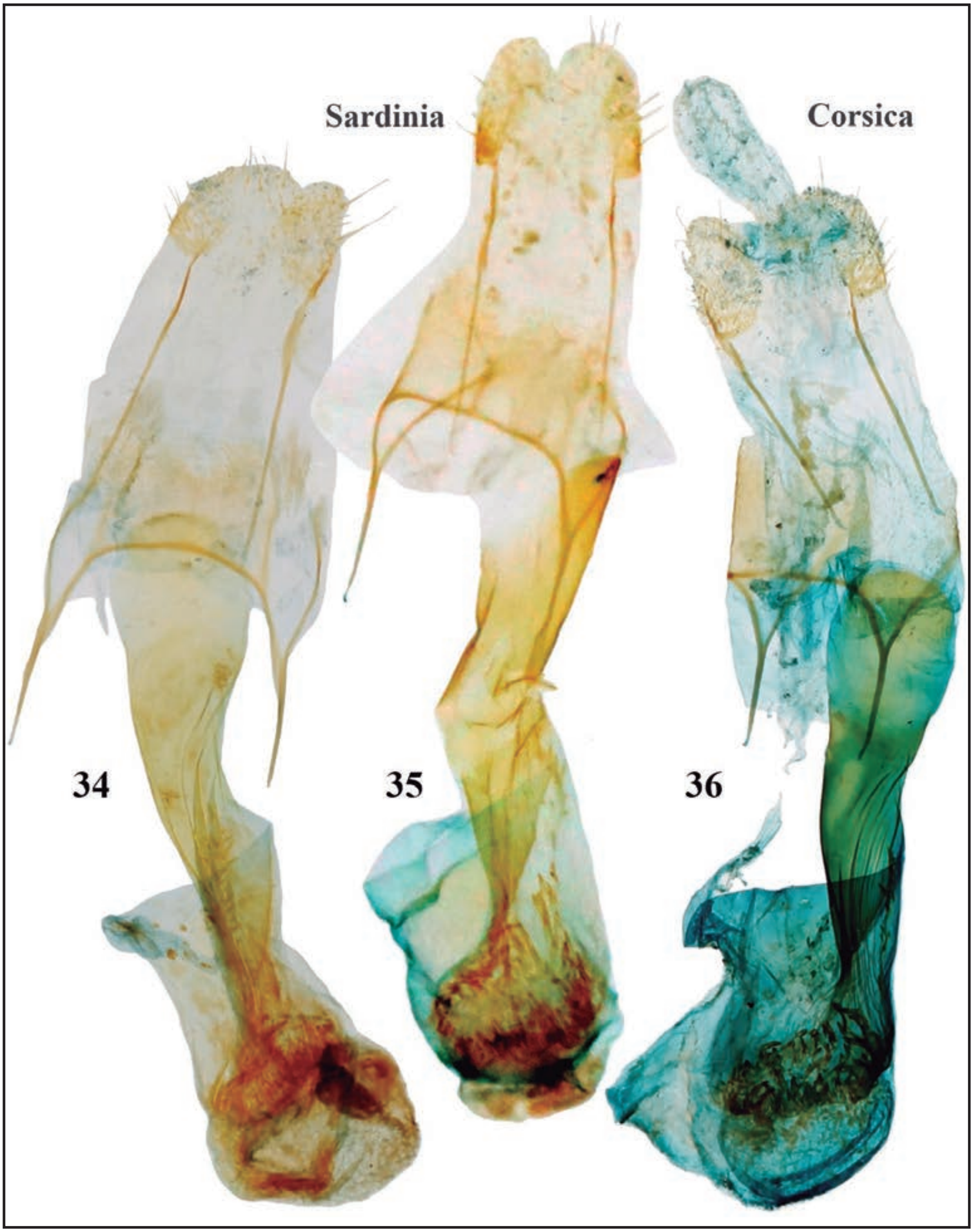
Figures 27-30. Comparison of *E. sardoa* Dietze, 1910, and *E. iberica* sp. nov. **27.** *E. iberica* (after a specimen from Ibiza). **28.** *E. sardoa* (after a specimen from Sardinia). **29.** Zoom on the antenna of male of *iberica*, with two different angles of view (A, dorsal view; B, ventral view), Tarifa (same specimen as figures 7-8). **30.** Zoom on the antenna of male of *sardoa*, Corsica (drawings and photo 30: Cl. Tautel; photos 29: A. Lévêque).



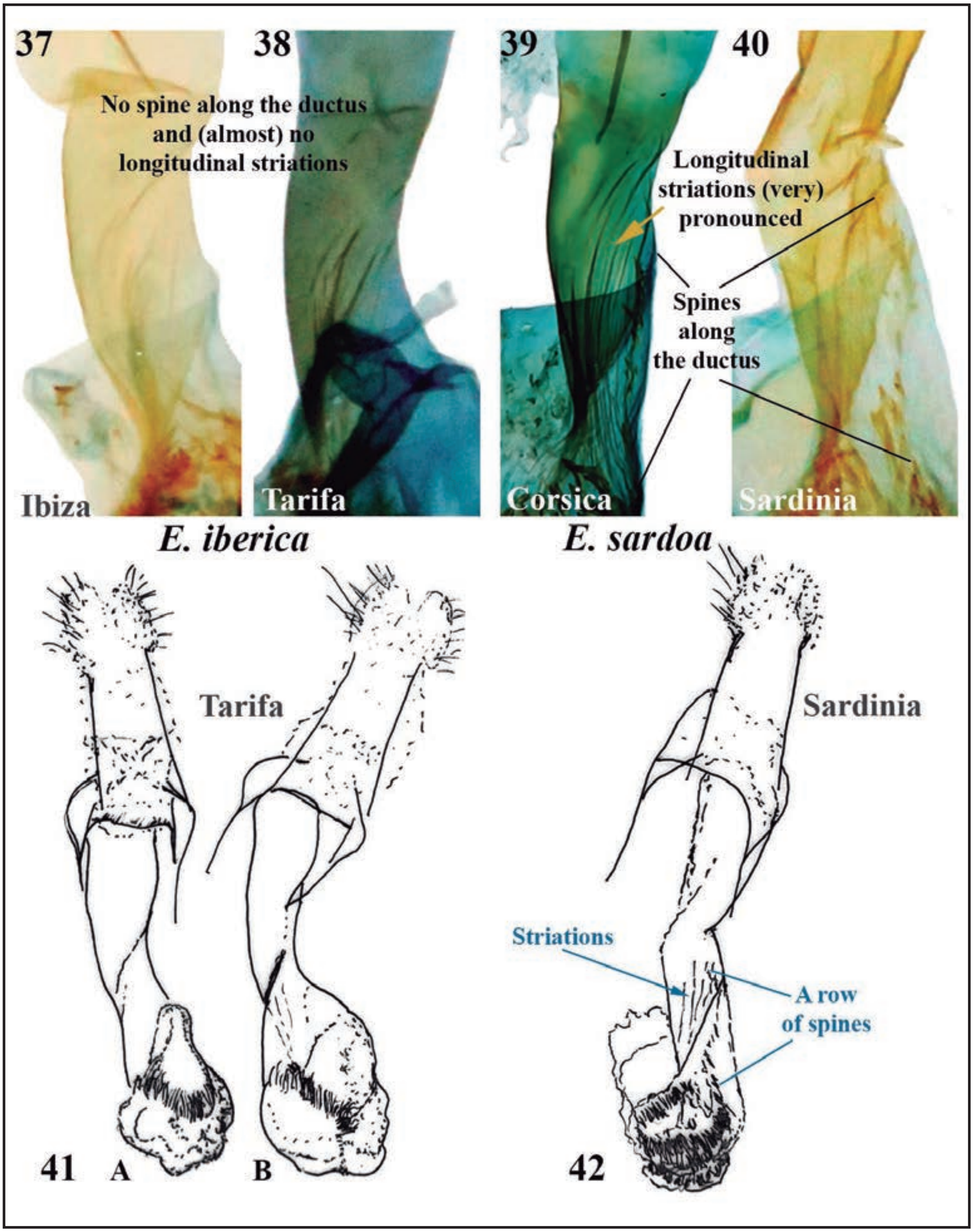
Figures 31-33. Female genitalia of *E. iberica* sp. nov. **31.** Same specimen as figure 5 (slide A. Lévêque AL40). **32.** Same specimen as figure 19 (slide Cl. Tautel E308). **33.** Same specimen as figure 1 (slide Cl. Tautel E306) (All photos: A. Lévêque).



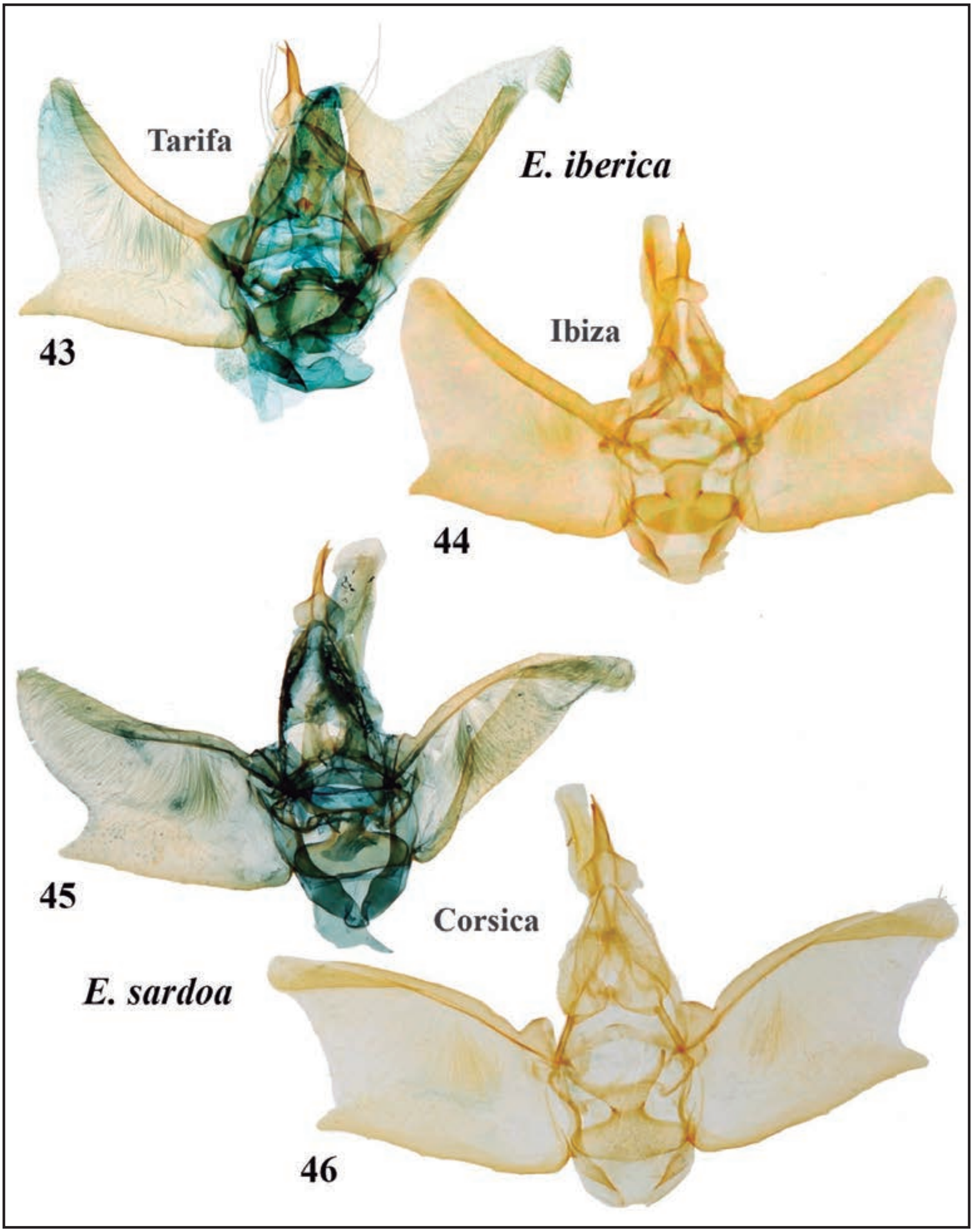
Figures 34-36. Female genitalia of *E. sardoa* Dietze, 1910. **34.** Same specimen as figure 11 (slide Cl. Tautel E200). **35.** Same specimen as figure 9 (slide Cl. Tautel E309). **36.** Barcoded specimen n° LPRC2022-0336, Corsica (slide A. Lévêque AL42) (All photos: A. Lévêque).



Figures 37-42. Comparison of the female genitalia of *E. sardoa* Dietze, 1910, and *E. iberica* sp. nov., and highlighting of the main distinctive characters. **37.** Zoom of figure 33. **38.** Zoom of figure 31. **39.** Zoom of figure 36. **40.** Zoom of figure 35. **41.** *E. iberica*, with two different angles of view (after a specimen from Tarifa). **42.** *E. sardoa* (after a specimen from Sardinia) (All photos: A. Lévêque; all drawings: Cl. Tautel).



Figures 43-46. Male genitalia of *E. iberica* sp. nov. and *E. sardoa* Dietze, 1910. **43.** Same specimen as figure 7 (slide A. Lévêque AL41). **44.** Same specimen as figure 3 (slide Cl. Tautel E307). **45.** Barcoded specimen nº LPRC2022-0338, Corsica (slide A. Lévêque AL43). **46.** Corsica, Sorbo-Ocagnano, 27-X-2022, Cl. Tautel leg., slide Cl. Tautel E199 (All photos: A. Lévêque).



Figures 47-63. 8th abdominal segment, aedeagus and valva of *E. iberica* sp. nov. and *E. sardoa* Dietze, 1910. **47-55.** 8th segment (tergite on the left, sternite on the right): *E. iberica*, whole abdomen (A) and zoom on the 8th sternite (B), slide E307 (47), and slide AL41 (48-49); *E. sardoa*, slides AL43 (50-51) and E199 (52-53); drawings of interpretation of the 8th sternite (54-55). **56-57.** Aedeagus with everted vesica: *E. iberica*, slide AL41 (56); *E. sardoa*, slide AL43 (57). **58-59.** Aedeagus with vesica not everted: *E. sardoa*, slide E199 (58); *E. iberica*, slide E307 (59). **60-61.** Drawings of interpretation of valva of *E. sardoa* (60) and *E. iberica* (61). **62-63.** Interpretation of figures 58-59 (All photos: A. Lévêque; all drawings: Cl. Tautel).

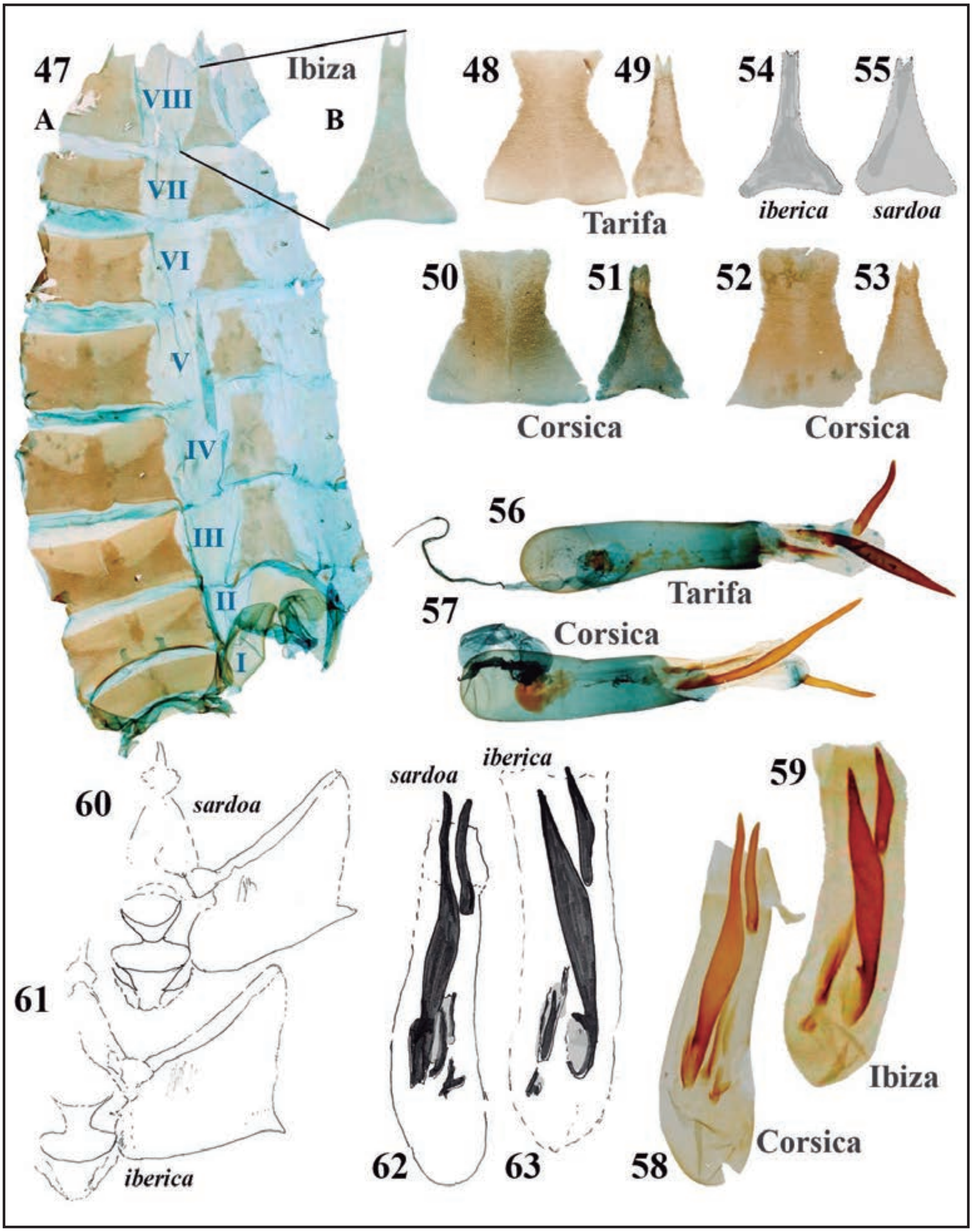


Figure 64. Maximum Likelihood tree reconstructed from 243 records of the *interruptofasciata* species-group for the standard DNA barcode fragment (part of mitochondrial COI gene). The tree with the highest log likelihood (-2,194.09) is shown. Initial tree(s) for the heuristic search were obtained automatically by applying Neighbor-Join and BioNJ algorithms to a matrix of pairwise distances estimated using the Maximum Composite Likelihood (MCL) approach and then selecting the topology with superior log likelihood value. Branch lengths are proportional to the number of substitutions per site (see scale in upper left corner and the grey number above each branch).

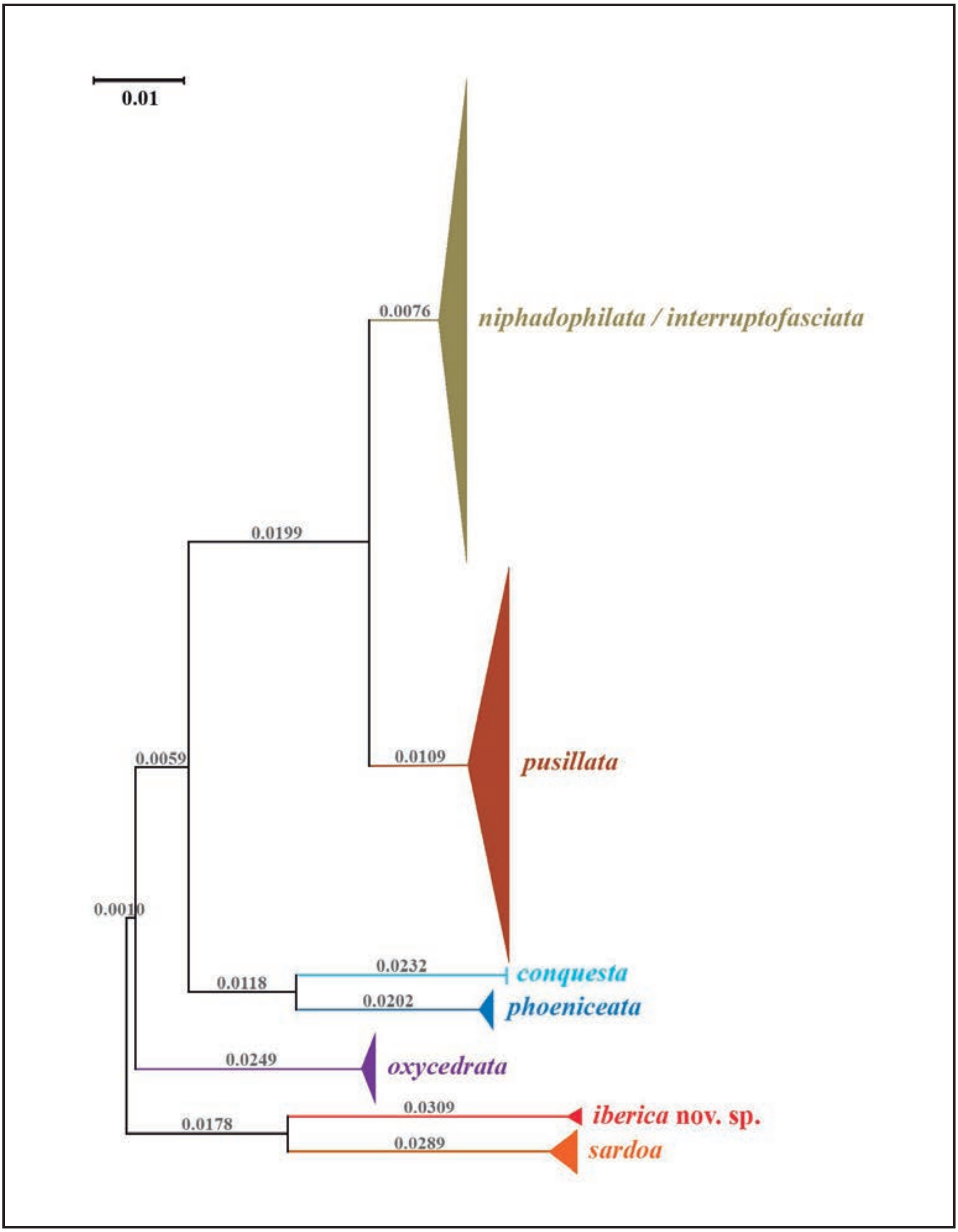
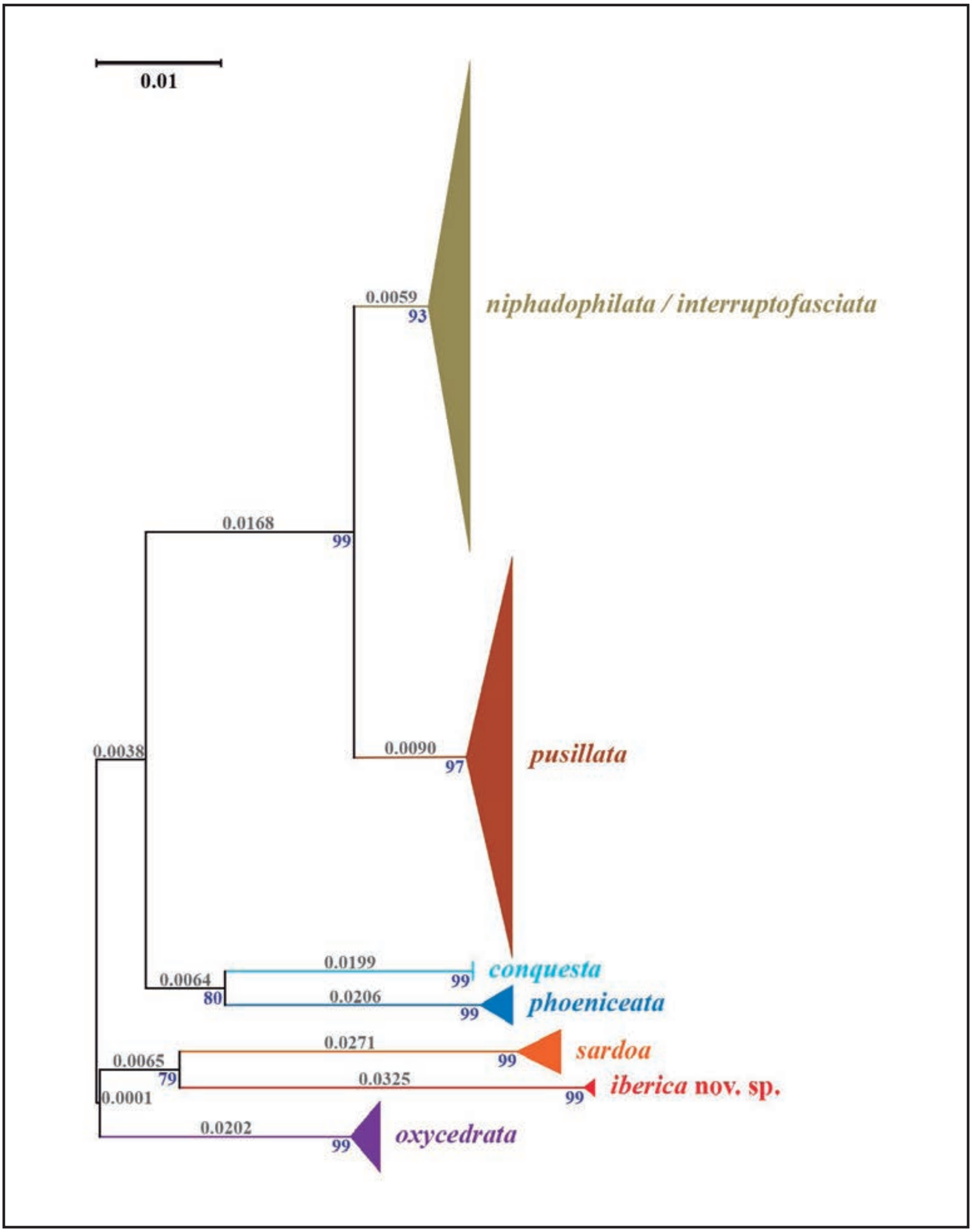
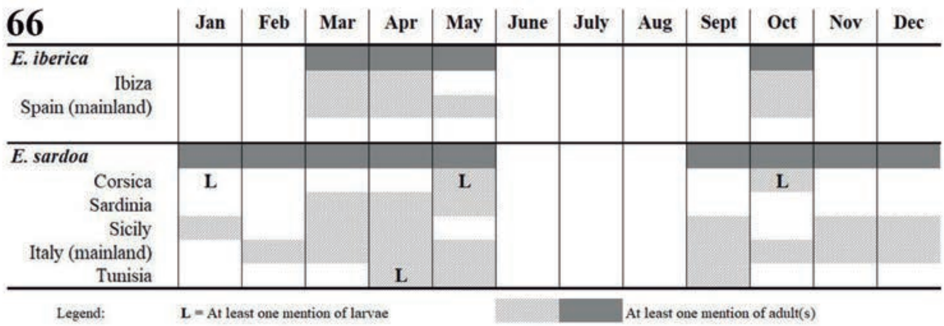


Figure 65. Neighbor-Joining optimal tree reconstructed from genetic distance analysis of 243 records of the *interruptofasciata* species-group for the standard DNA barcode fragment (part of mitochondrial COI gene). Branch lengths are proportional to genetic distance (p-distance; see scale in upper left corner and the grey number above each branch). The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (1,000 replicates) are shown in blue below the branches.



Figures 66-67. Larval phenology and flight period of *E. iberica* sp. nov. and *E. sardoa* Dietze, 1910, based on bibliographic data and our own observations. **66.** Monthly phenology, detailed by territory (*iberica*: n = 15; *sardoa*: n = 38). Larval phenology unknown for *iberica*. **67.** Flight period, detailed by decades (*iberica*: n = 15; *sardoa*: n = 31).



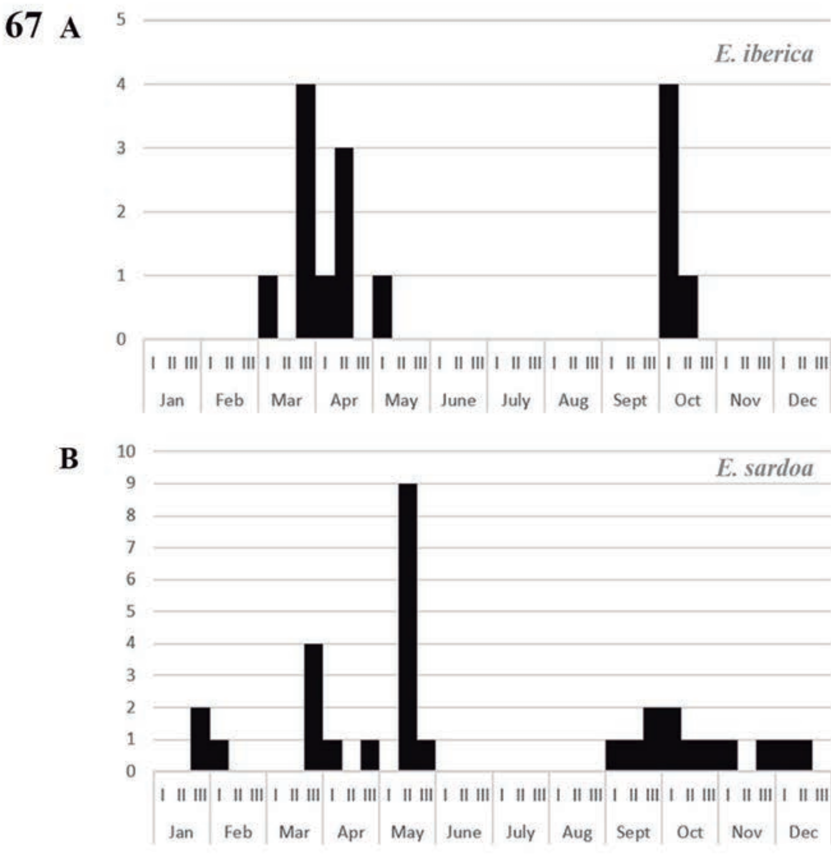
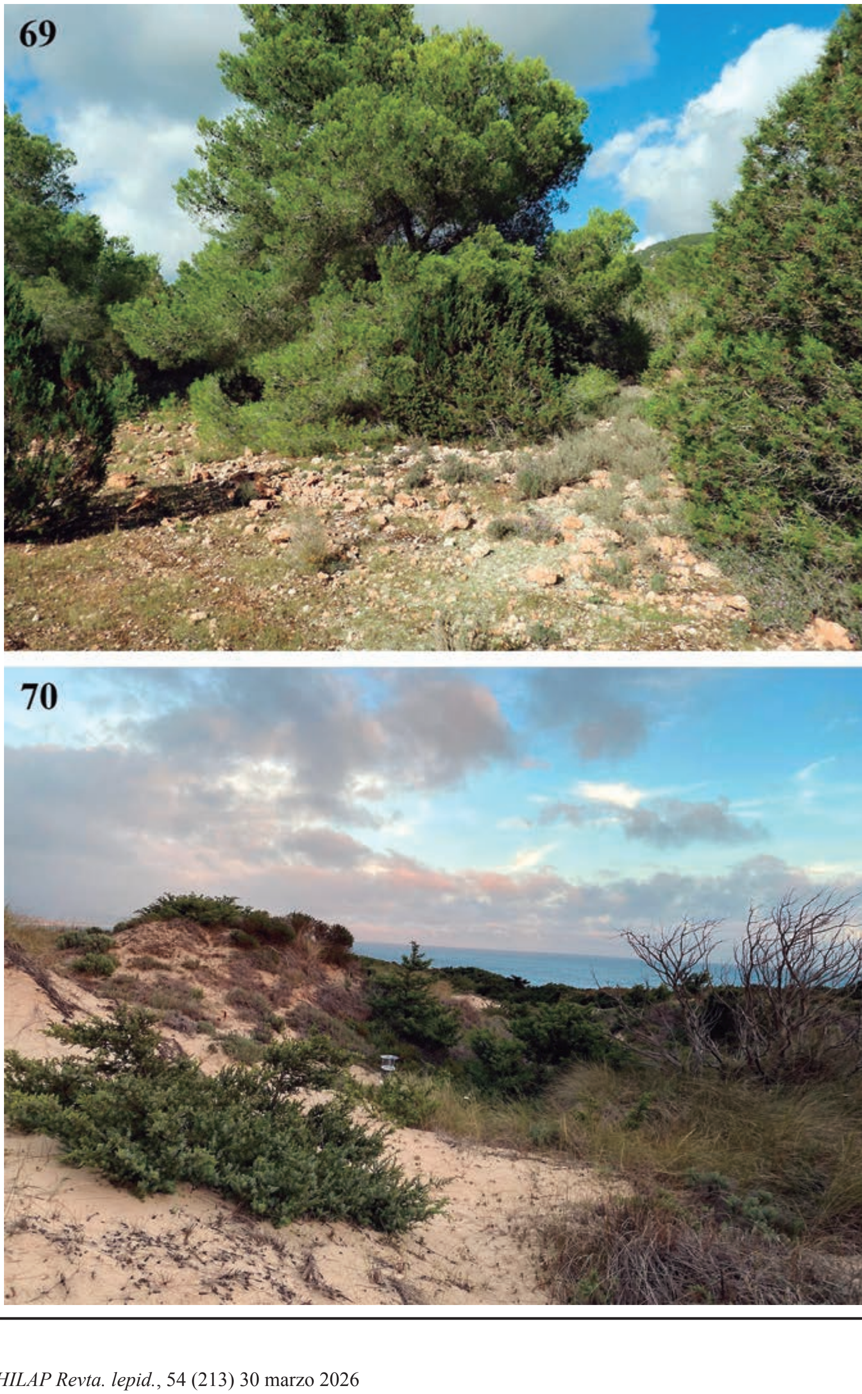


Figure 68. Distribution map of the vicariant species *E. sardoa* Dietze, 1910 (black dots) and *E. iberica* sp. nov. (red triangles). **A.** General map. **B.** Detailed map for *iberica* on the island of Ibiza. **C.** Detailed map for *iberica* in mainland Spain (map design: A. Lévêque, based on bibliographic data and our own observations).

Figures 69-70. Habitat of *E. iberica* sp. nov. **69.** On the island of Ibiza, 1.2 km ENE Cala d'Hort, 3-X-2018 (Photo: P. Skou). **70.** In mainland Spain, near Tarifa, at Punta Paloma, 15-IV-2021 (Photo: T. Ranki).

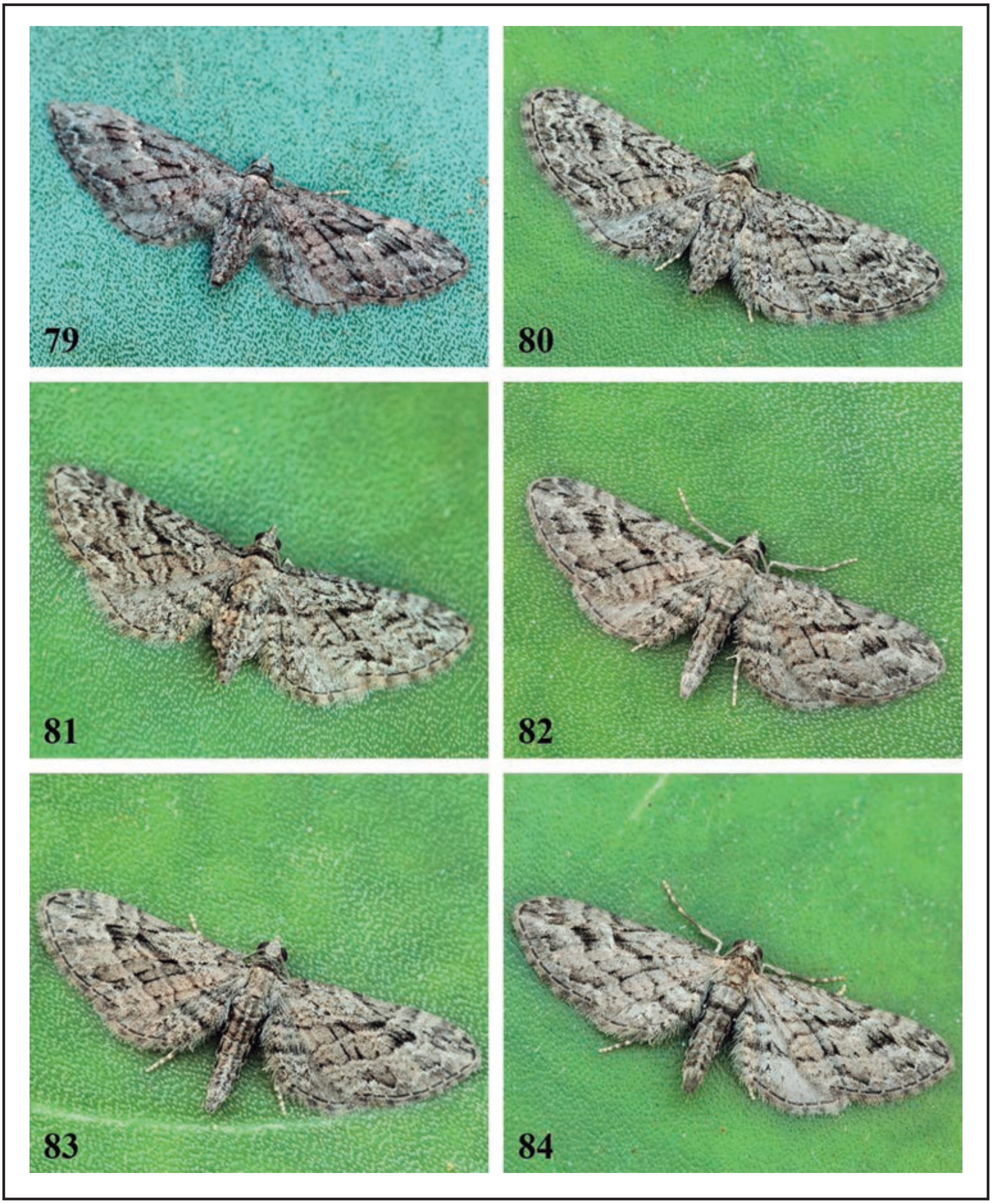


Figures 71-72. *Juniperus macrocarpa*, presumed host plant of *E. iberica* sp. nov., at Punta Paloma, 16-X-2021. **71.** Overview, in its coastal sandy habitat. **72.** Detailed view (All photos: T. Ranki).

Figures 73-74. Two different Juniper trees, which are present in a mixture at the Punta Paloma site, are likely to be host plants of *E. iberica* sp. nov.: a *Juniperus* sp. nr. *phoenicea* species-group (detailed on the figure 74, 14-IV-2021) and *J. macrocarpa*, 16-X-2021 (Photos: T. Ranki). **Figure 75.** Malaise Trap installed among Juniper trees in the Ostriconi dunes, at Palasca, which captured *E. sardoa*, X-2020 (Photo: Our Planet Reviewed in Corsica).

Figures 76-78. Different views of the habitat and the host plant (*J. macrocarpa*) of *E. sardoa* Dietze, 1910, on the coastal sandy site of Marina di Pinarello, at Sorbo-Ocagnano, Corsica, 16-X-2023 (All photos: A. Lévêque).

Figures 79-84. *Eupithecia sardoa* Dietze, 1910, in natura, Corsica. All at Sorbo-Ocagnano, except nº 81 at Aléria. All in October 2023, except nº 79 in May 2022. **79-81.** Females. **82-84.** Males (All photos: Daniel Morel).



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A new species of the genus *Comostola* Meyrick, 1888 from Xizang, China (Lepidoptera: Geometridae)

Boxin Wen, Zhaohui Pan & Hongxiang Han

Abstract

Comostola rectiuscula Wen, Pan & Han, sp. nov., described as a new species from Xizang, China. Additionally, *C. caerulea* Warren, 1893 recorded as new for the fauna of China. Description and diagnoses for both species are provided, and their external characters and genitalia are illustrated.
Keywords: Lepidoptera, Geometridae, *Comostola*, diagnosis, morphology, taxonomy, new record, China.

Una nueva especie del género *Comostola* Meyrick, 1888, procedente de Xizang, China (Lepidoptera: Geometridae)

Resumen

Comostola rectiuscula Wen, Pan & Han, sp. nov., descrita como una nueva especie de Xizang, China. Además, *C. caerulea* Warren, 1893, registrada como nueva para la fauna de China. Se proporcionan la descripción y el diagnóstico de ambas especies, así como ilustraciones de sus caracteres externos y genitalia.
Palabras clave: Lepidoptera, Geometridae, *Comostola*, diagnóstico, morfología, taxonomía, nuevo registro, China.

Introduction

The genus *Comostola* Meyrick, 1888, a member of the tribe Hemitheini within the subfamily Geometrinae, was established based on the type species *Eucrostis perlepidaria* Walker, 1866. In Parsons et al. (1999), 45 species were listed, and over the past two decades, five additional species have been described. As a result, total of 50 species are currently listed within the genus *Comostola* (Rajaei et al. 2022), which are primarily distributed across the Oriental and Australian regions. The main contributions to the taxonomy of this genus are as follows: Walker (1861, 1866) described seven species from south-east Asia and Australia; Warren (1893, 1896a, 1896b, 1899, 1903, 1906, 1909) and Prout (1912, 1913, 1917, 1920, 1925, 1926, 1928, 1934) described nine and eighteen species, respectively, from Indo-Australia region; Holloway (1977, 1979, 1997) added five species from New Caledonia, Borneo and Norfolk Island. More recently, Yazaki and Wang (2003) described a new species from Nanling, China; Smetacek (2004) established a new species from India; and Tautel (2015), as well as Tautel and Barrion-Dupo (2017) reported three species from Philippines. To date, 18 species of *Comostola* have been recorded in China (Han & Xue, 2011).

Through examination of newly collected specimens of *Comostola* and comparison with many other specimens from different sources, a new species and one new record species were discovered from Xizang, China. In this work, we describe the new species *Comostola rectiuscula* Wen, Pan & Han, sp. nov., and redescribe the new record species *Comostola caerulea* Warren, 1893. For all taxa, comparative figures and illustrations of external features and genitalia of males and females are presented.

Material and methods

All studied specimens, including the types of the new species, are deposited in the Institute of Zoology, Chinese Academy of Sciences, Beijing, China (IZCAS) and the Xizang Agricultural and Animal Husbandry University (XAAHU). Terminology for wing venation follows the Comstock-Needham System (Comstock,1918) as adopted for Geometridae by Scoble (1992) and Hausmann (2001); that for genitalia follows Pierce (1914, reprinted 1976), Klots (1970), and Nichols (1989). Photographs of moths were taken with a digital camera. Composite images were generated using Auto-Montage software version 5.03.0061 (Synoptics Ltd). The plates were compiled using Adobe Photoshop software 2020.

Taxonomy

Comostola Meyrick, 1888
Comostola Meyrick, 1888. *Proc. Linn. Soc. N.S. Wales,* (2)*2*, 836, 869. Type species: *Eucrostis perlepidaria* Walker, 1866
Pyrrhorachis Warren, 1896. *Novit. zool., 3*, 292. Type species: *Pyrrhorachis cornuta* Warren, 1896
Leucodesmia Warren, 1899. *Novit. zool., 6*, 25. Type species: *Comibaena dispansa* Walker, 1861
Chloeres Turner, 1910. *Proc. Linn. Soc. N.S. Wales, 35*, 561 (key), 570. Type species: *Chlorochroma citrolimbaria* Guenée, [1858] 1857

Han & Xue (2011) already provided a number of characters defining the genus *Comostola*. They are summarized here as follows:

Adults: Antenna of male bipectinate, pectination gradually shorter towards tip, filiform, ciliate or serrate in female. Frons not protruding. Labial palpus small and weak. Thorax and abdomen without dorsal crests. Hind tibia of male usually not dilated, few species dilated and with hair-pencil and short terminal process, with two pairs of spurs.

Wing pattern: Body small. Apex of fore- and hind wings rounded, or slightly protruding on hind wing. Forewing with costa straight or slightly protruding. Outer margin of forewing straight or shallowly curved, that of hind wing shallowly curved or slightly angled, without tail process. Wings bluish green or green. Antemedial and postmedial lines often composed of dots on veins (linear in *C. rectiuscula* sp. nov. and *C. christinaria* (Oberthür, 1916), pale yellow or reddish brown, usually with both colours simultaneously, dots of postmedial line usually absent above M_1; occasionally antemedial line present on hind wing; terminal line red alternated with black, with inner margin wavy, serrate or smooth, colourful terminal line absent in few species. Discal spot absent or present, usually with three layers, pale-centered, darker ring in the middle and pale ring outside. Underside: paler than upperside, usually without streaks. Some species usually bluish green or fresh green, only with red costa and outer margin, without other streaks.

Male genitalia: Uncus bifid posteriorly less than one third, mostly pointed, few blunt, quite few species not bifid. Socii tapered, of even width, or long narrow, slightly sclerotized basally and strongly sclerotized terminally, or membranous, some species with small to large, sclerotized tooth. Gnathos with median process long narrow, usually pointed. Valva broad or long narrow; costa usually expanded basally; harpe usually present, some species with valva asymmetry, fish bone-like, setae cluster, tooth-like, with several long setae terminally or not; area joined two sacculus pocket-like; sometimes with process or setae hair on ventral margin of valva. Saccus broad. Coremata present or absent. Cornutus one to three dense sclerotized spines on vesica, or absent.

Female genitalia: Lamella antevaginalis usually slightly sclerotized process; lamella postvaginalis slightly sclerotized, broad, tongue-like, sometimes concave. Ductus bursae short, weakly sclerotized. Corpus bursae round or long narrow, sometimes slightly sclerotized posteriorly; signum present or absent.

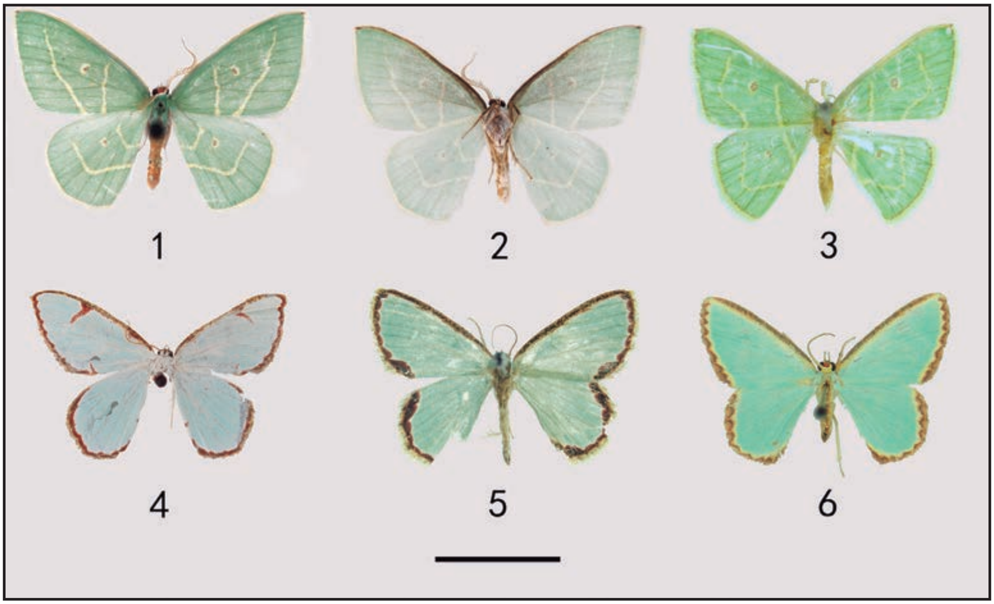
Diagnosis: *Comostola* can usually be recognized by a combination of the following characters (not necessarily all present in each species): antemedial and postmedial lines often composed of dots on veins; discal spot usually with three layers, pale-centered, darker ring in the middle and pale ring outside. In the male genitalia, most species of *Comostola* have bifid uncus. Another genus in the Hemitheini that also has bifid uncus is *Hemistola*. But these two genera are very different on the wing pattern, such as: if postmedial line is present in *Comostola*, then it is composed of spots on veins *C. christinaria* and *C. rectiuscula* sp. nov. and the colour of which is pale yellow alternated with white, while the postmedial line of *Hemistola* is dentate or linear.

Distribution: Oriental and Australasian regions.

Comostola rectiuscula **Wen, Pan & Han, sp. nov.** (Figures 1-2, 7-8, 13, 15-16**)**
https://zoobank.org/C05FA579-AB64-4B60-ABB4-15A9DE2E0CB2

Material examined: Holotype ♂, CHINA: Xizang (XAAHU): Sejila Mountains, 3780 m, 18-VII-2020, leg. Xian Chunlan. Paratypes: Xizang (XAAHU): 2 ♂, 2 ♀, Sejila Mountains, 3780 m, 18-VII-2020, leg. Xian Chunlan; 5 ♂, Xizang, Sejila Mountains, 3350 m, 22-VII-2020, leg. Xian Chunlan, Pan Zhaohui; Xizang (IZCAS): 1 ♂, 10 ♀, Xizang, Mêdog, Lage, 3213 m, 7-8-VIII-2006, leg. Lang Songyun; 1 ♀, Xizang, Bomi, Baibung, 3300-3450 m, 3-IX-1973, leg. Huang Fusheng; 2 ♂, 2 ♀, Sejila Mountains, 3780 m, 18-VII-2020, leg. Xian Chunlan.

Figures 1-6. Adults. **1-2.** *C. rectiuscula* sp. nov., holotype, upperside. **2.** ibidem, underside. **3.** *C. christinaria* Oberthür. **4.** *C. caerulea* Warren. **5.** *C. turgescens* Prout. 6. *C. pyrrhogona* Walker (Scale bar = 1 cm).



Description: Head (Figures 1-2). Antenna in male bipectinate for about basal two-thirds, filiform terminally; rami protruding from first 1/4 of each segment, and the longest rami about 4 times diameter of antennal shaft. Antenna filiform in female. Frons flat, upper half reddish brown, lower half gray. Labial palpus with tip projecting out of frons. Vertex white.

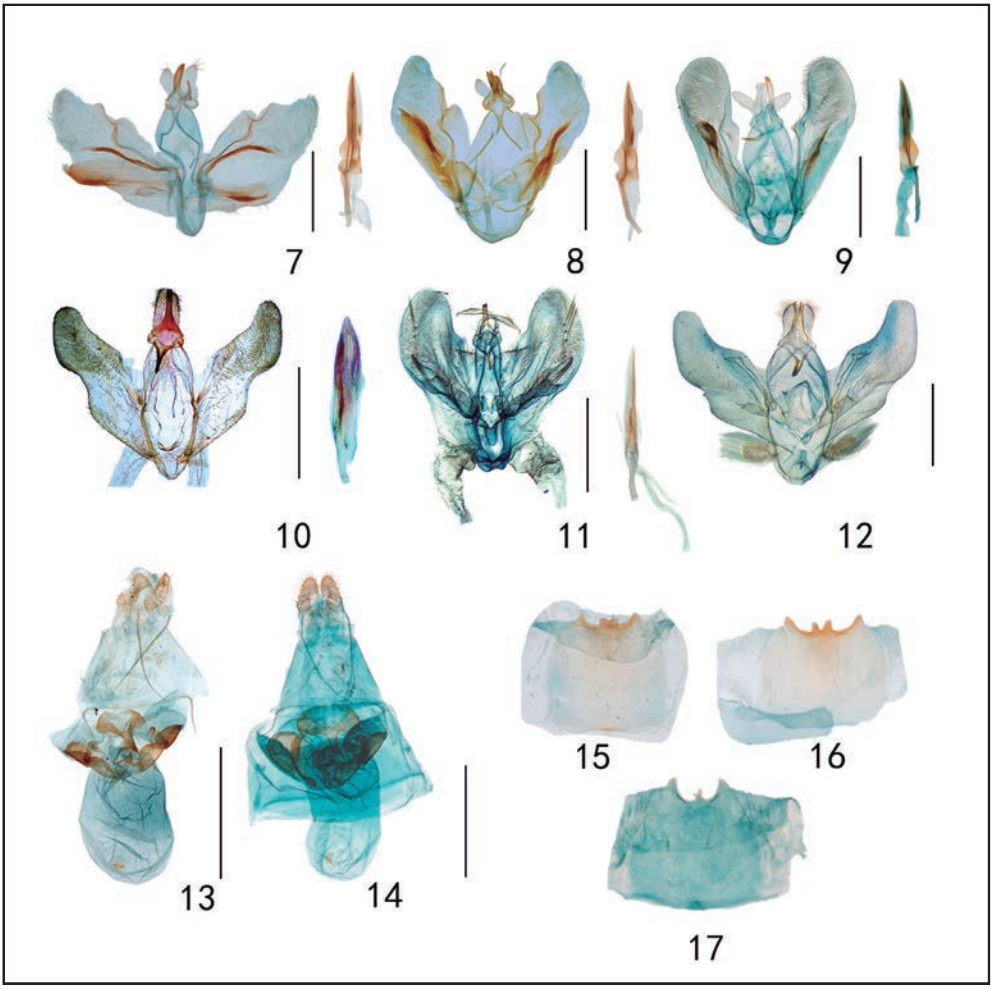
Thorax: Dorsal and ventral sides of thorax bluish green. Femora of legs covered with whitish hair-scales, remaining parts of legs yellow-white. Hind tibia in male not dilated, without hair-pencil, both sexes with two pairs of spurs. Forewing length. male 21~26 mm, female 20~25 mm. Wing bluish green. Apex pointed; termen almost straight, slightly bulging outward; tornus round. Forewing with costa fulvous; antemedial line white and straight, slightly convex outwards at middle, tapering from basal 1/3 of inner margin towards costa, terminated at upper edge of discal cell; postmedial line white and straight, not reaching costa, bended at vein M_3 and slant to middle of inner margin; submarginal line absent; terminal line not obvious, in some specimens terminal line appearing as sparse black scales; discal spot elliptical and brown, with a yellow-white ring around it. Fringes often white, sometimes pale yellow, as a small black dot at apex; fringes on inner margin green. Hind wing with rounded apex; outer margin bulged at vein M_3. Antemedial line white and shallow arced, sometimes curved in an elbow shape at the anal fold; postmedial line white, straight from Rs to $M_{3,}$ forming a blunt angle between M_3 and CuA_1, then straight to middle of anal margin; discal spot as on forewing, but rounder; fringes as on forewing.

Underside similar to upperside, markings on upperside faintly discernible; brown scales scattered at forewing base; costal base brown, gradually yellowish towards apex.

Abdomen (Figures 15-16): Dorsal side of abdomen blue-green and ventral sides gray. Third sternite of male without setal patch. Eighth sternite of male sclerotized, shallowly concaved, with lateral blunt process and a middle process with shallow or deep concavity at posterior margin.

Male genitalia (Figures 7-8): Uncus in even width, terminal 1/5 bifurcated. Socii broader and slightly longer than uncus. Gnathos with median process slender and pointed. Valva broad, apex narrow and blunt; costa with two blunt protuberances, between which costa deeply concave; harpe a ribbon-like bundle of bristles. Sacculus asymmetrical, left part with a long strongly sclerotized zone, decorated with long setae, right part with a short one and with setae. Juxta unmodified. Saccus round. Aedeagus with coecum slender, enlarged at middle, posterior part tapering; cornutus with two setal patches.

Figures 7-12. Male genitalia. 7-8. *C. rectiuscula* sp. nov. **7.** Holotype. **8.** Paratype. **9.** *C. christinaria* Oberthür. **10.** *C. caerulea* Warren. **11.** *C. pyrrhogona* Walker. **12.** *Hemistola euethes* Prout. **13-14.** Female genitalia.**13.** *C. rectiuscula* sp. nov., paratype. **14.** *C. christinaria* Oberthür. **15-17.** Eighth sternite. **15-16.** *C. rectiuscula* sp. nov. **15.** Holotype. **16.** Paratype. **17.** *C. christinaria* Oberthür (Scale bars = 1 mm).



Female genitalia (Figure 13): Apophyses posteriores about twice as long as the apophyses anteriores, tip elongated. Lamella postvaginalis sclerotized, nearly two-petaled sclerites, joined and spiky at middle. Lamella antevaginalis flap-shaped, extending posteriorly as a band; adjacent to lamella antevaginalis, another flap-shaped, fold, spinulose sclerite present. Corpus bursae elliptical. Signum round and located in lower left side of ventral surface, center with a sclerotized ridge. adjacent to the outer side.

Diagnosis: On the wing pattern, *C. rectiuscula* is similar to *Comostola christinaria* (Oberthür, 1916) (Figure 3), a species transferred from the genus *Hemistola* Warren (Han and Xue, 2009), for sharing distinct linear antemedial and postmedial lines on both fore- and hind wings. In *C. rectiuscula*, the antemedial and postmedial lines on both wings are less protruding, and both transverse lines are closer to each other on the forewing and separated on the hind wing. However, in *C. christinaria*, the transverse lines are more protruding, further from each other, and connected on the anal angle of the hind wing. The male genitalia are also different: the apex of the valva is more sharper and the edge of valva is more strongly curved than *C. christinaria* (Figure 9), distinctly, *C. rectiuscula* bears larger sacculus and *C. christinaria* possesses smaller one; costa has two protuberances in *C. rectiuscula*, but only one in *C. christinaria*. In addition, the male eight sternite of *C. rectiuscula* is more shallowly concaved than in *C. christinaria* (Figure 17). The female genitalia of the two species are very similar (Figure 14).

Distribution: China (Xizang).

Etymology: The specific name is based on the Latin word *rectiusculus*, referring to the straight postmedial line of the forewing.

Remarks. The middle process of the male eighth sternite is more or less variable in different specimens. For example, the process appears as one broad process with posterior margin very shallowly concave in the holotype (Figure 15), and almost two separate small middle processes (Figure 16) in one paratype.

Comostola caerulea Warren, 1893, **new record to China (**Figures 4, 10**)**
Comosota caerulea Warren, 1893, *Proc. Zool. Soc. Lond., 1893*(2), 354, pl. 31, Fig. 1 Syntype(s) ♂: INDIA, Sikkim. (BMNH)

Material examined: CHINA, Xizang (IZCAS), Mêdog, Zhamo, 2073 m, 1 ♂, 17-IX-2020, leg. Xian Chunlan; Xizang (XAAHU), Hanmi, 2123 m, 2 ♂, 17-IX-2021, leg. Pan Zhaohui; Xizang, Lalu, 3645 m, 1 ♂, 6-VIII-2021, leg. Pan Zhaohui; Xizang, Sejila Mountains, 3330 m, 1 ♂, 9-IX-2020, leg. Chen Enyong.

Description: Head (Figure 4). Antenna brownish in male, bipectinate for about basal two-thirds, rami protruding from first 1/4 of each segment, and the longest rami about 3 times diameter of antennal shaft; filiform terminally; antenna filiform in female. Frons reddish brown and flat. Labial palpus greyish-white and tip sticking out of the frons. Vertex white.

Thorax: Dorsal and ventral sides of thorax bluish-green. Hind tibia not dilated, without hair-pencil, both sexes with two pairs of spurs. Forewing length. Male 22 mm. Wing overall blue-green. Forewing with rounded apex. Costa yellowish-brown, mixed with black spots. Antemedial line reddish-brown, only retain a small protrusion, at most reaching 1/2 of the discal cell. Postmedial line reddish-brown, incomplete, only visible at 3/4 of costa, terminated around M_2 and tapering; at inner margin only appearing as a protrusion extending to above vein 2A. Terminal line reddish-brown, concaved on veins, extending to inner margin and very close to postmedial line protrusion. Hind wing with rounded apex and tornus. Postmedial line only retain as a little reddish-brown protrusion around vein 2A. Terminal line similar as on forewing, extending inwards along anal margin to its middle. Fringes tawny. Discal spot absent on both fore- and hind wings. Underside no maculation, only forewing base decorated with brownish scales.

Abdomen: With dorsal side reddish-brown, ventral sides gray.

Male genitalia (Figure 10): Uncus in even width, tip slightly bifurcated. Socii with equal length as uncus. Gnathos sclerotized, with median process thin and pointed. Valva with rounded apex; ventral margin deeply concave near middle; costa with triangular bulge at middle. Saccus round. Aedeagus stout, large middle part broad, apical part tapering and with large sclerotized process, coecum very short; cornutus present, tapering with blunt tip.

Female genitalia: Unknown.

Diagnosis: On the wing pattern, *Comostola caerulea* is similar to *Comostola turgescens* (Prout, 1917) (Figure 5) and *Comostola pyrrhogona* (Walker, 1866) (Figure 6) for sharing bluish wings, reddish brown costa and termen, and the absence of the discal spot. *C. caerulea* can be distinguished by the distinctive postmedial line one the forewing, which is only retained as long tapering stick on costa and a very short one on inner margin. The terminal line on *C. caerulea* is concave on the veins but concaved between veins in *C. turgescens* and *C. pyrrhogona*. In addition, the terminal line is normal in *C. caerulea* and *C. pyrrhogona*, but broadened on anal angle in *C. turgescens*. The male genitalia are very different, for example, *C. caerulea* lacks a harpe on the valva but *C. pyrrhogona* possesses a harpe (Figure 11). The male genitalia of *C. caerulea* are also close to some species of *Hemistola* for sharing similar uncus, socii, gnathos and the shape of the valva, for example *H. euethes* (Figure 12), however, a sclerite is present on the base of the valva in *H. euethes* but absent in *C. caerulea*.

Distribution: China (Xizang); India.

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Conflict of Interest

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

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A New Chance: Recovery of Nymphalidae diversity twelve years after mining in a peri-urban Andean Forest of Colombia (Lepidoptera: Papilionoidea)

Oscar Mahecha-J., Vanessa Díaz-S., Alexander García-García, Miguel Gonzalo Andrade-C. & Tomasz W. Pyrcz

Abstract

Various human activities, including mining, have significantly impacted ecosystems in Colombia, leading to a decline in biodiversity. These activities have led to changes in the distribution and diversity of different species, such as Lepidoptera. A study was conducted to analyze the changes in the diversity of Papilionoidea in a peri-urban forest located in Bogotá, twelve years after the cessation of mining activities in the area. Seven study stations were established, and standardized sampling techniques were employed to collect Papilionoidea. The results showed an increase in Nymphalidae diversity compared to studies conducted in the early years after the end of mining in the area. The most common Nymphalidae belonged to the Pronophilina subtribe. This research demonstrates the success of ecological restoration projects implemented in the area after the cessation of mining activities, which allowed for the recolonization of the region by various species, indicating the regeneration of the Andean Mountain Forest. Further studies focused on ecological restoration in the area are recommended, as positive effects on the assemblage of Andean Lepidoptera fauna have been observed.
Keywords: Lepidoptera, Papilionoidea, Nymphalidae, Pronophilina, ecological restoration, synanthropic species, habitat disturbance, Anthropocene, Colombia.

Una nueva oportunidad: Recuperación de la diversidad de Nymphalidae doce años después de la minería en un Bosque Andino periurbano en Colombia (Lepidoptera: Papilionoidea)

Resumen

Diversas actividades humanas, incluida la minería, han impactado significativamente los ecosistemas en Colombia, provocando una disminución de la biodiversidad. Estas actividades han generado cambios en la distribución y diversidad de diferentes especies, como los Lepidoptera. Se realizó un estudio para analizar los cambios en la diversidad de Papilionoidea en un bosque periurbano ubicado en Bogotá, doce años después de haber cesado las actividades mineras en la zona. Se establecieron siete estaciones de estudio, y se emplearon técnicas de muestreo estandarizadas para la recolección de Papilionoidea. Los resultados mostraron un aumento en la diversidad de Nymphalidae en comparación con los estudios realizados en los primeros años después del fin de la minería en la zona. Los Nymphalidae más comunes pertenecían a la subtribu Pronophilina. Esta investigación demuestra el éxito de los proyectos de restauración ecológica implementados en la zona tras el cese de las actividades mineras, que permitieron la recolonización de la región por diversas especies, indicando la regeneración del Bosque Andino de Montaña. Se recomienda realizar más estudios enfocados a la restauración ecológica en la zona, ya que se han observado efectos positivos en el ensamblaje de la fauna

de Lepidoptera andina.
Palabras clave: Lepidoptera, Papilionoidea, Nymphalidae, Pronophilina, restauración ecológica, especies sinantrópicas, perturbación del hábitat, Antropoceno, Colombia.

Introduction

Papilionoidea constitute one of the most diverse insect groups worldwide, with the highest species richness reported in the Neotropical realm, comprising approximately 7,700 species (Lamas, 2000; De-Silva, et al. 2015). Colombia is the second species-rich country after Peru, a total of 3,877 species is reported currently (Garwood et al. 2022). Lepidoptera play a specific and important role in ecosystems (e.g., as pollinators) and serve as valuable conservation bioindicators of habitat health. They frequently contribute to elaborate and carry out of conservation programs (Andrade, 1998). Besides, the Papilionoidea are considering as the umbrella species in biology conservation (New, 1997; Weibull et al. 2000; Díaz-Suárez et al. 2022).

In Colombia, as in other countries around the world, many anthropogenic practices have caused a sharp decline in the total area of ecosystems and many local extinction processes (Mahmoud & Gan, 2017; Murillo-P. et al. 2018; Ouyang et al. 2018; Le Roux et al. 2019; Fowler et al. 2021; Díaz-Suárez et al. 2022; Méndez-Zambrano & Fajardo-Medina, 2024), causing a negative impact on populations of plant and animal native species which may disappear from the face of the planet (Andrade, 1998; Van der Hammen & Andrade, 2003; Le Roux et al. 2019; Fowler et al. 2021). High Andean forests are among the ecosystems most heavily impacted by human population density, agriculture, livestock, and industrial activities that exploit natural resources (Méndez-Zambrano & Fajardo-Medina, 2024). This negative impact is notably reflected on the fauna-flora from the surrounding Andean forests of large cities, such as Bogotá in Colombia (Mahecha-Jiménez et al. 2011; Marín et al. 2014; Ouyang et al. 2018).

Additionally, the urbanization processes have generated the fragmentation of different forest communities, leading to the evolution of secondary forest patches, which in many cases, have lost connectivity between them, reducing the gene flow between populations. As a result, it may reduce the local genetic biodiversity (Van der Hammen & Andrade, 2003; Fahrig, 2003; Mckinney, 2008; While & Whitehead, 2013; Ouyang et al. 2018; Méndez-Zambrano & Fajardo-Medina, 2024). Further, urbanization has been linked to negative effects on biodiversity, which is often greatly reduced by intense urban development but can flourish in suburban and peri-urban areas (Aronson-Myla et al. 2017; Ouyang et al. 2018). The habitat in the peri-urban fragmentation areas allows highlighting many changes that occur between rural and urban ecosystems. It shows that different environmental factors proper to urban areas impact the surrounding ecosystems, by transforming their soil, surface, and groundwater resources (Fahrig, 2003; Mckinney, 2008). Therefore, these peri-urban areas show particularly high ecological fragility due to intensive activities that take place in their proximity and are often described as critical areas for biota (Capel, 1994; Marín et al. 2014).

The Serranía del Zuque is a peri-urban forest that constitutes a source of ecosystem and environmental services for the south-eastern part of Bogotá city. Currently, due to ongoing urban expansion, the natural habitats in this area are under severe anthropogenic pressure, leading to a gradual loss of native vegetation (Aguilar-Garavito, 2010, 2015) and, consequently, a decline in faunal diversity, including Papilionoidea (Mahecha-Jiménez, 2008; Mahecha-Jiménez et al. 2011). The introduction of non-native tree species, including *Acacia decurrens* Willd, *Acacia melanoxylon* Brown, and *Ulex europaeus* L., has disrupted the natural balance of plant and animal communities in the area (Solorza, 2012). This has altered the relationships between different species, changed the functioning of the ecosystem, and displaced native species (Mack et al. 2000; Fahrig, 2003; Mckinney, 2008; Solorza, 2012).

The factors mentioned above increase the likelihood of human-induced land-use disturbances, including erosion, landslides, alterations to hydrological cycles, and changes in the physical and chemical properties of the soil (Solorza, 2012). These disturbances could have impacted the ecological succession dynamics in the Serranía del Zuque (Mahecha-Jiménez et al. 2011; Aguilar-Garavito, 2015). Moreover, the Serranía del Zuque was subject to mining activities from 1960 to 1996, and asphalt production occurred between 1987 and 2006. During this period, frequent avalanches were reported due to the instability of the terrain. Following several slope stabilization efforts, the area was eventually abandoned. In 2009, approximately 35.6 hectares of the Serranía del Zuque were invaded by *U. europaeus* L. (Aguilar-Garavito, 2010, 2015). This invasion resulted in mixed thickets with native vegetation or dense monospecific thickets along the internal road, the network of roads, edges of ravines, in the old mining area, in forest plantations undergrowth, and within native successional bushes (Aguilar-Garavito, 2015).

The Serranía del Zuque is currently threatened by unregulated urban development, contributing to the progressive loss of native vegetation. Mining activities, wildfires, and water pollution caused by human land-use are contributing to high fragmentation in the peri-urban forest (Aguilar-Garavito, 2010, 2015; Mahecha-Jiménez et al. 2011). This promoted the invasion of *U. europaeus* L., causing a displacement of the native plant populations of the Andean forest and possible local extinctions (Aguilar-Garavito, 2010, 2015; Mahecha-Jiménez et al. 2011; Solorza, 2012). In addition, it has triggered forest fires during the dry season, particularly during El Niño events (Aguilar-Garavito, 2015).

However, the Serranía del Zuque was designated as part of the Forest Reserve East of Bogota in 2006. Subsequently, a management plan was established (CAR, 2006a). This resulted in restrictions on human land use (Aguilar-Garavito, 2010, 2015; Mahecha-Jiménez et al. 2011). In addition, the District Environmental Department from Bogotá initiated the ecological restoration of 10.4 hectares invaded by *Ulex europaeus* in the Serranía del Zuque in 2009-2010 (Aguilar-Garavito, 2010, 2015).

This study aimed to analyze the changes in Papilionoidea diversity at the Serranía del Zuque peri-urban Andean forest twelve years after mining operations ceased. We hypothesized that, after the completion of mining operations in the study area, there would be an increase in diversity due to the native vegetation recovery at the Serranía del Zuque, allowing the establishment of host plants for mountain Papilionoidea such as Poaceae and Melastomataceae (Devries, 1987; Pyrcz et al. 2009; Greeney et al. 2009; Montero & Ortiz, 2013; Mahecha et al. 2019). Our results indicate an increase in the diversity of Papilionoidea at the Serranía del Zuque, suggesting that the peri-urban forest is progressively regenerating after mining, contrasting with the findings of Mahecha-Jiménez (2008) and Mahecha-Jiménez et al. (2011).

Material and methods

Study location and sampling methods

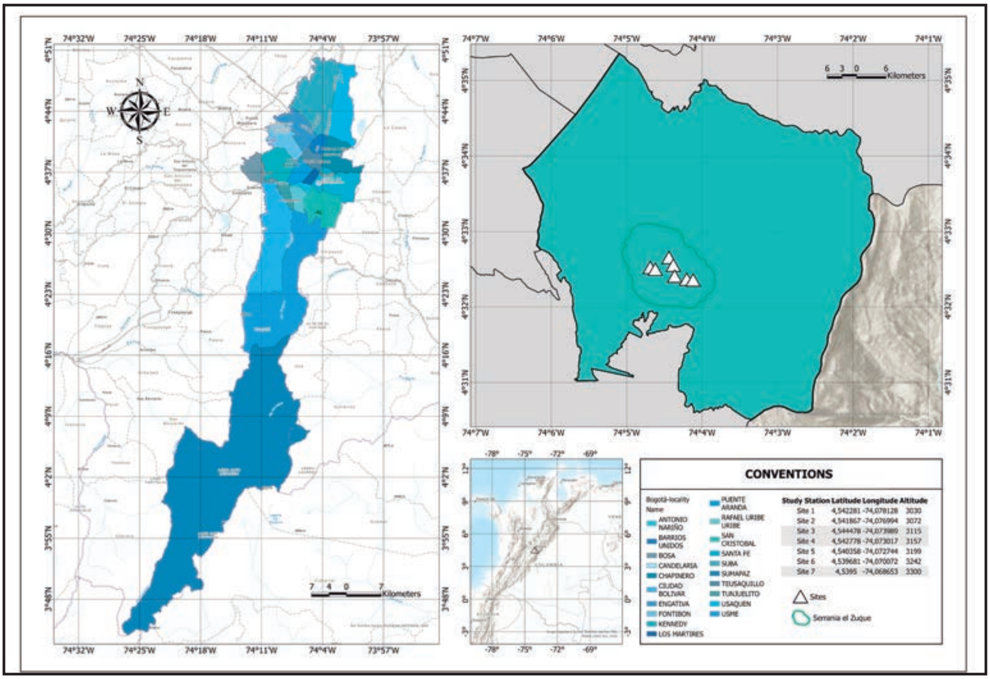
This study took place in the peri-urban Andean forest of Serranía del Zuque, situated in the southeastern part of the eastern hills of Bogotá, on the eastern slopes of the Cordillera Oriental of the Andes in Colombia (4º2’30.38”N and -74º 4’22.40”W; altitude: from 3000 to 3400 m) (Figure 1) (Aguilar-Garavito, 2015). The Serranía del Zuque is an ecotone between high Andean forest and sub-páramo (Mahecha-Jiménez, 2008; Aguilar-Garavito, 2015). The average annual rainfall is 1.500-3.000 mm/year, although this value can vary considerably depending on the ecosystem, with two wet seasons during the year, the first between April and May and the second from October to November (Camelo et al. 2009). The eastern hills have a varied topography in their entirety, where different soil types vary widely in the area since these soils were formed by the interaction between the geological formation, the vegetation cover and the influence of climate. Besides, due to the slow degradation of organic matter and the geological structure results in very acid soils and low fertility (Mahecha, 2000; CAR, 2006b). The climate of the study area is Tropical Mountain, humid with zenithal showers. Its geographical location and the presence of warm and cold currents influence the development of many microclimates. The Eastern Cordillera serves as a barrier against the winds coming from the Llanos and Magdalena Valley that can affect both the rainfall as well as the average temperature of the zones. Temperatures vary between 6 ºC and 13 ºC. (Mahecha, 2000).

The native vegetation from the Serranía del Zuque consists of cloud forests dominated by *Weinmannia tomentosa* L.F, *Bejaria* Mutis, *Clusia* sp., *Drymis granadensis* L.F, *Eugenia* spp., *Macleania rupestris* Kunth A.C. Smith., *Espeletia* sp., *Puya* sp., and *Calamagrostis effuse* Adans. Epiphytic shrubs and vines, such as *Tillandsia* spp., dominate in the sub-canopy, as well as lichens and mosses, and *Chusquea* spp. (Aguilar-Garavito, 2010, 2015). Additionally, the native vegetation has been recovering, the populations of *Chusquea* spp., *W. tomentosa, Espeletia* spp., *Sellaginella* spp., and *Puya* spp. have increased their coverage in comparison to previous years (Aguilar-Garavito, 2010, 2015).

Fieldwork

Fieldwork was performed every 15 days from June 2017 to June 2018 (29 field trips during all study), to cover both rainy and dry season (Freitas et al. 2021; Díaz-Suárez et al. 2022); each sampling consisted of five days of collection (145 days at the end of the fieldwork). Papilionoidea were sampled using 20 × 20 m (400 m²) collecting stations, systematically established at 42-meter intervals, yielding a total of seven stations, covering an altitude between 3000 and 3300 m (Figure 1). These stations were located in areas where Mahecha-Jiménez (2008) and Mahecha-Jiménez et al. (2011) identified significant human impact, including deforestation, the introduction of non-native plant species (e.g. *U. europaeus*), and illegal mining activities. The ecological impact of mining activities during 2006-2007 was reflected in a pronounced decrease in Papilionoidea species richness in the study area (Mahecha-Jiménez, 2008; Mahecha-Jiménez et al. 2011). Following this, Aguilar-Garavito (2010) initiated an ecological restoration project in the affected areas to recover ecological functionality.

Figure 1. Location map of the study stations in the Serrania del Zuque peri-urban Andean forest in Bogotá, Colombia. The white triangles indicate the study stations.



Two collect forms were used: passive and active collect. To passive collect, five Van Someren-Rydon traps baited with dog feces, and decaying fish were placed, as this kind of bait has proven to be very attractive for many groups of cloud forest Lepidoptera (Pyrcz & Wojtusiak, 2002; Pyrcz & Garlacz, 2012; Díaz-Suárez et al. 2022; Cerdeña et al. 2024). Each trap was spaced by 5 m from each other and were located between 1 and 3 m. from the ground surface and at least 100 m altitudinal distance from each other (Freitas et al. 2014; Clavijo-Giraldo et al. 2020). Traps were checked every three hours between 09:00 and 17:00. Active sampling was conducted manually using entomological nets from 08:30 to 17:00. At each study station, four longitudinal transects, spaced 5 meters apart, were established to cover the entire area. Each transect was walked for approximately 30 minutes (Andrade-C et al. 2013; Freitas et al. 2021).

Taxonomic Analysis

The biological material was determined and deposited in the Museum of Natural History at the Universidad Distrital Francisco José de Caldas, Bogotá, Colombia. Taxonomic determination was conducted using an analysis of morphological characters as alar pattern and, the structure of male genitalia. The latter was extracted following the standard procedure and macerated in a warm 10% KOH solution, and subsequently, they were preserved in glycerol vial. Taxonomic arrangement was based on the works of Adams (1985, 1986), Andrade & Amat (1996), Pyrcz (2004a, 2004b), and Pyrcz et al. (2009, 2010, 2013). Comparative material deposited in the Instituto de Ciencias Naturales (ICN) of the Universidad Nacional de Colombia, and the collection of the Nature Education Centre of the Jagiellonian University, Krakow, Poland, was examined. The nomenclature was checked against the checklists of Lamas et al. (2004), Pyrcz et al. (2010, 2013), and Warren et al. (2013). The collected material was covered under the ''Permiso Marco de Recolección de Especímenes de Especies Silvestres de la Diversidad Biológica con Fines de Investigación Científica No Comercial', granted to the Universidad Distrital Francisco José de Caldas through Resolution 0738 of July 8, 2014, issued by the Autoridad Nacional de Licencias Ambientales – ANLA.

Data analysis

Diversity estimates were calculated in terms of effective species or Hill numbers, which enables a better approach to species richness, incorporates the relative abundance of the same, allowing to give importance to the less abundant and rare species, or taking into account the dominance. That is to say, this method sets a greater emphasis on the most abundant species, thus handling the problem of "abundance", a subject frequently discussed in different studies on diversity when making comparisons between assemblages and communities (Hill, 1973; Jost, 2006; Moreno et al. 2011; Chao et al. 2014). Likewise, it has been shown that for a better analysis of diversity in an assemblage, the numbers of effective species are best compared with the estimates based on the theory of communication such as the index of Shannon entropy (Ellison, 2010; Moreno et al. 2011; Chao et al. 2014). Therefore, Hill numbers are parameterized by a diversity order q, which determines the measures' sensitivity to species relative abundances (Hsieh et al. 2016). Hill numbers include the three most widely used species diversity measures: species richness (q = 0), Shannon diversity (q = 1) and Simpson diversity (q = 2) (Moreno et al. 2011; Chao et al. 2014; Hsieh et al. 2016). In addition, a Bootstrap was calculated as estimated in the expected range for the order 0 (0D), the estimate of Chao & Shen (2003) for the expected diversity of order 1 (1D) and the expected diversity of order 2 (2D) the MVUE estimator (*Minimum variance unbiased estimator*) (Gotelli & Colwell, 2011; Moreno et al. 2011; Gotelli & Chao, 2013).

The Relative Abundance Distribution (RAD) was estimated to characterize the sampled community (Chao et al., 2015; Cusack et al., 2015). In this approach, the relative abundance of each species is plotted on the y-axis-often log10-transformed to account for several orders of magnitude-while species are ranked from the most to the least abundant along the x-axis (Chao et al. 2015). The Akaike's Information Criteria (AIC) was carried out to select the best RAD model for the study area (Cusack et al. 2015).

Coverage-based rarefaction/extrapolation (R/E) sampling curves were generated for each sampling station. The R/E method estimates species diversity (Hill numbers) for both rarefied and extrapolated samples, using sample completeness (measured as sample coverage) up to a coverage value equivalent to twice the reference sample size (Hsieh et al., 2016). However, Hill numbers of any order are influenced by sample size and inventory completeness. To address this, Chao et al. (2014) and Hsieh et al. (2016) proposed a unified framework for estimating species diversity through sample-size- and coverage-based R/E, allowing for statistically robust comparisons across communities. Likewise, a R/E curve can compare sites that have different sizes in their samples (Cleary & Genner, 2006; Gotelli & Colwell, 2011; Chao & Jost, 2012; Chao et al. 2014; Hsieh et al. 2016).

Therefore, when producing an R/E curve, it is possible to evaluate how representative the sampling was at each station, and in general, the whole study area, allowing us to reduce the effect of "sample size" in research (Chao et al. 2014). To determine the similarity between sampling stations according to the abundance and species composition, a cluster analysis was done, using the Bray-Curtis similarity index and as the cluster method the UPGMA (Unweighted Pair Group Method with Arithmetic Mean). Additionally, to support the results of the cluster analysis was conducted by a test ordination Non-Metric Multidimensional Scaling (NMDS) using the similarity Bray-Curtis index (Brehm et al. 2003b; Addo-Fordjour et al. 2015).

To assess significant differences in species abundance and composition between sampling stations, non-parametric statistical tests were used, as the data did not follow a normal distribution according to the Shapiro-Wilk test (p-value= 0.00002*,* p <0.05). Consequently, a Kruskal–Wallis test (Zar, 1974; Sá, 2007) and an ANOSIM test, based on the Bray–Curtis dissimilarity index with 999 permutations (Binz et al., 2014; Addo-Fordjour et al., 2015; Marín et al., 2015), were performed. Combined both methods (ANOSIM and NMDS) complement visualization of group differences along with significance test (Buttigieg & Ramette, 2014). All analyses were conducted at a 95% significance level. Statistical and diversity analyses were performed in R version 4.2.3 (R Development Core Team, 2023) by iNEXT package (Hsieh et al. 2016), and BiodiversityR (Kindt & Coe, 2005).

Results

A total of 685 individual Lepidoptera were reported, belonging to 4 families, 34 genera and 52 species. The majority (80% of the sample) belonged to the Nymphalidae family, followed by Lycaenidae and Pieridae. Papilionidae was represented by a single species, making it the family with the lowest species richness in the dataset. The most representative subfamilies were Satyrinae (29 species) and Theclinae (10 species). The three most diverse genera in the sample, *Pedaliodes* Butler, *Corades* Doubleday, and *Lymanopoda* Westwood, all belong to the subtribe Pronophilina (Satyrinae) (Table I).

Considering the abundance for each species, *Pedaliodes ochrotaenia* (C. Felder & R. Felder) and *Pedaliodes polla* Thieme had a higher abundance than other species registered in the zone and were the co-dominants species for each sampling station. However, species such as *Colias dimera* Doubleday, *Pedaliodes cocytia* (C. Felder & R. Felder), *Lymanopoda samius* Westwood, *Viloriodes manis* (C. Felder & R. Felder), and *Pedaliodes phoenissa* (Hewitson) presented a high abundance in the study area in comparison to other species as *Junea doraete* (Hewitson), *Cyanophrys agricolor* (Butler & H. Druce) and *Papilio polyxenes* Fabricius. Sequentially, three of the less abundant species correspond to Lycaenidae: *Salazaria sala* (Hewitson), *Marachina maraches* (H. Druce), and *Lamprospilus* sp. Geyer. Nevertheless, something to highlight in the results is that several species of Lycaenidae are reported, although they presented a low abundance.

Table II. RAD models with AIC values at the Serrania del Zuque peri-urban forest.

Model	Serrania del Zuque
Null	304.2
Preemption	233.9
Log-normal	**226.4**
Zipf	263.2
Zipf-Mandelbrot	**226.9**

Table III. The observed and estimated Hill numbers diversity values (effective species) obtained for each study station.

	Observed			Estimated		
Study Station	**0D**	**1D**	**2D**	**0D**	**1D**	**2D**
Station 1	33	30.45	28.09	35	32.23	29.86
Station 2	42	38.33	35.34	46	39.16	36.23
Station 3	40	36.25	33.15	42	38.02	34.12
Station 4	36	33.3	31.39	39	35.23	32.67
Station 5	32	29.74	27.92	35	31.12	29.3
Station 6	30	27.46	25.33	33	29.56	27.02
Station 7	27	23.8	21.18	30	25.34	23.36

* Kruskal-Wallis test: *p-value* = 0.169. There isn't significant difference between observed and estimated Hills numbers values.

Five models of RAD were tested (null, preemption, lognormal, Zipf and Zipf-Mandelbrot models) and according to the AIC criterion, the best adjustment for the Alto del Zuque turned out to be the lognormal and Zipf-Mandelbrot distribution models, as a kind mix model (Table II). This result provides evidence of a similar pattern in the abundance distribution between dominant and rare Papilionoidea species in the study area.

Figure 2. Sample Coverage curve based on R/E analysis.

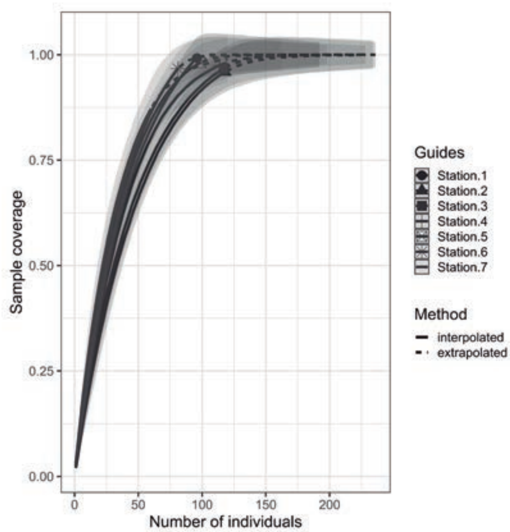
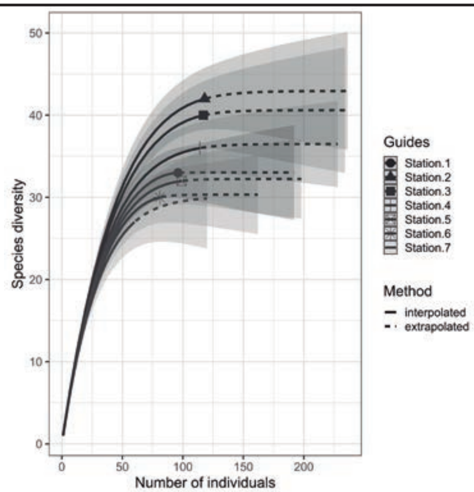


Figure 3. Species diversity curve according to R/E analysis.



The observed and estimated Hill numbers of diversity (0D, 1D, and 2D) were similar, showing no significant differences between them (Table III), so that we can infer to the community is homogeneous among all the stations in the study area. Moreover, the analysis of the sample Coverage-R/E curve (Figure 2) indicates that the sampling effort was appropriate for all the established stations, although it is noteworthy that no curve reached an asymptote, this suggests that a more extensive sampling could potentially increase the number of species in the study area. However, when comparing the 0D, 1D, and 2D diversity values (Table III) with the species diversity curve based on the R/E analysis (Figure 3), it can be inferred that the sampling effort was adequate. The number of species observed closely matched the number of species expected at each sampling station, supporting the validity of the R/E curve results.

Figure 4. Cluster analysis with the Bray- Curtis index and UPGMA.

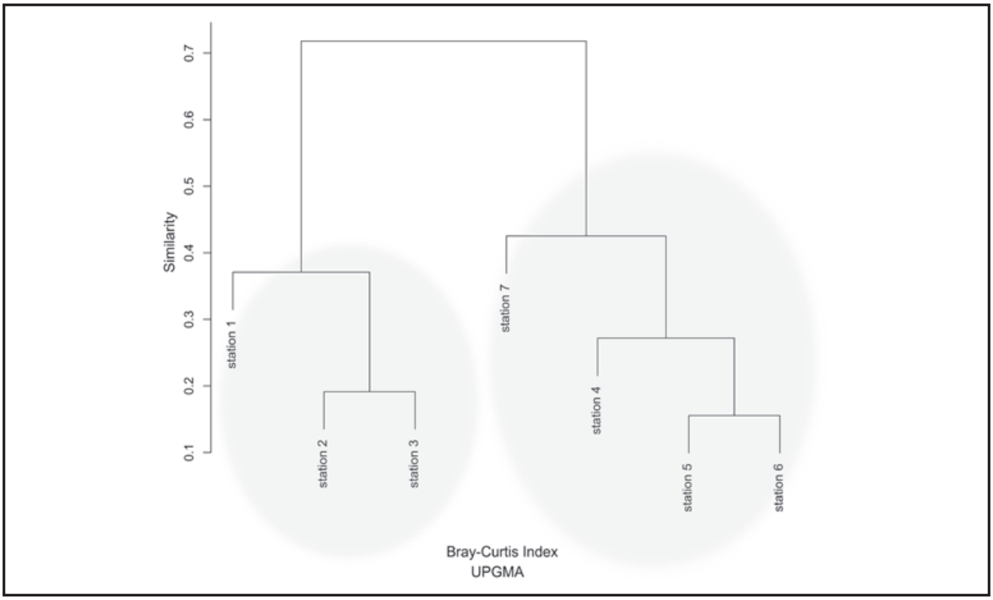
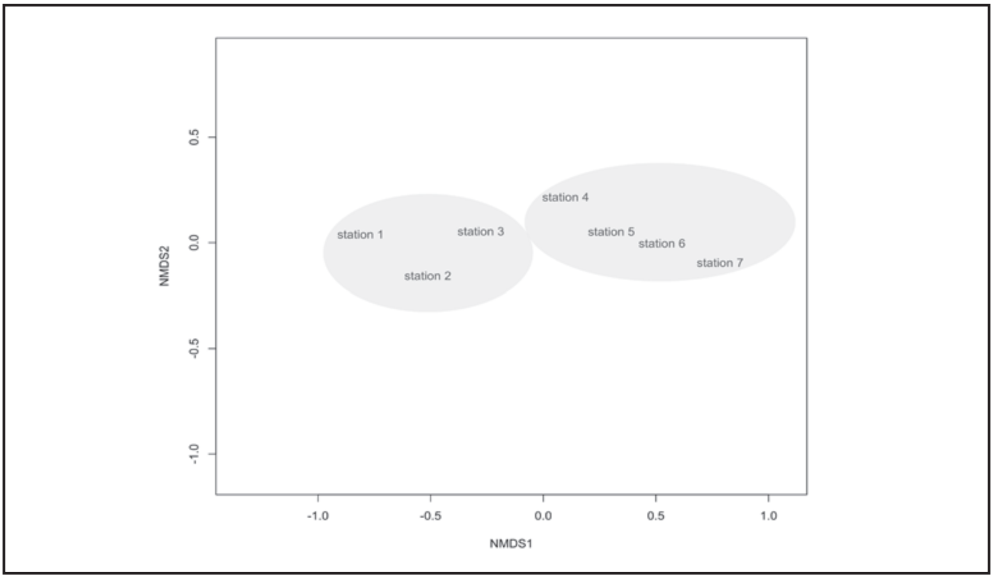


Figure 5. NMDS analysis using the similarity Bray-Curtis index.



On the other hand, based on the similarity analysis, a clear difference in species turnover is uncovered and grouping into two groups, the first group had stations 1, 2, and 3 (72.3% similarity), and the second group contained stations from 4 to 7 (68.8% similarity). Also, there is a high degree of similarity between station 2 and 3 (84.4% similarity), and between station 5 and 6 (85.8% similarity) (Figure 4). The NDMS ordination analysis results (*Kruskal stress = 0, R= 1*) corroborated these results (Figure 5). Therefore, there was a significant difference in the composition of species among sampling units (*ANOSIM test: R=0.346*, *p-value= 0.001*).

We compared the species diversity data (effective number of species) for Papilionoidea reported by Mahecha-Jiménez (2008) (Table IV) and for Pronophilina by Mahecha-Jiménez et al. (2011) (Table V) at the Serranía del Zuque. Our current observations revealed a significant increase in both abundance and species richness. The number of Papilionoidea species increased from 26 to 52, while Pronophilina species rose from 13 to 30, reflecting a substantial enrichment of the butterfly community in the study area. Finally, it is noteworthy that a newly identified species in the genus *Eretris* Thieme, 1905 has been reported. It will be described in an upcoming monograph (Pyrcz et al. in prep.) (see Table I).

Table IV. Comparison of Hill numbers values (numbers of effective species) observed in Mahecha-Jiménez (2008) and the results from the current study for Papilionoidea at the Serrania del Zuque.

	Hill Numbers values		
Study	**0D**	**1D**	**2D**
Mahecha-Jiménez (2008)	26	24.7	21.2
Mahecha-J. et al. current one	52	50.4	47.3

Table V. Comparison of Hill numbers values (numbers of effective species) observed in Mahecha-Jiménez et al. (2011) and the results from the current study for Pronophilina at the Serrania del Zuque.

	Hill Numbers values		
Study	**0D**	**1D**	**2D**
Mahecha-Jiménez et al. (2011)	13	10.07	9.40
Mahecha-J. et al. current one	30	27.46	25.33

Discussion

A total of 52 species of Papilionoidea were identified, representing a significant increase compared to the 26 species previously reported by Mahecha-Jiménez (2008). Likewise, 30 species of Pronophilina were recorded, exceeding the 13 species reported by Mahecha-Jiménez et al. (2011) for the Serranía del Zuque. An ecological restoration process was implemented in the study area between 2009 and 2010 to facilitate the regeneration of natural habitats (Aguilar-Garavito, 2010, 2015), this restoration process appears to have played a key role in enhancing Papilionoidea diversity in the area. Additionally, the area is undergoing ecological succession from a mix of pasture and forest to a closed forest (Aguilar-Garavito, 2015). This transition is leading to changes in the habitats and the composition of Lepidoptera communities in the area (Waltz & Wallace, 2004; De Souza et al. 2013), because we reported a high increase in the diversity values compared to previous diversity study data reported in the same zone by Mahecha-Jiménez (2008) and Mahecha-Jiménez et al. (2011). Some species related to cloud forests in good conditions previously not recorded in the Serranía del Zuque (Mahecha-Jiménez, 2008; Mahecha-Jiménez et al. 2011) have colonized the area, such as Pronophilina Satyrinae: *Daedalma dinias* Hewitson, 1858, *Manerebia levana* (Godman, 1905), *Lymanopoda lebbaea* C. Felder & R. Felder, [1867] and Lycaenidae: *Salazaria sala* (Hewitson, 1867).

There was an increase in Lycaenidae species in the study area, and we found abundant species in forest edge areas and clearings with varying levels of human disturbance such as *Rhamma comstocki* Johnson, 1992, *Hemiargus hanno bogotana* Draudt, 1921 and *Penaincisalia loxurina* (C. Felder & R. Felder, 1865) (Pulido & Parrales, 2011; Henao-P & Stiles, 2018; Henao-Bañol et al. 2018). However, we reported rare and endemic species of Papilionoidea at the Serranía del Zuque, for example, Nymphalidae: *Daedalma dinias* Hewitson, 1858, *Lymanopoda samius* Westwood, *Lymanopoda lebbaea* C. Felder & R. Felder, 1867, *Idioneurula erebioides* Felder, 1867, *Manerebia levana* (Godman, 1905), and *Manerebia apiculata* (C. Felder & R. Felder, 1867); Lycaenidae: *Salazaria sala* (Hewitson, 1867) and *R. comstocki* Johnson, 1992; Pieridae: *Catasticta semiramis* (Lucas, 1852) and *Catasticta chrysolopha* (Kollar, 1850); Papilionidae: *Papilio polyxenes* Fabricius, 1775 (Henao-Bañol et al. 2018b). Moreover, *Junea doraete* Hewitson, 1858, is considered a bioindicator of natural forests in a state of good conservation (Duran-Prieto & Molina-Fonseca, 2020).

On the other hand, species such as *Pedaliodes polla* Thieme, *Viloriodes manis* (C. Felder & R. Felder), *Pedaliodes ochrotaenia* (C. Felder & R. Felder), *Pedaliodes phoenissa* (Hewitson, 1862), *Corades chelonis* Hewitson, 1863, *Lasiophila circe* C. Felder & R. Felder, 1859, *Pedaliodes empusa* C. Felder & R. Felder, 1867, and *L. samius* Westwood are often associated with Andean secondary forests. These species may be considered potential generalists capable of colonizing early stages of ecological succession in montane habitats (Díaz-Suárez et al., 2022). Henao-Bañol et al. (2018) also found that several Pronophilina species are associated with forest edges and clearings with varying degrees of human disturbance, and tend to be more abundant in moderately disturbed areas.

Furthermore, the genus *Chusquea* serves primarily as a host plant for several Pronophilina species in the Neotropical region (Pyrcz, 2004a, 2004b; Pyrcz & Viloria, 2005; Greeney et al., 2009; Pyrcz et al., 2009; Montero & Ortiz, 2013; Mahecha et al., 2019; Díaz-Suárez et al., 2022). Most *Chusquea* species readily colonize disturbed sites (Judziewicz et al., 1999; Fisher et al., 2014), exerting long-term influence on the structure and diversity of dynamic plant communities and contributing to habitat resilience (Beckage et al., 2000; Holz & Veblen, 2006; Raffaele et al., 2007; Giordano et al., 2009; Muñoz & González, 2009; Muñoz et al., 2012). As pioneer species in forest succession, *Chusquea* plays an ecologically important role in facilitating tree cover regeneration (González et al., 2002; Pacheco, 2013). This ecological context may help explain the observed increase in Pronophilina species in the study area.

Three lines of evidence support the recovery of Papilionoidea diversity in the Serranía del Zuque: (1) an increase in the total number of species; (2) the recolonization by forest specialist species typically found in undisturbed habitats; and (3) a shift in the proportion of synanthropic species within the sample. For instance, species such as *Viloriodes manis* (C. Felder & R. Felder), *Pedaliodes polla* Thieme, *Panyapedaliodes drymaea* Forster, and *Colias dimera* Doubleday & Hewitson, 1847, exhibited lower abundances compared to previous studies.

The RAD analysis for the study area fits a log-normal and Zipf-Mandelbrot distribution model, which indicates that a natural community is extensive, varied and mature (Magurran, 1988), and complies with most of the ecological requirements of a community (May, 1975). It is important to highlight that this result reveals a similar pattern in the abundance distribution between dominant and rare Papilionoidea species in the study area. This pattern may suggest a community structure characterized by hierarchical niche subdivision, in which a small fraction of species exploits a large portion of the available resources. In turn, under as proposed by Hill & Hamer (1998) and Marín et al. (2014) communities that compose log-normal series of distribution models present some level of disturbance (Mouillot & Lepretre, 2000; Matthews & Whittaker, 2015; Nallis, 2021; Cerdeña et al. 2024). According to Wilson (1991), species presence is influenced by initial physical conditions and the presence of other species, which represent ecological 'costs.' In this framework, pioneer species require minimal preconditions and thus incur low costs, whereas late-successional species face higher costs –such as greater energy expenditure, longer establishment times, and dependence on ecosystem organization– before they can successfully colonize an area. These temporal and ecological differences among species can result in a Zipf-Mandelbrot distribution pattern. Whereas a log-normal model may result from many factors acting simultaneously, a Zipf-Mandelbrot model is indicative of many factors acting sequentially (Wilson, 1991; Marimon et al. 2015; Nallis, 2021; Cerdeña et al. 2024).

The RAD described by Mahecha-Jiménez (2008) in the same region followed a log-normal distribution, suggesting that the butterfly community at that time was subject to substantial environmental disturbance, causing a rise up in the heterogeneous environment that benefits several times the most dominant species, which causes an increase in the dominance of some species about others, observing a low diversity in the community (Matthews & Whittaker, 2015). We have to point out, however, that these models have been widely debated (Mouillot & Lepretre, 2000; Williamson & Gaston, 2005; Ferreira & Petrere, 2008; Matthews & Whittake, 2015; Nallis, 2021; Cerdeña et al. 2024).

As the study area undergoes ecological succession, the formation of diverse ecotones may facilitate increased species richness and expanded distribution patterns (Uehara-Prado et al. 2005; Weyland & Zaccagnini, 2008; Uehara-Prado & Freitas, 2009; Urbano et al. 2014). Similar diversity estimates across the stations in the Serranía del Zuque may, at least partially, be attributed to the Intermediate Disturbance Hypothesis, which posits that species richness is highest at intermediate levels of disturbance (Townsend et al. 1997; Kershaw & Mallik, 2013), or by the mass ratio hypothesis, which proposes that the biological traits of the dominant species are the critical drivers of ecosystem function and that these species increase in biomass rapidly after disturbance then stabilize. Consequently, species diversity first peaks then decline after a disturbance as a few species dominate the site. Both hypotheses provide a conceptual link among disturbance, species diversity, and productivity (Kershaw & Mallik, 2013). The highest level of species richness often occurs at moderate altitudes due to species turnover between lowland and highland areas. This intermediate zone tends to have greater diversity, a phenomenon known as the mid-domain effect. This may explain why stations 2 and 3 exhibited higher diversity values compared to the other stations and were more similar to each other (Colwell & Lees, 2000; Sanders, 2002; Colwell et al. 2004; Guerrero & Sarmiento, 2010; Giraldo-Cañas, 2021).

Some studies of Papilionoidea in other Colombian Andean forests have reported higher overall species richness, particularly within the subtribe Pronophilina, which was the most representative taxon in our sample. For example, Pyrcz & Wojtusiak (1999) reported 44 species for Pronophilina in the Tambito Reserve in the Western Cordillera of Colombia, whereas Prieto (2003) reported richness of 40 species in the nearby Cerro Munchique. Pyrcz & Rodríguez (2007) found 85 species in the Páramo de Tatamá, Farallones de Citará Cerro Frontino massifs in the Western Cordillera. Pyrcz & Viloria (2007) found 54 species of Pronophilina in the Serranía del Tamá, on the Colombian-Venezuelan border. Montero & Ortíz (2013) reported 60 species of Papilionoidea (Papilionoidea + Hesperioidea), including 32 species of Pronophilina, for El Tablazo Andean forest in the Subachoque-Cundinamarca in East Cordillera. Marín et al. (2014) found 75 species of Papilionoidea (Papilionoidea + Hesperioidea), including 38 species of Pronophilina, at the Romeral peri-urban forest of the Central Cordillera in Medellín, southwest of the Aburrá Valley. Olarte-Quiñonez et al. (2016) reported 69 Papilionoidea in the East Cordillera on the Norte de Santander and Santander border. Pyrcz et al. (2016) identified 48 species of Pronophilina on the Páramo de Belmira on the Central Cordillera. Clavijo-Giraldo et al. (2020) found 69 species of Papilionoidea (Papilionoidea + Hesperioidea) but they did not find any representative of Papilionidae. Clavijo-Giraldo et al. (2024) reported 108 Papilionoidea species in high-montane ecosystems of the Central Cordillera in Antioquia.

However, some studies have reported a lower richness compared to our research in other Colombian Andean forests, for example, Pérez et al. (2017) reported 31 Papilionoidea species (12 Pronophilina species) for Andean forest at the Santa Rosa de Viterbo in Boyacá-Colombia. Henao-B & Stilles (2018) reported 55 species of Papilionoidea (Papilionoidea + Hesperioidea) in Tabio in East Cordillera on Cundinamarca, where 13 species were Pronophilina. Murillo-P. et al. (2018) identified only eight species of Papilionoidea in Neuta, San Isidro, and Tierra Blanca wetlands in Soacha municipality in East Cordillera. Duran-Prieto & Molina-Fonseca (2020) reported 45 Papilionoidea species, including 18 Pronophilina species, in the Bogotá region of the East Cordillera in Cundinamarca. Olarte-Quiñonez et al. (2021) found 25 Pronophilina species in Cerro de Tierra Negra in the East Cordillera on the Norte de Santander and Santander border. Díaz-Suárez et al. (2022) reported 23 species of Pronophilina in the Frailejonal Andean forest in the East Cordillera in Cundinamarca. Nonetheless, the results obtained in these studies cannot be immediately compared due to different sampling methodologies applied, sampling time effort, and the area size.

The relatively low species diversity in the study area is likely a consequence of the long-term habitat degradation resulting from past mining operations (Aguilar-Garavito, 2010). This disturbance led to the formation of forest patches that hindered gene flow between subpopulations, resulting in a reduction in the diversity of various animal and plant taxa (Murillo-P. et al. 2018). Although nearly eight years have passed since the beginning of the ecological restoration process and twelve years since the cessation of mining activities (see Aguilar-Garavito, 2010; 2015), complete recovery of the habitat in the study area has not been observed. However, vegetal coverage has been gradually regenerating. For instance, the cover by the species of Poaceae and Melastomataceae has been increasing (Aguilar-Garavito, 2015). This has allowed for the growth of different plants that serve as hosts for many Papilionoidea species, leading to a gradual recovery of the diversity of Papilionoidea, particularly Pronophilina, in the Serranía del Zuque after the mining activity. Finally, these findings reinforce the need for ongoing ecological restoration initiatives aimed at preserving native montane ecosystems in peri-urban regions of Colombia.

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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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Table I. List of species of Papilionoidea butterflies found at the Serrania del Zuque with their respective abundances for each study station and the abundance total at the study area.

Family/ Subfamily	Species/Subspecies	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Abundance Total
Nymphalidae/ Satyrinae	*Corades chelonis* Hewitson, 1863*□	2	4	3	4	3	2	2	20
	Corades chirone Hewitson, 1863	0	0	0	2	2	3	1	8
	Corades cybele Butler, 1866	0	2	2	3	2	2	1	18
	Corades dymantis Thieme, 1907*□	4	3	3	2	2	1	0	15
	Corades medeba columbina Hewitson, 1850	1	2	2	3	2	1	1	12
	Daedalma dinias Hewitson, 1858	0	0	0	3	3	2	2	10
	Daedalma drusilla Hewitson, 1858	0	0	0	0	0	3	4	7
	Eretris apuleja bogotana E. Krüger, 1924*□	4	3	1	0	0	0	0	8
	Eretris n. sp.	0	0	3	4	3	2	2	14
	Forsterinaria difficilis (Forster, 1964)	2	3	2	3	1	0	0	11
	Idioneurula erebioides Felder, 1867*□	2	2	3	4	3	4	3	21
	Junea doraete (Hewitson 1858)	0	0	0	0	3	2	2	7
	Lasiophila circe C. Felder & R. Felder, 1859*□	0	3	3	4	3	2	1	16
	Lymanopoda ionius Westwood, 1851*□	0	3	3	2	3	2	2	15
	Lymanopoda lebbaea C. Felder & R. Felder, 1867	0	1	2	2	3	1	1	10
	Lymanopoda obsoleta Westwood, 1851	2	3	3	4	3	2	1	18
	Lymanopoda samius Westwood, 1851*□	4	3	4	5	4	3	2	25
	Manerebia apiculata (C. Felder & R. Felder, 1867)	0	2	3	2	3	2	1	13
	Manerebia levana (Godman, 1905)	0	0	0	2	3	3	4	12
	Panyapedaliodes drymaea Forster, 1964*□	0	3	4	4	4	3	2	20
	Pedaliodes polla Thieme, 1905* □	6	7	6	5	5	4	3	36
	Pedaliodes empusa C. Felder & R. Felder, 1867	2	3	5	4	2	2	0	18
	Pedaliodes cocytia (C. Felder & R. Felder, 1867) *□	0	1	2	4	6	6	6	25
	Pedaliodes ochrotaenia (C. Felder & R. Felder, 1867) *□	6	5	7	6	5	5	3	37
	Pedaliodes phoenissa (Hewitson, 1862)	3	5	5	4	4	3	2	26
	Pedaliodes polusca (Hewitson, 1862)	0	3	3	3	2	2	0	13

	Pronophila unifasciata bogotensis Lathy, 1906	2	3	0	0	0	0	0	5
	Steremnia pronophilia (C. Felder & R. Felder, 1867) *□	0	0	3	3	5	4	3	18
	Steroma bega andensis Westwood, [1851]	0	0	4	4	3	3	2	16
	Viloriodes manis (C. Felder & R. Felder, 1867) *□	0	4	5	4	5	4	3	25
Nymphalidae/ Nymphalinae	*Hypanartia kefersteini* (E. Doubleday, [1847])	2	3	2	2	1	0	0	10
	Vanessa virginiensis (Drury, 1773) *	2	4	2	3	2	2	2	17
Nymphalidae/ Heliconinae	*Altinote tinacria* (C. Felder & R. Felder, 1862 *	5	4	4	3	2	0	0	18
	Dione glycera (C. Felder & R. Felder, 1861) *	3	4	3	4	3	2	1	20
Pieridae/ Pierinae	*Catasticta chrysolopha* (Kollar, 1850) *	3	2	2	0	0	0	0	7
	Catasticta semiramis (Lucas, 1852) *	3	4	2	2	0	0	0	11
	Phulia xanthodice (Lucas, 1852) *	3	3	2	1	0	0	0	9
	Leodonta zenobia (C. Felder & R. Felder, 1865)	2	2	3	1	0	0	0	8
	Leptophobia eleone (E. Doubleday, 1847) *	4	2	2	2	0	0	0	10
Pieridae/ Coliadinae	*Colias dimera* Doubleday, 1847 *	5	4	4	5	4	4	3	29
Lycaenidae/ Theclinae	*Atlides havila* (Hewitson, 1865)	2	2	2	0	0	0	0	6
	Cyanophrys pseudolongula (Clench, 1944)	2	1	1	0	0	0	0	4
	Cyanophrys agricolor (Butler & H. Druce, 1872)	2	1	0	0	0	0	0	3
	Lamprospilus sp. Geyer, 1832	2	0	0	0	0	0	0	2
	Micandra aegides (C. Felder & R. Felder, 1865)	3	2	1	0	0	0	0	6
	Marachina maraches (H. Druce, 1912)	3	1	0	0	0	0	0	4
	Penaincisalia loxurina (C. Felder & R. Felder, 1865) *	4	3	3	0	0	0	0	10
	Rhamma commodus (C. Felder & R. Felder, 1865)	3	2	1	1	0	0	0	7
	Rhamma comstocki Johnson, 1992 *	2	3	1	0	0	0	0	6
	Salazaria sala (Hewitson, 1867)	2	2	0	0	0	0	0	4
Lycaenidae/ Polyommatinae	*Hemiargus hanno bogotana* Draudt, 1921*	3	2	0	0	0	0	0	5
Papilionidae/ Papilioninae	*Papilio polyxenes* Fabricius, 1775 *	0	2	2	0	0	0	0	4

* Mahecha-Jiménez (2008) also reported these species of Papilionoidea butterflies.

□ Mahecha-Jiménez et al. (2011) also documented these species of Pronophilina butterflies.

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Aegocera rectilinea Boisduval, 1836 a new Noctuidae species from Algeria (Lepidoptera: Noctuidae, Agaristinae)

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Abstract

Aegocera rectilinea Boisduval, 1836 is reported for the first time from Algeria. Notes on the distribution and habitat of the adult are included. This observation would indicate that the species' range has expanded in North Africa. Some notes on the distribution, food plants and habitats of this species are also given. Illustrations of the adults are included.
Keywords: Lepidoptera, Noctuidae, Agaristinae, *Aegocera rectilinea*, first record, Algeria.

Aegocera rectilinea **Boisduval, 1836 una nueva especie de Noctuidae para Argelia (Lepidoptera: Noctuidae, Agaristinae)**

Resumen

Aegocera rectilinea Boisduval, 1836 se cita por primera vez en Argelia. Se incluyen notas sobre la distribución y el hábitat del adulto. Esta observación indicaría que el área de distribución de la especie se ha ampliado en el norte de África. También se presentan algunas notas sobre la distribución, plantas nutricias y los hábitats de esta especie. Se incluyen ilustraciones de los adultos.
Palabras clave: Lepidoptera, Noctuidae, Agaristinae, *Aegocera rectilinea*, primeros registros, Argelia.

Aegocera rectilinea **Boisduval, 1836 une nouvelle espèce de Noctuidae en Algérie (Lepidoptera: Noctuidae, Agaristinae)**

Résumé

Aegocera rectilinea Boisduval, 1836 est signalé pour la première fois en Algérie. Des notes sur la distribution et l'habitat de l'adulte sont incluses. Cette observation indiquerait que l'aire de répartition de l'espèce s'est étendue en Afrique du Nord. Quelques notes sur la distribution, les plantes alimentaires et les habitats de cette espèce sont également données. Des illustrations de l'adulte sont incluses.
Mots-clés: Lepidoptera, Noctuidae, Agaristinae, *Aegocera rectilinea*, première observation, Algérie.

Introduction

The Sahara Desert, the largest hot desert on Earth, extends across Northern Africa, stretching from the Atlantic Ocean in the west to the Red Sea in the east. Encompassing more than 10 million square kilometres, it covers a range of countries, such as Morocco, Algeria, Tunisia, Libya, Egypt, Mauritania, Mali, Niger, Chad, and Sudan (Hereher, 2011). In Algeria, the Saharan regions cover about 80% of the country's total land area, exceeding 2 million square kilometres. This vast territory is predominantly characterized by gravel-covered plains (Regs), expansive sand dune fields (Ergs), and saline lakes. The region experiences drought and irregular rainfall, ranging from 12 to 200 mm from south to north. High temperatures, surpassing 45 ºC, are common, with substantial fluctuations between day and night. Additionally, the air's relative humidity is consistently low (Djellouli-Tabet, 2010).

The southern Algerian Sahara belongs to the Afrotropical region, whereas the northern part belongs to the Palearctic region. The biodiversity of North Africa, notably within the Sahara Desert, constitutes a clear example of a region that has been underexplored and largely ignored (Durant et al. 2014).

Knowledge about Lepidoptera species of the Algerian Sahara remains insufficient and fragmented. Studies, such as those by Rothschild (1915, 1916), Riley (1934), Speidel & Hassler (1989), and Yakovlev et al. (2023a, 2023b), provided initial data on the lepidopteran fauna. However, due to the vastness of the area, these studies are to be expanded and deepened.

Globally, the Noctuidae family is the third largest group among Lepidoptera, with more than 12,000 species described, and thousands more awaiting identification (van Nieukerken et al. 2011).

This note provides the first record of *Aegocera rectilinea* Boisduval, 1836 (Noctuidae, Agaristinae) for Algeria and the Maghreb area.

Materials and methods

From October 11 to 16, 2022, an entomological survey was conducted in the extreme southwest of the Algerian Sahara. The adults were collected by attraction to light with a Led lamp on a white sheet. Most of the insects approaching the sheet were collected and photographed using a Nikon 7200 D camera with macro lens.

Study area

The surveyed location, Tawendert (20º23'16" N, 2º27'28" E) is situated in the Tinzaouatine region, bordering Mali. The climate in this area is classified as a "hot desert type" (Köppen-Geiger climate classification, zone BWh) (Peel et al. 2007). Summers are characterized by extreme heat, while winters tend to be more moderate. The region encounters very little summer precipitation, and a total average rainfall of 47.7 mm per year. Most of the rainfall occurs during July and August, with minimal or no rainfall for the rest of the year. The annual average temperature is 27.7 ºC. The light trap method using a lamp on a white sheet was used to attract insects and moths in a natural ecosystem primarily represented by the desert date palm, *Phoenix dactylifera* L. (Arecaceae), *Balanites aegyptiaca* (L.) Delile (Zygophyllaceae), *Acacia* spp. (Fabaceae), and the mustard tree, *Salvadora persica* L. (Salvadoraceae) shrub.

Results and discussion

During a field survey on the night of 15-X-2022, 2 individuals of *Aegocera rectilinea* were observed and photographed in the Tawandert Valley, in the far south-west of the Algerian Sahara.

Aegocera rectilinea Boisduval, 1836 (Figure 1)
Aegocera rectilinea Boisduval, 1836. *Hist. nat. Ins., Spec. gén. Lépid., 1*, pl. 14, f. 5
TL: SENEGAL

Note on identification: Head white; antennae and sides of the second and extremity of the third pal joint black; collar striped with rufous and black; tegulae edged with blue-black and orange; thorax white with sublateral blue-black and orange stripes; tibiae and tarsi orange, with black-white bands; abdomen orange with dorsal black spots, underside whitish. Forewing dark brown, thickly sprinkled with ochreous; a metallic blue spot below base of costa; a creamy white fascia edged with rusty-red from base along the media and below vein 6, ending in a point just before termen, its upper edge indented by silvery-blue cell and disco-cellular spots, and its lower edge by a spot before the triangular expansion at the cell-extremity; terminal orange-red; cilia blackish tipped with whitish. Hindwings orange; discocellular spot and terminal band rusty-red in 8, black in 9; terminal line orange; cilia dark brown, tipped with whitish. Length of forewing 14-19 mm (adopted from Kiriakoff, 1977).

Figure 1. *Aegocera rectilinea* Boisduval, 1836. Algeria, Tinzaouatine region, 15-X-2022.

Note on distribution: *Aegocera rectilinea* has a widespread distribution in Africa, encompassing a vast area from tropical regions to countries such as the Angola, Benin, Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of the Congo, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Ivory Coast, Kenya, Mali, Mauritania, Mozambique, Niger, Nigeria, Rwanda, Saudi Arabia, Senegal, Somalia, Sudan, Tanzania, Uganda, Western Sahara, and Yemen (African Moths, 2024; De Prins et al. 2011-2024). In the northernmost part of the continent, it is reported only in Egypt (Kiriakoff, 1977).

Photos relating to the presence of *Aegocera rectilinea* in Algeria were recently posted on the online GBIF platform, with the following data: Adrar province, Bordj Badji Mokhtar, 10-X-2022, photos by Missoum M. (GBIF.org. 2024). Furthermore, the presence of *A. rectilinea* is also reported for Guinea-Bissau, 17-VII-2022, photos by R. Lima (INATURALIST.org. 2024).

The present work confirms the presence of *A. rectilinea* in North Africa, and this finding also significantly expands the known range to the north of the continent (Maghreb area).

Note on biology: According to Abdelfattah (2020), Boireau (2021) and African Moths (2024), caterpillars of *A. rectilinea* have been observed on the following host plants: *Arachis hypogaea* L., *Phaseolus vulgaris* L., *Vigna unguiculata* (L.) Walp. (Fabaceae), *Boerhavia diffusa* L., *B. erecta* L. (Nyctaginaceae), *Brassica oleracea* L. (Brassicaceae), *Lagenaria sicerana* (Molina) Standl. (Cucurbitaceae), *Lycopersicon* sp. (Solanaceae), *Manihot esculenta* Crantz (Euphorbiaceae), and *Zea mays* L. (Poaceae). The species flies in all months of the year.

Conclusion

Although it is considered a pest of cultivated plants in the Democratic Republic of Congo, the *Aegocera rectilinea* larvae are recognized as a viable food source for human consumption. Raising this insect in a controlled environment, along with the advantages of its short development cycle and the wide choice of its host plants, not only guarantees successful breeding but also presents a promising pathway for sustainable animal protein production. In fact, this method has the capacity to satisfy the dietary requirements of the local population in the western part of the country, as indicated by Numbi Muya et al. (2022).

In Algeria, the Sahara Desert covers more than 4/5 of the total land area, with its southernmost region remaining largely unexplored and subject to limited scientific studies in recent years. In this vast and challenging terrain, encompassing a significant portion of the country, there are high possibilities of discovering further new species records for Algeria, or even entirely new taxa. The difficult pedoclimatic conditions and the vastness of this region have so far limited significant research efforts. Over the past two decades, this underexplored area has revealed potential for significant findings within the fauna of the Sahel like the new species of Lepidoptera found by Yakovlev et al. (2023 a, b) and the new species of scorpion by Ythier et al. (2021), or the study of Eitschberger et al. (2014) on the Sphingidae with several new species records. In addition, several first-time observations of various vertebrate animal species, including birds and reptiles (Boulaouad et al. 2021, 2022, 2023; Soukkou et al. 2023) underlines the need of further and more systematic surveys.

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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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The globally rare *Argyresthia impura* (Staudinger, 1879) adventive in the Netherlands and Belgium, with notes on synonymy, biology, and distribution (Lepidoptera: Argyresthiidae)

Erik J. van Nieukerken & Dick Groenendijk

Abstract

The rare Western European *Argyresthia buvati* (Gibeaux, 1993) is synonymised with *A. impura* (Staudinger, 1879) from Turkey. Single stray records of the species in the Netherlands and Belgium prompted this study. We describe and illustrate the genitalia and provide information on distribution and biology. The species is believed to feed on *Juniperus* species.
Keywords: Lepidoptera, Argyresthiidae, *Argyresthia impura*, *Argyresthia buvati*, new synonymy, distribution, The Netherlands, Belgium.

La mundialmente rara *Argyresthia impura* (Staudinger, 1879) adventicia en los Países Bajos y Bélgica, con notas sobre sinonimia, biología y distribución (Lepidoptera: Argyresthiidae)

Resumen

La rara *Argyresthia buvati* (Gibeaux, 1993) de Europa occidental se sinonimiza con *A. impura* (Staudinger, 1879) de Turquía. Los registros aislados de la especie en los Países Bajos y Bélgica motivaron este estudio. Describimos e ilustramos la genitalia y proporcionamos información sobre su distribución y biología. Se cree que la especie se alimenta de especies de *Juniperus*.
Palabras clave: Lepidoptera, Argyresthiidae, *Argyresthia impura*, *Argyresthia buvati*, nueva sinonimia, distribución, Países Bajos, Bélgica.

Introduction

The last decades exotic conifers have become popular plants in gardens and for hedges, leading to an influx of associated herbivore insect species in cities, far away from their native habitat. The micro moth genus *Argyresthia* has many species feeding on conifers, during the last decades several of these have started using planted conifers in Europe, especially Cupressaceae. The American species *Argyresthia thuiella* (Packard, 1871) was recorded for the first time in the Netherlands in 1972 and has spread since over much of Europe (van Frankenhuyzen, 1974; Konečná & Šefrová, 2014), feeding on various species of *Thuja* and *Chamaecyparis*. The European *A. trifasciata* Staudinger, 1871, feeding mostly on *Juniperus*, spread from its native area in the Alps, and reached the Netherlands and the British Isles in the early 1980's (Konečná & Šefrová, 2014; Stigter & van Frankenhuyzen, 1992), and is now distributed and common over much of Europe. Another North American species entered the British Isles in or before the 1990's: *A. cupresella* Walsingham, 1890 (Agassiz & Tuck, 1999). Identification of such newcomers is not always easy, and misidentifications occur. We report here another unexpected newcomer in the Netherlands and Belgium.

In the evening of 11 January 2018, a small unknown micro-moth was found indoors in the home of the second author in IJmuiden, Noord-Holland, the Netherlands (Figure 3). The identification was troublesome, and sending photographs to different Dutch lepidopterologists, did not give any clues either. The moth was collected and dissected by Koen van Dijken, which showed that it was a male of an *Argyresthia* species. However, identifying the specimen to species level still remained a puzzle. Clearly, the species was not one of the known North-Western European species (Agassiz 1996; Bengtsson & Johansson 2011; Gibeaux 1983; Sterling & Parsons 2012), as it showed unknown external characters. Some photographs of the genitalia (Figure 7) were sent to European experts. Rachel Terry finally identified the specimen as *Argyresthia buvati* (Gibeaux, 1993), which was confirmed by David Agassiz of the Natural History Museum in Londen.

While studying the literature on this species, we learned that according to Laštůvka & Laštůvka (2019), *A. impura* (Staudinger, 1879) is closely related to *A. buvati*, or maybe even conspecific. Study of the Lectotype of *A. impura* confirmed this, and we therefore synonymise *A. buvati* here with *A. impura*. Meanwhile, a second specimen of this species had been observed in Belgium, Oost-Vlaanderen, Ruien-Dorp on 13 March 2023, also indoors. We summarise the scarce knowledge of this species and discuss how it could reach the homes in the Netherlands and Belgium.

Material and methods

The material we studied ourselves are the Dutch specimen and three genitalia slides from Lecto- and Paralectotype (Table 1). Other specimens were studied from photographs and literature data. The wingspan data are obtained from the type series of *A. impura* (6 specimens, courtesy Théo Léger, Berlin) plus literature data (Gibeaux, 1993; Lepiforum E.V., 2025).

Geographical coordinates for localities were obtained (estimated) from Google Earth, as accurate as possible. For recent localities GPS data were available.

For the morphological terminology we follow Liu et al. (2017). Photographs of genitalia were prepared with a manually operated Zeiss Axioskop H and a MRc5 camera, using Zeiss AxioVision software version 4.8. Photographs were edited with Adobe Photoshop, avoiding changes to the real object. Measurements of genitalia were taken on micrographs with AxioVision measurement tools.

The DNA barcode of the Dutch specimen was obtained from a leg of the specimen, following the procedures as described by Doorenweerd et al. (2015). The DNA barcodes of the specimens from Munich were generated in the framework of the EU-HORIZON project Biodiversity Genomics Europe (BGE). All DNA barcodes are in BOLD Dataset DS-ARGIMP (https://dx.doi.org/10.5883/DS-ARGIMP). Genbank accession numbers are given in Table 1 and in Dataset DS-ARGIMP.

Taxonomy

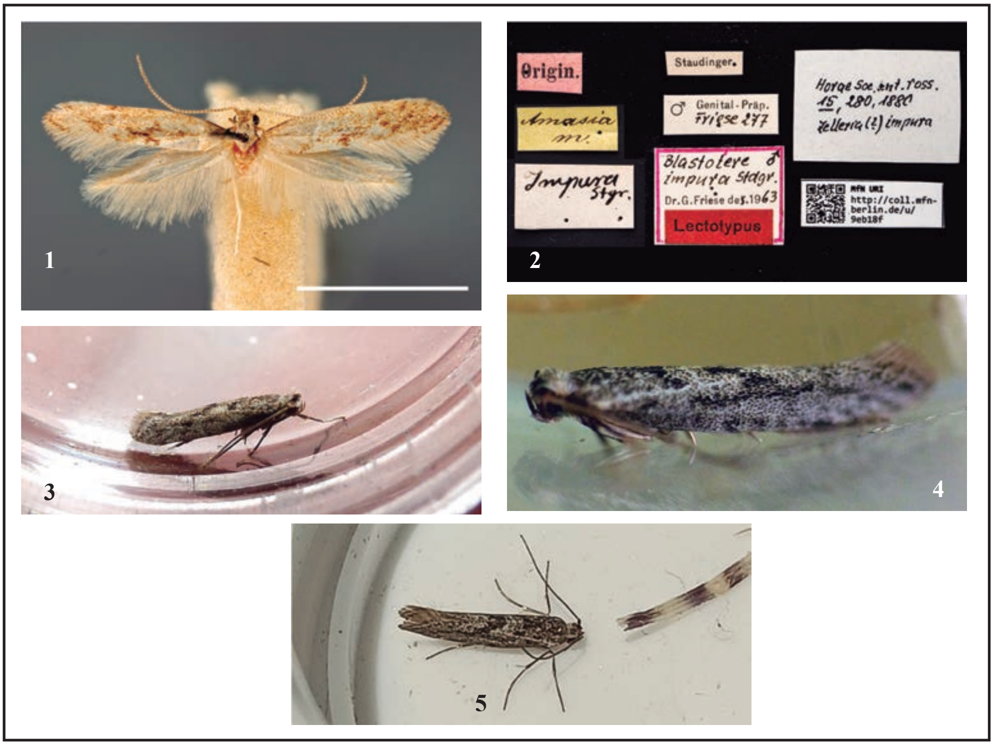
Argyresthia (Blastotere) impura (Staudinger, 1879)
Zelleria impura Staudinger, 1879, 280
Lectotype (designated by Friese, 1963, p. 407), Türkiye, Amasia [Jenikeui-Hochebene bei Amasia, 7-VI-1875, Staudinger, Genitalpräparat Friese Nr. 277 (Museum für Naturkunde Berlin)
Hofmannia impura (Staudinger, 1879). Rebel, 1901, 34. Recombination.
Argyresthia impura (Staudinger, 1879). Friese, 1963, 407. Recombination, record North Macedonia.
Blastotere buvati Gibeaux, 1993, 189. Holotype. 1 ♂, France, Hautes-Alpes, Saint-Crépin, junipéraie, 7-V-1959 (R. Buvat). (Coll. Gibeaux) **syn. nov.**
Argyresthia (Blastotere) impura; Agassiz & Friese 1996, 57
Argyresthia (Blastotere) buvati; Agassiz & Friese, 1996, 57
Argyresthia buvati; Laštůvka & Laštůvka, 2019, 239. New record Spain, suggested possible synonymy with *impura*.

Recognition

Externally *A. impura*, with its grey flecked appearance (Figures 1-5, see also water colour by Laštůvka & Laštůvka (2019) and photos on BOLD) does not resemble other European *Argyresthia* species. The whole moth is grey, with indistinct black spots, usually two on dorsum. Head with black tuft, ringed antennae. The lectotype is faded and now looks more ochreous. Wingspan 12-14.5 mm.

Male genitalia (n=3) (Figures 6-9). Tuba analis about as long as width of valva, tapering. Socius covered with ca 24 scale-like setae, with a 1-3 setae posteriorly. Valva broadly rounded, with almost parallel margins, length 570-580 µm. Vinculum (saccus) broad, truncate anteriorly. Phallus slightly curved, 965-1055 µm long; cornutus with probably four strong denticles (difficult to see, Figure 9). Eighth sternite Y-shaped (Figure 8).

Figures 1-5. *Argyresthia impura*, adults. **1**. Lectotype male, photo Eran Wolff. **2**. Labels of lectotype. **3.** Live specimen, the Netherlands, photo Dick Groenendijk. **4-5**. Live specimen Belgium, photos Cedric de Noyette. Scale bar 5 mm.



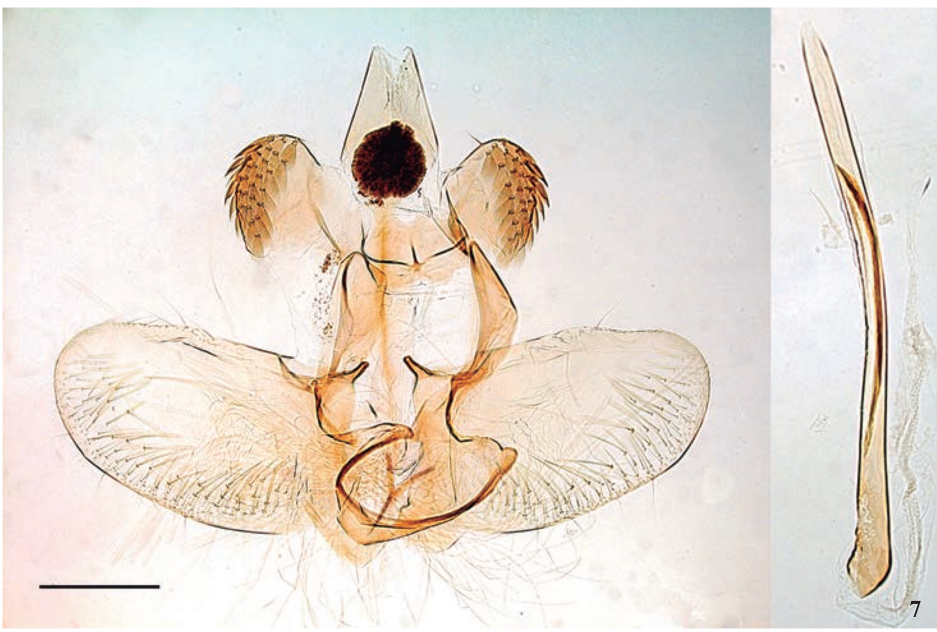
Female genitalia (n=1) (Figures 10-12). Posterior apophyses ca 1125 µm long, anterior apophyses 775 µm long, bifurcate at distal 43%; ventral branches joined and forming ventral margin of ostium bursae. Lamella postvaginalis ca. triangular. Antrum not well visible in slide. Signum (Figure 12) with straight horns, 230 µm.

Comments

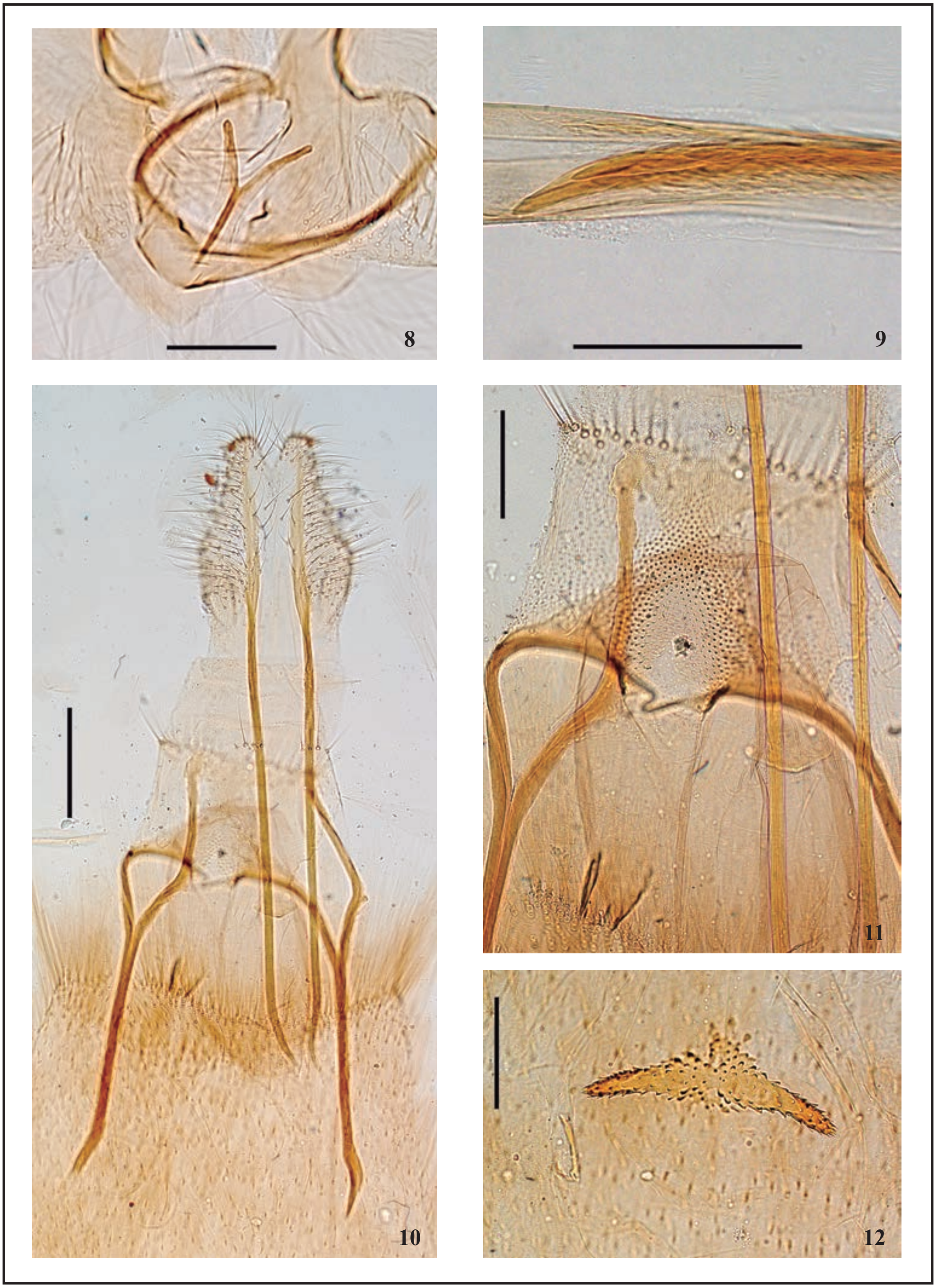
Argyresthia impura was described as *Zelleria impura* from seven males and three females from Turkey (Amasia), and Staudinger further included two Iranian specimens (“Schliesslich finde ich noch zwei am 26 Mai bei Tasch in Nord-Persien von Christoph gefundene Stücke, die sicher auch zu dieser Art gehören”). Some authors give the year of description as 1880, but the issue in which the species was described was published on 1 November 1879 (https://www.biodiversitylibrary.org/page/41262088).

Friese (1963), who found the species in North Macedonia, was the first to recognise that *impura* belongs to *Argyresthia* and selected a Lectotype. Unfortunately, he did not publish any illustrations.

Figures 6-7. *Argyresthia impura*, male genitalia, phallus at right. 6. Lectotype male, slide Friese 277. 7. Male from the Netherlands, slide GKVD02022018, RMNH.INS. 15582. Scale bars 200 µm.



Figures 8-9. *Argyresthia impura*, details of genitalia. **8.** Eighth segment male, slide GKVD02022018. **9.** Detail cornuti in phallus, slide Friese 277. **10-12.** Female genitalia, paralectotype, slide Friese 278, **10.** ovipositor and apophyses. **11.** detail lamella postvaginalis and antrum. **12**. signum. Scale bars 200 µm (10) 100 µm (other figures).



Argyresthia buvati was described from France, Hautes Alpes, Saint-Crépin, where it was found in the vegetation of *Juniperus thurifera* L., also known as the Spanish juniper. It was found together with *A. reticulata* Staudinger, 1877 and *A. thuriferana* (Gibeaux, 1993), described at the same time as *A. buvati* and occurring on the same host. The original records were from 1959 to 1989, but the species was still present in 2013 and 2014 (Christian Gibeaux, personal communication). The only other record is from northern Spain, Soria, Aldehuela de Calatañazor, where it was taken in June 2018 in *J. thurifera* vegetation, in company with the same two species as in France (Laštůvka & Laštůvka, 2019). The description year of *A. buvati* is often erroneously cited as 1992; however, according to the cover page of vol. 3, fasc. 4 was published in March 1993 (Huemer, 2010).

The male and female genitalia as described and illustrated in detail here, match the original photos and description of *A. buvati* well (Gibeaux 1993), confirming the synonymy of the species.

Distribution (Figure 13)

France, Spain, North Macedonia, Turkey, Armenia (new record), North Iran. The single records from Belgium and the Netherlands are most likely from accidental imports. Lewis & Sohn (2015) also list Uzbekistan, but according to Jay Sohn (e-mail 2025), this may have been a misinterpretation of Friese's record from Tasch (in Iran) as Tashkent (in Uzbekistan). Everywhere a very scarcely recorded species, see Table 1 for all records and Figure 13 for a map. Apart from the Macedonian one, all native records are from higher mountains, above 1000 m at least. Based on the distribution of the *Juniperus* species that may be the hosts, the species could be expected to occur also in Morocco, Greece, Georgia, Azerbaijan, Turkmenistan and maybe further east.

Figure 13. Distribution records of *Argyresthia impura*, mapped on distribution area of *Juniperus thurifera* (solid green) and *J. excelsa* (solid ochreous). The adventive records are presented with a star.

Biology

Juniperus thurifera is most likely the native hostplant in France (Gibeaux, 1993) and Spain (Laštůvka & Laštůvka, 2019), although there is no positive proof of feeding. The Spanish juniper has a restricted distribution, mainly in Spain, with some small occurrences in the French and Italian Alps, the Pyrenees and Corsica, and occurs in Algeria and Morocco (San-Miguel-Ayanz et al. 2015). This means that the Turkish and Macedonian populations must have other hosts. Several species of *Juniperus* occur in that area, but only the closely related *J. excelsa* Bieb. (Mao et al. 2010) occurs in all localities of *A. impura*, with a distribution spanning from North Macedonia through

Greece and Turkey to the western Himalaya. The distribution of both species is mapped in Figure 13, green for *J. thurifera*, and ochreous for *J. excelsa*, including its several subspecies (map source: Caudullo et al. 2017; 2024). Although there is a striking match in distribution, this is of course no proof that *J. excelsa* is the hostplant.

It is remarkable that the Belgium specimen was found in a house, where at that moment the Serbian spruce (*Picea omorika* (Pančić) Purk.) was present as Christmas tree as the only plant. This tree has a limited native distribution in Bosnia-Hercegovina and Servia (San-Miguel-Ayanz et al. 2015) but is commonly grown as ornamental and Christmas tree. Several species of *Argyresthia* that are known to feed on Cupressaceae are known to be able to use several species in that family (e.g. *A. cupressella*, *A. thujella, A. trifasciata*), but none of these also uses conifers in the Pinaceae. On the other hand, the *Argyresthia* species known to feed on Pinaceae are usually strictly monophagous on either *Abies, Picea* or *Larix* (Bengtsson & Johansson, 2012). As the records of "*A. buvati*" in France and Spain strongly suggest that they are associated with *Juniperus thuriferana*, the hostplant *Picea* seems rather unlikely, and we must consider the possibility that the Belgian specimen might not have fed on *Picea*. It could still be possible that it was brought indoors as pupa on this tree, as this might have come from a place where also material of Cupressaceae was kept or was growing.

DNA barcodes

Five specimens are barcoded in total, the Dutch specimen, the one from Armenia and three specimens from the Klimesch collection in the Munich Museum. The DNA barcodes are almost identical, the maximum distance between these is 0.46%, with the Armenian one most distant from the others. All belong to the Barcode Index Number BOLD:ADR8059. see Table 1. The nearest neighbour is an unidentified *Argyresthia* from Kyrgyzstan with BIN BOLD:AEI2999 at a distance of 5.05%.

Discussion

The morphological examination of the types and published photos clearly showed that *Argyresthia buvati* and *A. impura* are one species, with a disjunct distribution: western populations in Spanish and French mountains, and eastern populations reaching from the Balkans, through Turkey to the Alborz mountains in Iran. Whereas the western population are clearly associated with the local tree *Juniperus thurifera*, there are no records of host or associated trees for the eastern populations, but the distribution match with the species *Juniperus excelsa*, related to *J. thuriferana* is remarkable, and requires further study. DNA barcodes are only available for the eastern populations and show hardly variation. We expect that the DNA barcode of western populations will be rather different due to geographic isolation.

The two specimens found in the Netherlands and Belgium should be regarded as adventive. The barcode of the Dutch specimen is identical to Turkish and Macedonian specimens, suggesting an eastern origin. As both specimens were found in house in winter, far too early for the normal flying time, it is most likely that the specimens emerged indoors from pupae that were brought indoors. As both Belgium and the Netherlands have many inhabitants with close ties to Turkey, a possible scenario could be that cocoons of the species were brought in with objects or artefacts originating from Turkey, allowing the moths to emerge due to the higher temperatures. An origin from cultivated *Juniperus* seems less likely but cannot be completely excluded. In both houses there were no *Juniperus* or related plants present at the time of discovery of the moth, only in Belgium a Christmas tree of the genus *Picea* was reported. The combination of *Juniperus* and *Picea* as hosts for the same species, both belonging to a different family, would be rather unlikely, but also this scenario cannot be excluded altogether.

The rareness of *A. impura* suggests a rather specialised life history, and we urge lepidopterists to search for the species in stands of *Juniperus* species and pay attention to the presence of leafmines or spinning's in wintertime.

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Conflict of Interest

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

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Table 1. Records of *Argyresthia impura*, locality details, sources and Genbank accession numbers.

Country	Locality	Date	Collector	Coordinates	Specimens	Sources, material details	GenBank #
Western populations							
France	Hautes-Alpes, Saint-Crépin	07-V-1959	R. Buvat	44.71, 6.61	1 ♂ HT buvati	Gibeaux, 1993	
	Hautes-Alpes, Saint-Crépin	29-31-V-1981	Chr. Gibeaux	44.71, 6.61	1 ♀ PT buvati	Gibeaux, 1993	
	Hautes-Alpes, Saint-Crépin	17-18-V-1989	R. Buvat	44.71, 6.61	adults PT buvati	Gibeaux, 1993	
Spain	Soria, Aldehuela de Calatañazor	15-19-VI-2018	A. & Z. Laštůvka	41.71, 2.793	2 ♀	Laštůvka & Laštůvka, 2019	
Eastern Populations							
North Macedonia	W. of Skopje, Treschkaschlucht [Matka Canyon]	1-10-V-1956	F. Kasy	41.935, 21.3	1 ♂, 1 ♀	Friese, 1963	
	Skopje, Matka, Treska Canyon	20-V-1956	F. Kasy	41.935, 21.3	1 ♂	BOLD: BGE_ZSM_LEP_2223	PV217822
Turkey	Amasya Province, Jenikeui [Yeniköy]-Hochebene [plateau E of Vermis]	7-VI-1875	O. Staudinger	40.65, 35.88	1 ♂ LT, 2 ♂, 2 ♀ PLT	Staudinger 1879. slides: LT Friese 277, PLT ♀ Friese 278, PLT ♂ Friese 279	
	Isparta, Anamas Dag	17-VI-1966	J. Klimesch	37.705, 31.283	1 ♂	Lepiforum E.V., 2025	
	Isparta, Anamas Dag	17-VI-1966	J. Klimesch	37.705, 31.283	1 ♂	BOLD: BGE_ZSM_LEP_2221	PV217819
	Isparta, Anamas Dag	17-VI-1966	J. Klimesch	37.705, 31.283	1 ♂	BOLD: BGE_ZSM_LEP_2222	PV217820
Armenia	Ararat, Khosrov forest state reserve	26.IV-9-V-2022	U. Jurivete & P. Ivinskis	40.037, 44.777	1 ♀	BOLD: MM28032	PV217818
Iran	Semnan Province, Tasch [Tāsh-e-olyā]	26-V-1875	Christoph	36.57, 54.68	1 ♂	Staudinger, 1879	
Adventive records							
Netherlands	Noord-Holland, IJmuiden-Zeewijk	11-I-2018	D. Groenendijk	52.448, 4.596	1 ♂	https://waarneming.nl/observation/150499804/ RMNH.INS.15582 (also BOLD), slide GKVD02022018	PV217821
Belgium	Oost-Vlaanderen, Ruien-Dorp	13-III-2023	C. De Noyette	50.7733, 3.4868	1 adult	https://waarnemingen.be/observation/265135149/	

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https://zoobank.org/B14982BA-56D1-43D2-A0A3-54BEE9541468

Psychotrosia Becker, a new genus of Neotropical Trosiinae, with a description of new species (Lepidoptera: Megalopygidae)

Vitor O. Becker

Abstract

Psychotrosia Becker, gen. nov. [Type-species: *Trosia zernyi* Hopp, 1930], and three new species are described: *Microrape clenchi* Becker, sp. nov.; *M. melanica* Becker, sp. nov., and *P. venata* Becker, sp. nov., are proposed for a group Neotropical Trosiinae.
Keywords: Lepidoptera, Megalopygidae, Trosiinae, *Microrape, Psychotrosia***,** taxonomy, new combination, distribution, new species, Brazil, Peru.

Psychotrosia **Becker, un nuevo género de Trosiinae Neotropical, con descripción de nuevas especies (Lepidoptera: Megalopygidae)**

Resumen

Psychotrosia Becker, gen. nov. [Especie-tipo: *Trosia zernyi* Hopp, 1930] y tres especies nuevas: *Microrape clenchi* Becker, sp. nov.; *M. melanica* Becker, sp. nov., y *P. venata* Becker, sp. nov., son propuestas para un grupo de Trosiinae meotropicales.
Palabras clave: Lepidoptera, Megalopygidae, Trosiinae, *Microrape, Psychotrosia***,** taxonomía, nueva combinación, distribución, nueva especie, Brasil, Perú.

Psychotrosia **Becker, um novo gênero de Trosiinae Neotropical, com descrição de novas espécies (Lepidoptera: Megalopygidae)**

Resumo

Psychotrosia Becker, gen. nov. [Espécie-tipo: *Trosia zernyi* Hopp, 1930], e três espécies novas: *Microrape clenchi* Becker, sp. nov.; *M. melanica* Becker, sp. nov., e *P. venata* Becker, sp. nov., são propostas para um grupo de pequenos, cinza, ou cinza escuros, Trosiinae neotropicais.
Palavras-chave: Lepidoptera, Megalopygidae, Trosiinae, *Microrape, Psychotrosia,* taxonomia, nova combinação, distribuição, espécies novas, Brasil, Peru.

Introduction

Trosia zernyi Hopp, 1930, is a small uniform gray species. As Clench (1956, p. 10) pointed out: "*This genus differs from all others in the group by the short stalking of M2 and M3 on the fore wing, and M3 and Cu1 in the hind wing. Not having any material before me, it would be unwise to propose a new name for this curious species, small in size and apparently uniformly gray colored"*. Becker (2022) excluded it from *Trosia* Hübner, [1820] and allies, stating that it would be a subject of another article, what is done herein. Examination of similar looking specimens, also gray to blackish, which resemble small Psychidae species, revealed that at least three other species, one congeneric, and two belonging to *Microrape* Dyar, 1910.

Material and methods

This article is based on 29 specimens (14 g. s) in the author's collection (VOB), the type material in NHMW, and on pertinent literature. Genitalia were prepared following the methods described by Robinson (1976). Terms for morphological characters follow Hodges (1971). The type material representing the new taxa described here is currently deposited in the author's collection (VOB) and will be transferred, together with the collection, to a Brazilian institution, in the future.

Abbreviations

BA = Bahia State, Brazil
FW = Forewing
HW = Hind wing
MA = Maranhão State, Brazil
NHMUK = Natural History Museum, London, United Kingdom
NHMW = Naturhistorisches Museum, Wien, Austria
RO = Rondônia State, Brazil
VOB = Vitor O. Becker collection, Serra Bonita Reserve, Camacan, Bahia, Brazil
ZMC = Zoologisk Museum, Copenhagen, Dennmark

Results and discussion

Examination of the material resembling *Trosia zernyi* Hopp, 1930 in the author's collection (VOB) revealed that four species are represented, belonging to two different genera: two belonging to an undescribed genus, and two to *Microrape* Dyar, 1910. All previously known species of *Microrape* are white, or whitish; the two described here are the first melanic species recorded for the genus.

Nomenclatural summary

Microrape Dyar, 1910
    ***clenchi* Becker**, **sp. nov.**
    ***melanica* Becker**, **sp. nov.**
***Psychotrosia* Becker**, **gen. nov.**
    ***venata* Becker**, **sp. nov.**
    zernyi (Hopp, 1930) (*Trosia*), **comb. nov.**
Key to genera and species

1. Gray, FW with M2+M3 stalked ....*Psychotrosia* 2
   Blackish, FW with M2+M3 connected .... *Microrape* 3

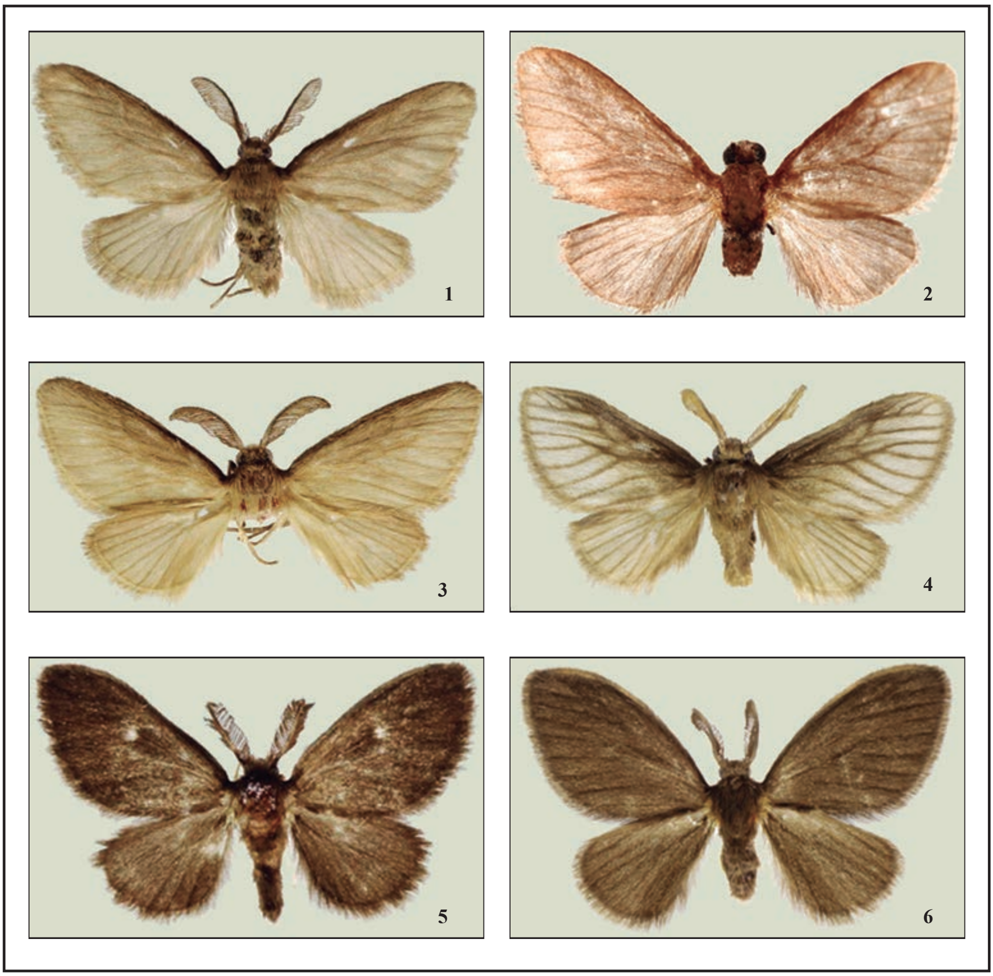
2. FW plain gray, male genitalia with sacculus longer than uncus tip .... *zernyi*
FW with veins contrasting gray, male genitalia with sacculus not reaching uncus tip .... *venata*

3. Male genitalia with sacculus large, flat, almost as long as genitalia .... *clenchi*
Male genitalia with sacculus small, half as long as genitalia .... *melanica*

Psychotrosia Becker, gen. nov.

TS: *Trosia zernyi* Hopp, 1930, here designated.
https://zoobank.org/5955D00A-E92A-4196-B4BB-35E75F65915E

Figures 1-6. *Psychotrosia* and *Microrape,* adults, dorsal view. **1-2.** *P. zernyi* (Hopp). **1.** Brazil, Rondônia. **2.** holotype, Brazil, Pará. **3-4.** *P. venata* Becker, Ecuador, Napo. **3.** Paratype. **4.** holotype. **5.** *M. melanica* Becker, holotype, Brazil, Bahia. **6.** *M. clenchi* Becker, holotype, Brazil, Rondônia.



Diagnosis: Small, plain gray.

Description: Small, plain gray. FW length 6-8 mm (14-16 mm wingspan), M2-M3 stalked halfway between cell and termen, HW with M3-Cu1 stalked halfway between cell and termen.

Male genitalia: Male genitalia with valva split along middle, sacculus well developed, much larger than the costal area.

Distribution: Amazonian (Brazil).

Etymology**.** From the Greek Ψυχή (*Psyche*) =breath, life, soul, in reference to the genus *Psyche* Schrank, for its similarity to several species belonging to the Psychidae, + *Trosia,* a genus; feminine.

Remarks: Hopp (1930, p. 274) stated that this species differs from all the others belonging to *Trosia* not only by its small size, but also by its venation: FW with veins 4-5 [M2+M3], and HW with 3-4 [M3+Cu1] stalked, which led Clench (1956: 10) to suggest that a new genus should be erected to accommodate it. This is confirmed by the characters of the male genitalia, which among others, has the valva split along middle, with smaller costal part ["*harpe*" of Hopp, 1927], and a long, curved, well developed sacculus.

Psychotrosia zernyi (Hopp, 1930) **comb. nov. (**Figures 1, 2, 6, 7)
Trosia zernyi Hopp, 1930. *Ann. Naturhist. Mus. Wien, 44*, 274. Holotype ♂
TL: BRAZIL [PA], Taperinha (Zerny) (NHMV) [image examined].

Material examined (6 ♂, 2 ♀, 2 g. s.). Brazil: RO, Ariquemes, 180 m, 3 ♂, 13-16-IV-1989 (Becker 61818); 2 ♂, 2 ♀, Cacaulândia, 140 m, XI-1991, XI-1994, g. s. 5939, 5940) (Becker 80094, 96258). Ecuador: Napo, Misahualli Lodge, 450 m, 1 ♂, XII-1992 (Becker 102150) (VOB).

Diagnosis: Plain gray, paler ventrally. Wings with no contrasting veins.

Description: Plain gray, paler ventrally. Male FW length 6-7 mm (14-16 mm wingspan) (Figures 1-2), female 10 mm (22 mm wingspan).

Male genitalia (Figures 6-7): Uncus a thin, short, slender digit. Tegumen broad, expanded distal. Valva with costal tiny part as a small bent process, next to distal end of tegumen; sacculus long, slender, curved, reaching beyond uncus tip. Penis (Figure 7) a curved ventrad rod, vesica with no spines.

Female genitalia: Ostium narrow; ductus bursae shorter than diameter of corpus bursae; corpus bursae a large, sclerotized sphere.

Distribution: Amazonian (Brazil, Ecuador).

Remarks: Easily distinguished from *P. venata* by the plain gray color, with contrasting veins in *P. venata.*

***Psychotrosia venata* Becker, sp. nov.** (Figures 3-4, 9-10)
https://zoobank.org/95B9BE81-3C68-475B-9C27-F4306337B4AB

Material examined (5 ♂, 2 g. s.). Holotype ♂, Ecuador: Napo, Misahualli, 450 m, XII-1992 (Becker 102149); Paratypes: 3 ♂, same data as holotype, g. s. 5942. Excluded from the type-series: Brazil: RO, 1 ♂, Cacaulândia, 140 m, XI-1991, g. s. 5941 (Becker 80095) (VOB).

Diagnosis: Gray. FW paler, with contrasting gray veins towards termen.

Description: Gray (Figures 3-4), paler gray ventrally. FW length 7-8 mm (15-18 mm wingspan), paler, with contrasting gray veins towards termen.

Male genitalia (Figures 9, 10): Uncus long, slender, curved ventrad. Valva split along middle: costal part nearly as long as uncus, narrow, angled about middle, covered with sparse, long setae; sacculus robust, twice as long as the costal part, tapering distal into a pair of thin, sharp, twisted processes at apex. Juxta a slender V, as long as costal part of valva, with lateral arms curved. Penis

(Figure 10) a curved rod, as long as juxta.

Distribution: Amazonian (Brazil, Ecuador).

Etymology: From the Latin *vena* =vein, in reference to the marked veins; feminine.

Remarks: The male from Cacaulândia was excluded from the type based on the plain gray ground colour of the wings, which look like a larger *P. zernyi.* Its genitalia are identical to those of the type specimen.

Microrape clenchi **Becker, sp. nov.** (Figures 6, 13-14)
https://zoobank.org/F045A588-46B0-4C67-A580-96B3725B34A2

Material (11 ♂, 2 g. s.). Holotype ♂, Brazil: RO, Ariquemes, 180 m, 16-IV-1989 (Becker 61817). Paratypes: 9 ♂, Cacaulândia, 140 m, XI-1991, 13-31-XII-1997, 2 g. s. 5943, 5945, 5946 (Becker 80096, 112637) (VOB); 1 ♂, Porto Velho, 180 m, 24-IV-1989, g. s. 5944 (Becker 75945).

Diagnosis: Plain blackish.

Description: Plain blackish (Figure 6). Legs, and abdomen ventrally, whitish. FW length 5-7 mm (11-15 mm wingspan). Legs, and abdomen ventrally, whitish.

Male genitalia (Figures 13-14): Uncus short, split into a pair of socii tapering distal to sharply pointed apex. Valva reduced to a large, twice as long as broad flat sacculus, with costal and apex edges bearing two small, shallow teeth. Penis (Figure 14) longer than sacculus, curved, bulbose at base; vesica with dense pack of sharply pointed spines.

Distribution: Brazil (Amazonian).

Etymology: In honor of the late Dr Harry K. Clench, curator, Carnegie Museum of Natural History (USA), who was the first to call attention to the fact that *T. zernyi* Hopp, the type species, does not belong in *Trosia,* but required a new genus.

Remarks: This and the following are the only blackish species in the genus; almost indistinguishable from *M. melanica,* described below*,* slightly larger on average. Easily distinguished by the large, flat sacculus, which can be easily seen by rubbing the end of the abdomen. One genitalia preparation (Fig.) was mounted showing the valva and pennis in lateral view, and the tegumen and uncus in ventral view, according to the method described by Pitkin (1986).

Microrape melanica **Becker, sp. nov.** (Figures 5, 11-12)
https://zoobank.org/8E99ECFC-1DD1-4A16-9EA0-ABA935ED7D7C

Material examined (3 ♂, 2 g. s.): Holotype ♂, Brazil: BA, Camacan, 800 m, 15º23’S, 39º33W, XI-2009, g. s. 5947 (Becker 145144) (VOB). Paratypes: 1 ♂, Porto Velho, 180 m, 24-IV-1989, 5948 (Becker 75944); 1 ♂, MA, Açailândia, 150 m, 19-27-XI-1990 (Becker 77385) (VOB).

Diagnosis: Small, blackish.

Description: Blackish (Figure 5). Legs whitish. FW length 7 mm (15 mm wingspan), with a conspicuous or indistinct, small dot at end of cell dorsally and ventrally; small white dots on veins, along termen, and one at end of cell of HW.

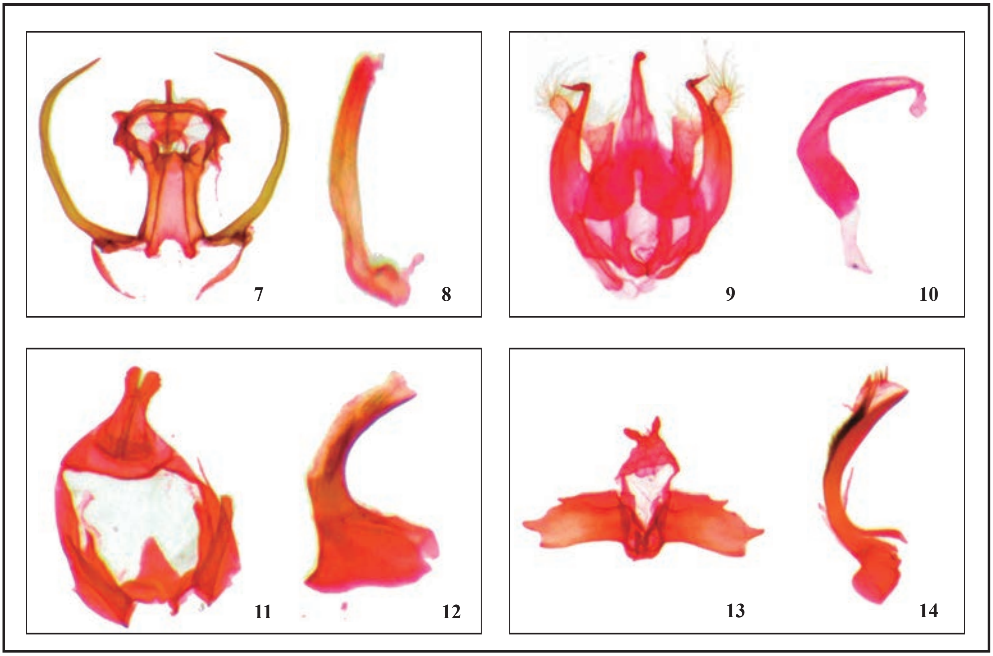
Male genitalia (Figures 11-12): Uncus bifurcate, slightly constricted along middle. Valva with the costal area vestigial; sacculus a digital, slender, straight rod, half as long as tegumen. Penis (Figure 12) evenly curved, broad basally, vesica with dense patch of long spines.

Distribution: Southern Brazil, from the type-locality only.

Etymology: From the Greek μελάνος (*melanos*) =black; feminine.

Remarks: This blackish species is very similar to *M. clenchi,* but easily distinguished by the shape of sacculus: a short, slender process almost identical to those of *M. signata,* a whitish species. FW has a small whitish dot at end of cell, distinct in the holotype, however hardly noticeable in the paratypes.

Figures 7-14. male genitalia, ventral view. **7-8.** *P. zernyi* (Hopp), Brazil, Rondônia. **9-10.** *P. venata* Becker, paratype, Ecuador, Napo. **11-12**. *M. melanica* Becker, paratype, Brazil, Rondônia: **12**. penis with juxta attached. **13-14.** *M. clenchi* Becker, paratype, Brazil, Rondônia.



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Conflict of Interests

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

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Arhopala kurzi (Distant, 1885) new to Indonesia (Lepidoptera: Lycaenidae, Theclinae)

Elpe Bibas

Abstract

Arhopala kurzi (Distant, 1885) is here recorded for the first time from Indonesia. The female specimen was collected from West Sumatra, Lima Puluh Kota district in Lembah Harau Nature Reserve.
Keywords: Lepidoptera, Lycaenidae, first record, Sumatra, Indonesia

Arhopala kurzi **(Distant, 1885) nueva en Indonesia**
(Lepidoptera: Lycaenidae, Theclinae)

Resumen

Arhopala kurzi (Distant, 1885) se registra aquí por primera vez en Indonesia. El espécimen hembra fue recolectado en Sumatra Occidental, distrito de Lima Puluh Kota, en la Reserva Natural del Lembah Harau.
Palabras clave: Lepidoptera, Lycaenidae, nuevo registro, Sumatra, Indonesia.

Introduction

Arhopala Boisduval, 1832 is one of the genera in the family Lycaenidae with the highest number of species, comprising more than 200 species. This genus is widely distributed from the Oriental region to Australia (Corbet, 1946; Megens et al. 2004). In Indonesia, this genus is distributed across various regions, ranging from Sumatra to Papua (Corbet, 1946; D'Abrera, 1971; Rawlins et al. 2017; Seki et al. 1991, Vane-Wright & de Jong, 2003; Vane-Wright & Gaonkar, 2006). In Sumatra specifically, more than 57 species have been recorded (Corbet, 1946; de Nicéville & Martin, 1896).

One of the species in this genus is *Arhopala kurzi* (Distant, 1885), which has been reported in West Malaysia (Corbet & Pendlebury, 2020; Fleming, 1983), Singapore (recorded as extinct) (Jain et al. 2018) and Thailand (specifically in Nakhon Si Thammarat and Yala) (Inayoshi, 2025). This species can be distinguished from other members of the genus by several key morphological traits. The postdiscal spot in space 3 on the underside of the forewing is markedly elongated and directed toward the wing base. A spot is present in space 1b, positioned approximately midway between the end-cell bar and the postdiscal spot in space 2. The hindwing underside features a postdiscal band that is distinctly dislocated at vein 2. Additionally, the hindwing tornus is characteristically rounded, which further aids in differentiating *A. kurzi* from other closely related species (Corbet & Pendlebury, 2020). To date, the presence of *Arhopala kurzi* in Indonesia has never been reported. This paper reports the first recorded sighting of this butterfly species in Indonesia, specifically in Sumatra.

Materials and Methods

This sample was obtained during a butterfly survey in the Lembah Harau Nature Reserve, Lima Puluh Kota District, West Sumatra, in 2019. Observations were conducted along forest trails in secondary forests on a sunny day. Specimens were caught using an insect net and stored in paper envelopes for identification. The species was identified using external morphology based on the references of Corbet (1941) and Corbet & Pendlebury (2020).

Results and Discussion

Arhopala kurzi (Distant, 1885)
Narathura kurzi Distant, 1885. *Rhop. Mal.*, 268, pl. 21, f. 1

Record: Indonesia, West Sumatra, Kabupaten Lima Puluh Kota, Lembah Harau (0º6’18”S, 100º40’15”E), 1 ♀, 26-VI-2019, leg. E. Bibas (coll. Elpe Bibas).

Description of Specimen

A single female specimen was examined, with a forewing length of approximately 20 mm. The upperside of both wings is predominantly purple with irregular black margins. On the forewings, the purple area extends from the wing base to approximately veins 1 to 4, not reaching the termen, which is bordered by a black band around 3 mm wide. On the hindwings, the purple coloration extends more extensively toward the termen.

The underside is brown with intricate postdiscal patterns. On the forewings, the postdiscal band is dislocated at vein 4, and the postdiscal spot in space 3 is conspicuously elongated and directed inward toward the wing base. A spot in space 1b is positioned approximately midway between the end-cell bar and the postdiscal spot in space 2. On the hindwings, the postdiscal band is broadly interrupted at vein 2. The hindwing tornus is rounded, which is also a distinguishing character.

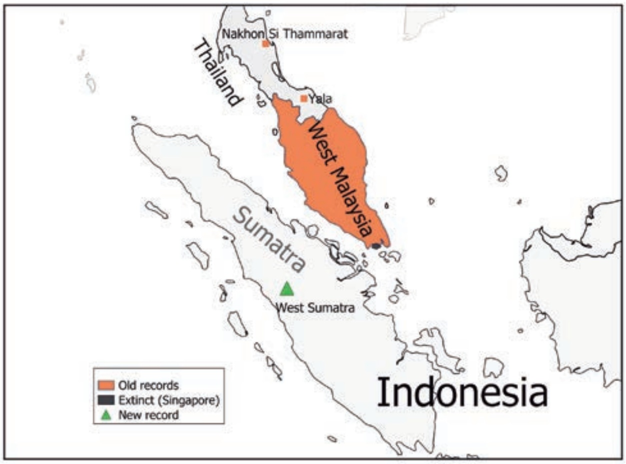
The characteristics described above serve as the diagnosis for this species (Figure 1). These characteristics distinguish *Arhopala kurzi* from other species within the Arhopala genus. Although only a single female was available for study, the observed morphological traits correspond well with previous descriptions of the species (Corbet, 1941; Corbet & Pendlebury, 2020) and support its identification. The female specimen of *Arhopala kurzi* from Sumatra exhibits broader black margins on both forewings and hindwings compared to individuals previously reported from Thailand (Inayoshi, 2025) and Malaysia (Corbet & Pendlebury, 2020). This difference may result from phenotypic plasticity influenced by local environmental conditions, or it could reflect geographic variation within the species. However, further research is needed to clarify the cause and taxonomic relevance of this variation.

Figure 1. Habitus of *Arhopala kurzi* (Distant, 1885). Scale bar 10 mm.

Distribution

This specimen was found in the secondary forest area of the Lembah Harau Nature Reserve. The forest is located on a hill of the Harau Valley, approximately several kilometers from the nearest town, Payakumbuh. This represents the first record of *Arhopala kurzi* in Sumatra, Indonesia. The distribution of this species now includes West Malaysia (Corbet & Pendlebury, 2020; Fleming, 1983), Thailand (specifically in Nakhon Si Thammarat and Yala) (Inayoshi, 2025) and Sumatra (Indonesia) (Figure 2). There has been limited research on this species. Therefore, further studies are needed in the biology and ecology of this species.

Figure 2. Distributional map of *Arhopala kurzi* (Distant, 1885)



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Conflict of interests

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

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Baseline Inventory of Papilionoidea in Buxa Tiger Reserve, West Bengal, India (Insecta: Lepidoptera)

Sayak Dolai, Md Abu Imran Mallick, Swapnanil Patra & Shilajit Barua

Abstract

A comprehensive survey of Papilionoidea fauna in and around Buxa Tiger Reserve, Alipurduar district, West Bengal, revealed a total of 138 species spanning 6 families and 55 genera. Nymphalidae (43%) dominated the recorded species, followed by Lycaenidae (23%), Hesperiidae (11%), Pieridae (10%), Papilionidae (9%), and Riodinidae (4%). Notably, 23 species are protected under the Wildlife (Protection) Amendment Act (2022), including 22 species listed in Schedule-II, and one in Schedule-I. The abundance of Papilionoidea species varied across different habitats. The highest number of species was recorded in HF (Hill Forest)-N22 (November 2022) (81 species), followed by RT (River trail)-N22 (68 species), and RT-A22 (April 2022) (50 species) and HF-A22 (47 species). This study contributes significantly to our understanding of the diversity in the region and informs conservation efforts aimed at protecting these vital pollinators and ecosystem indicators.
Keywords: Insecta, Lepidoptera, Papilionoidea, diversity, Wildlife Protection Act, conservation, Buxa Tiger Reserve, West Bengal, India.

Inventario de referencia de Papilionoidea en la Reserva de Tigres de Buxa, Bengala Occidental, India (Insecta: Lepidoptera)

Resumen

Un estudio exhaustivo de la fauna de Papilionoidea en la reserva de tigres de Buxa y sus alrededores, en el distrito de Alipurduar (Bengala Occidental), reveló un total de 138 especies de 6 familias y 55 géneros. Nymphalidae (43%) dominaba el número de especies registradas, seguida de Lycaenidae (23%), Hesperiidae (11%), Pieridae (10%), Papilionidae (9%) y Riodinidae (4%). En particular, 23 especies están protegidas por la Ley de Protección de la Fauna y Flora Silvestres (Enmienda de 2022), 22 de las cuales figuran en la Lista II y una en la Lista I. La abundancia de especies de Papilionoidea varió entre los diferentes hábitats. El mayor número de especies se registró en HF (Hill Forest)-N22 (noviembre, 2022) (81 especies), seguido de RT (River trail)-N22 (68 especies), y RT-A22 (abril, 2022) (50 especies) y HF-A22 (47 especies). Este estudio contribuye significativamente a nuestra comprensión de la diversidad en la región e informa los esfuerzos de conservación dirigidos a proteger estos polinizadores vitales e indicadores del ecosistema.
Palabras clave: Insecta, Lepidoptera, Papilionoidea, diversidad, Ley de Protección de la Vida Silvestre, conservación, Reserva del Tigre de Buxa, Bengala Occidental, India.

Introduction

Lepidoptera, specifically Papilionoidea, represent one of the most extensively taxonomically investigated insect orders. The world's Papilionoidea fauna comprises more than 28,000 species, and India is home to a notable 1,504 species, showcasing the region's exceptional biodiversity (Triple, 2012). This vast array is neatly categorized into six families including Hesperiidae, Papilionidae, Pieridae, Nymphalidae, Riodinidae, and Lycaenidae, providing a framework for understanding their intricate relationships (Braby, 2004). Faunal diversity is a key metric for assessing forest ecosystem health, as it contributes significantly to the resilience, stability, and sustainability of the forest's ecological processes (Bregman et al. 2016). The use of ecological indicator species has become a widespread practice globally, enabling effective monitoring and evaluation of ecosystem biodiversity (Thomas, 2005). Indicator species serve as valuable tools for informing forest management policies and assessing their subsequent impact on ecosystem structure and function (Fleishman & Murphy, 2009).

Lepidoptera are widely recognized as ideal bio-indicators due to their distinctive wing patterns, high diversity, short life cycles, specific host plant preferences, and sensitivity to environmental changes (Kotze et al. 2011; Lee et al. 2016). Contribute to ecosystem stability as herbivores, prey, and hosts, while also serving as pollinators and indicators of fauna and floral diversity, thereby maintaining community structure (Nicholls & Altieri, 2013; Oliver et al. 2015; Rusman et al. 2016; Chowdhury & Chowdhury, 2020).

The Northeastern region of India, extending from Sikkim through Assam to North Myanmar and up to Shan state, is one of the world's richest Papilionoidea areas (Kunte et al. 2012). This region's unique combination of flowering plants, habitats, topography, and climates supports an astonishing array of species (Rawal et al. 2013). Notably, 58% of the Papilionoidea found in the Indian subcontinent and Myanmar are concentrated in the Eastern Himalayan part and Northeastern region of India (Saikia et al. 2009). Papilionoidea species diversity, composition, and distribution patterns in the Northeastern region, particularly in Dooars and Terai plains of Northern Bengal, remains scarce (Rakshit, 2003). Conservation efforts have primarily focused on charismatic species, overlooking the importance of less glamorous taxa like Papilionoidea, which play vital roles in the ecosystem.

To address knowledge gaps, a survey was conducted to develop a comprehensive checklist of Papilionoidea species in the Dooars, a hilly region of Northern Bengal. The region is bounded by Bhutan and Assam to the north and east, and tea gardens and agricultural fields to the west and south (Pradhan & Khaling, 2020). The Buxa Tiger Reserve, situated in the foothills of the Eastern Himalayas, features the Sinchula hill range and peaks at 1800 m (Rai, 2002). Eight major rivers flow through the area, giving rise to ten distinct types of forests (Champion & Seth, 1968). The region hosts a diverse plant flora, including trees, shrubs, herbs, grasses, orchids, and ferns, alongside notable vertebrate populations such as the tiger, Asian elephant, Himalayan black bear, and gaur. With 68 mammalian species, 246 bird species, 41 reptile species, 103 fish species, and over 500 insect species (NTCA, 2022), Buxa Tiger Reserve boasts exceptional biodiversity. However, invertebrate diversity, particularly Papilionoidea diversity, remains understudied. Few studies have explored the diversity in the Himalayan foothills of West Bengal (Roy et al. 2012; Pal et al. 2015).

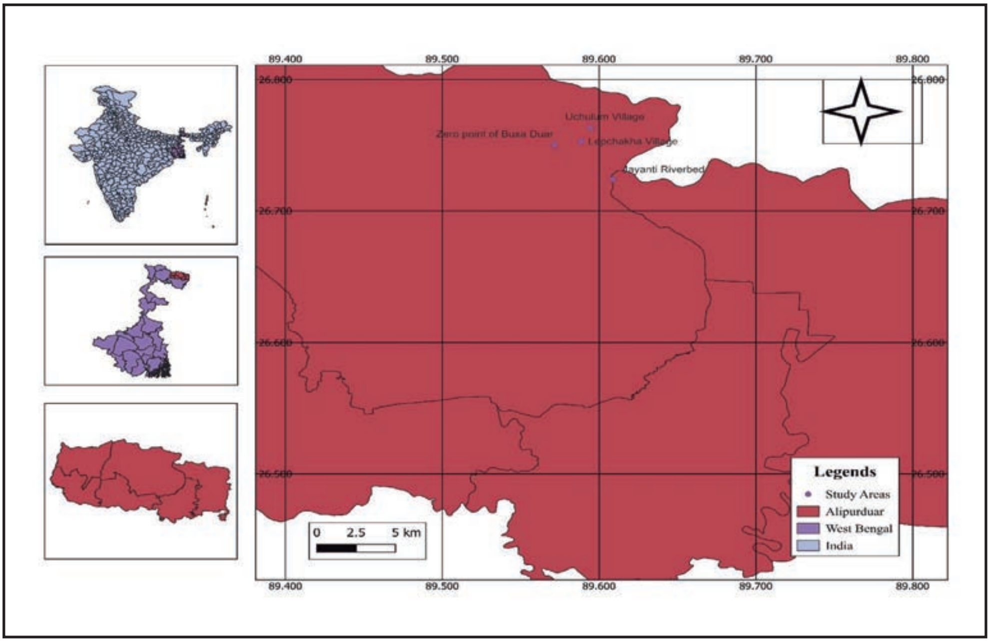
Buxa Tiger Conservation Foundation (2020) reported over 400 Papilionoidea species inside the reserve. The current investigation examines Papilionoidea diversity in Buxa Tiger Reserve, driven by three objectives. These objectives include compiling a preliminary checklist, assessing abundance and diversity.

Methodology

Study Areas

The present study was conducted inside the Buxa Tiger Reserve of West Bengal, India. The first study was performed in April 2022, and the final study was performed in November 2022. In this study, two specific trails were selected for monitoring Papilionoidea, and in both of our visits, each of the trails was explored. The first trail ran from Zero Point of Buxa Duar (26.749939, 89.571548) to Uchulum Village (26.763242, 89.594472) via Sadar Bazar, Buxa Fort, Cataline Village, and Chetedara. The second trail ran from Lepchakha village (26.752903, 89.588454) to Jayanti Riverbed (26.723986, 89.608794) via Katlum, Boro Mahakal, Sachi Chu, Doban, and Choto Mahakal. The QGIS software was used to produce area maps (Figure 1).

Figure 1. Map of Study Areas.



METHODS

For getting better diversity of Papilionoidea, two different times, post-monsoon and spring, were chosen from a calendar year, 2022. The first study was performed between 10 and 12 April 2022, and the final study was performed between 15 and 17 November 2022. In every visit, we started our fields at 8:00 in the morning and completed them before 4:00 in the afternoon using a modified "Pollard Walk" technique (Pollard, 1977; Pollard & Yates, 1997). We performed the survey of the first trail, Hill Forest, on the first dates (10-IV and 15-XI of 2022) of our visit, and the very next day remained as an off day. On the last day of our visit (12-IV and 17-IV of 2022), we used to perform our river trail survey which was the second trail. In these studies, no Papilionoidea were harmed or collected. Only photographic documentation was performed using digital cameras. Species were identified on the field using Kehimkar (2016), and the photographic documentation was used to confirm the actual species identity.

Results and Discussion

A comprehensive survey of Papilionoidea fauna in and around Buxa Tiger Reserve, Alipurduar district, West Bengal, yielded a total of 138 species belonging to 6 families (Table 1, Plates 1-18). The species composition revealed that Nymphalidae was the dominant family, accounting for 43% (59 species) of the recorded species, followed by Lycaenidae (23%, 32 species), Hesperiidae (11%, 15 species), Pieridae (10%, 14 species), Papilionidae (9%, 13 species), and Riodinidae (4%, 5 species) (Figures 2-3). Notably, 23 species recorded in the study area are protected under the Wildlife (Protection) Amendment Act (2022). Of these, 22 species are listed in Schedule-II, and 1 species in Schedule-I (Table 1). The abundance of Papilionoidea species varied across different habitats. The highest number of species was recorded in HF-N22 (81 species), followed by RT-N22 (68 species), RT-A22 (50 species) and HF-A22 (47 species) (Figure 4). Hierarchical clustering Paired group (UPGMA) in the study area were also shown in Figure 5.

The Buxa Tiger Reserve's diverse ecosystem, comprising forest trees, herbs, shrubs and grasses supports a rich Papilionoidea community. The combination of habitats provides an ideal environment for

Papilionoidea, offering food and shelter. Nymphalidae was the dominant family, consistent with previous studies in India and North Bengal (Kumar et al. 2007; Verma, 2009; Sing, 2010; Kunte et al. 2012; Sengupta et al. 2014; Samanta et al. 2017). Wing size and feeding habits distinguished Papilionoidea groups, with non-herb feeders having larger wingspans in forested habitats. Mud-puddling and basking behavior were observed, particularly among male seeking essential nutrients. Also gathered on over-ripe fruits, elephant dung, and carnivore feces. The reserve's unique climate, diverse flora, and water sources support a rich Papilionoidea diversity.

Figure 2. Family-wise Abundance of Papilionoidea species in study area.

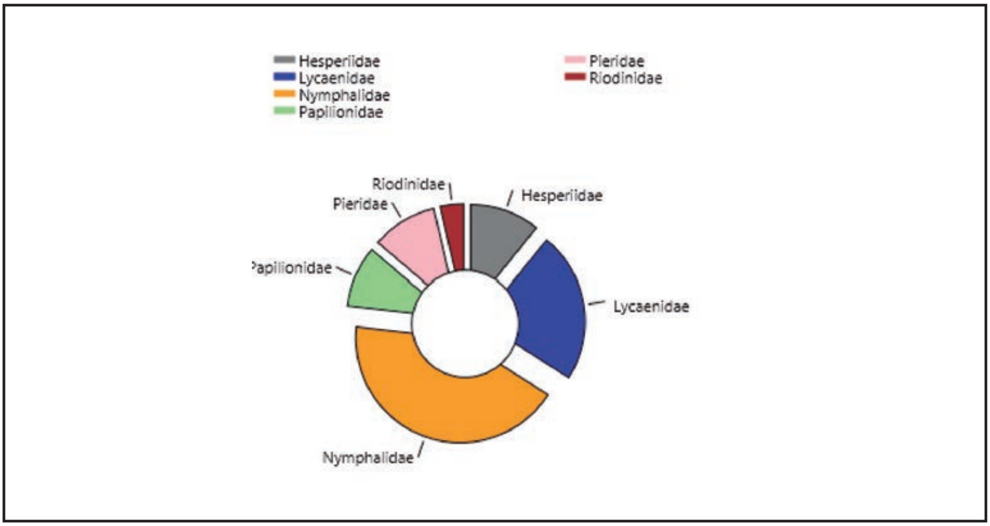


Figure 3. Family-wise abundance model of Papilionoidea species in study area. Note: X-axis numerical are Papilionoidea families; **1** = Nymphalidae, **2** = Lycaenidae, **3** = Hesperiidae, **4** = Pieridae, **5** = Papilionidae, and **6** = Riodinidae.

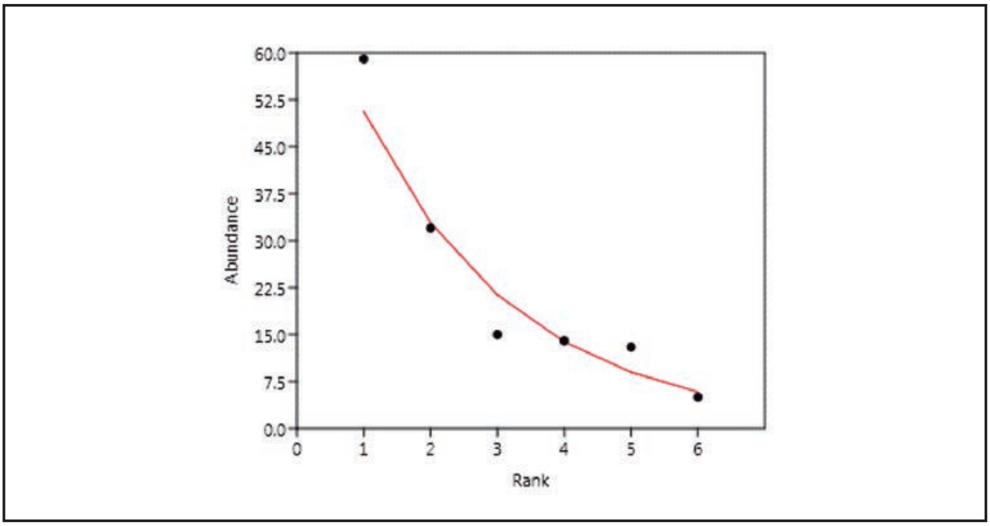


Figure 4. Abundance of Papilionoidea species in different habitats. Note: HF-A22 = Hill Forest - April; HF-N22 =Hill Forest - November22; RT-A22 = River Trail - April22; RT- N22 = River Trail - November 22.

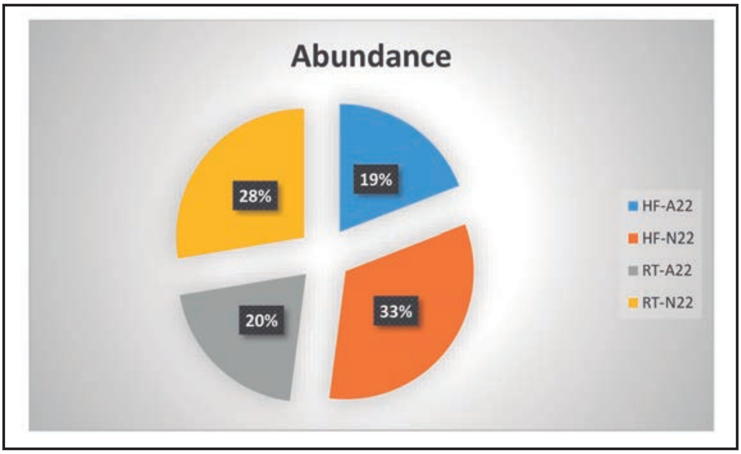
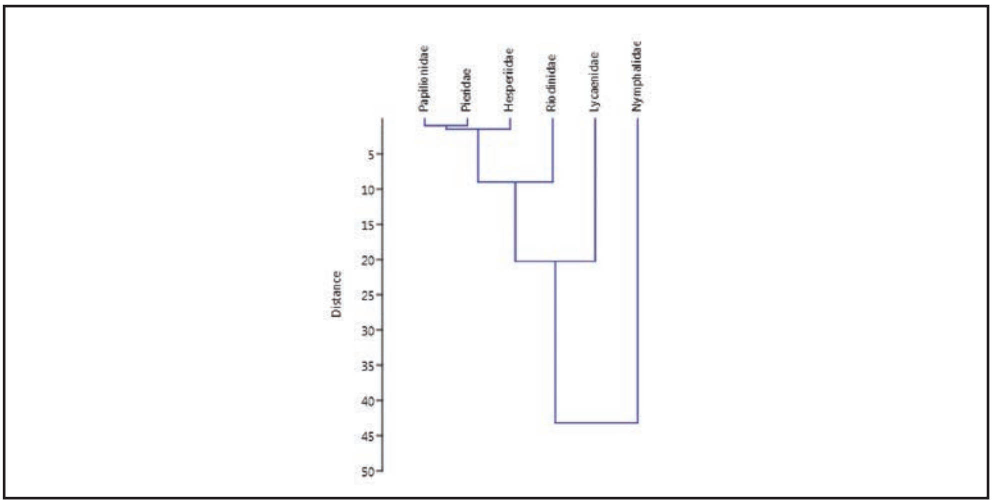


Figure 5. Hierarchical clustering Paired group (UPGMA) of Papilionoidea.



Conclusion

This preliminary study revealed that Papilionoidea were more abundant in the post-monsoon season than in spring in Buxa Tiger Reserve. Probably the prolonged monsoon boosts plant growth, and the availability of more fresh leaves helps the Papilionoidea larvae to thrive. Papilionoidea were more abundant in the hill forest habitat than on the river trail. Hill forest was rich with native flora, and the presence of many slow- to moderate-flowing streams inside the forest created different microhabitats, and the presence of versatile microhabitats contributed to the diversity.

This preliminary study recommends further long-term surveys to capture the complete picture of the Papilionoidea community in its different microhabitats. Future research should focus on seasonal variations, host plants, and environmental factors to conserve these pollinators. Anthropogenic disturbances, such as deforestation, tourism pressure, and, of course, global warming, pose threats, emphasizing the need for regular surveys and conservation strategies.

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Conflict of Interest

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

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Table 1: List of species found in the study area. Note: HF-A22 = Hill Forest - April; HF-N22 =Hill Forest - November22; RT-A22 = River Trail - April22; RT- N22 = River Trail - November 22; R= Recorded; N = Not Recorded; NA = Not Assigned; WLPAA 2022 = The Wildlife (Protection) Amendment Act, 2022.

Scientific Name	WLPAA 2022 Status	HF-A22	HF-N22	RT-A22	RT-N22
Hesperiidae					
Badamia exclamationis (Fabricius, 1775)	NA	R	N	N	N
Burara oedipodea (Swainson, 1820)	NA	N	R	N	N
Burara jaina (Moore, 1866)	NA	R	R	N	R
Burara amara (Moore, 1866)	NA	N	R	N	N
Tagiades menaka (Moore, 1866)	NA	N	R	N	R
Celaenorrhinus leucocera (Kollar, 1844)	NA	N	R	N	N
Sarangesa dasahara (Moore, 1866)	NA	R	N	R	N
Odontoptilum angulatum (Felder & Felder, 1868)	NA	N	N	N	R
Iambrix salsala (Moore, 1866)	NA	R	R	R	R
Notocrypta feisthamelii (Boisduval, 1832)	NA	R	R	N	N
Cupitha purreea (Moore, 1877)	NA	N	R	N	N
Zographetus satwa (de Nicéville, 1884)	NA	N	R	N	R
Pelopidas assamensis (de Nicéville, 1882)	NA	N	N	N	R
Oriens goloides (Moore, 1881)	NA	N	R	N	N
Telicota ancilla bambusae (Moore, 1878)	NA	N	R	N	N
Lycaenidae					
Curetis bulis (Westwood, 1851)	NA	R	N	N	N
Poritia hewitsoni (Moore, 1866)	Schedule II	N	R	N	N
Spindasis lohita (Horsfield, 1829)	Schedule II	R	R	N	N
Anthene lycaenina (Felder & Felder, 1868)	NA	R	N	R	N
Nacaduba pactolus (Felder & Felder, 1860)	NA	N	N	R	N
Prosotas aluta (Druce, 1873)	Schedule II	N	N	R	R
Prosotas nora (Felder, 1860)	NA	N	N	R	N
Nacaduba kurava (Moore, 1858)	NA	N	N	N	R
Prosotas dubiosa (Semper, 1879)	NA	N	R	N	R
Neopithecops zalmora (Butler, 1870)	NA	N	N	N	R
Caleta elna (Hewitson, 1876)	NA	N	R	N	N
Jamides alecto (Felder & Felder, 1860)	Schedule II	R	R	R	N

Catochrysops strabo (Fabricius, 1793)	NA	R	R	R	R
Lampides boeticus (Linnaeus, 1767)	NA	R	R	N	N
Castalius rosimon (Fabricius, 1775)	NA	N	R	N	N
Tarucus ananda (de Nicéville, 1884)	NA	N	R	N	R
Zizina otis (Fabricius, 1787)	NA	N	R	N	N
Udara dilecta (Moore, 1879)	NA	N	R	N	R
Lestranicus transpectus (Moore, 1879)	NA	N	R	N	N
Heliophorus brahma (Moore, 1858)	NA	N	R	N	R
Heliophorus epicles (Godart, 1824)	NA	R	R	R	R
Arhopala bazalus (Hewitson, 1862)	NA	N	N	R	N
Surendra quercetorum (Moore, 1858)	NA	N	R	N	N
Amblypodia anita (Hewitson, 1862)	NA	N	N	N	R
Hypolycaena erylus (Godart, 1824)	NA	R	R	R	R
Chliaria othona (Hewitson, 1865)	Schedule I	N	R	R	R
Zeltus amasa (Hewitson, 1865)	NA	N	R	N	N
Remelana jangala (Horsfield, 1829)	Schedule II	N	N	N	R
Loxura atymnus (Stoll, 1780)	NA	N	R	N	N
Horaga onyx (Moore, 1858)	Schedule II	N	R	N	N
Cheritra freja (Fabricius, 1793)	NA	N	R	N	R
Rapala pheretima (Hewitson, 1863)	NA	N	R	N	R
Nymphalidae					
Libythea lepita (Moore, 1858)	Schedule II	N	R	N	N
Parantica aglea (Stoll, 1782)	NA	N	R	N	R
Parantica melaneus (Cramer, 1775)	NA	N	R	N	R
Tirumala septentrionis (Butler, 1874)	NA	N	R	N	N
Danaus genutia (Cramer, 1779)	NA	N	N	N	R
Danaus chrysippus (Linnaeus, 1758)	NA	N	N	N	R
Euploea mulciber (Cramer, 1777)	NA	N	R	N	R
Polyura athamas (Drury, 1770)	Schedule II	N	N	R	R
Charaxes eudamippus (Doubleday, 1843)	NA	N	N	R	N
Charaxes arja (Felder & Felder, 1867)	NA	N	N	R	R
Charaxes bernardus hierax (Felder & Felder, 1867)	Schedule II	N	N	N	R
Charaxes marmax (Westwood, 1847)	Schedule II	N	R	N	R
Charaxes psaphon imna (Butler, 1870)	NA	N	R	N	R
Elymnias hypermnestra (Linnaeus, 1763)	NA	N	N	N	R
Elymnias vasudeva (Moore, 1858)	Schedule II	N	R	N	N

Orinoma damaris (Gray, 1846)	NA	N	R	N	N
Lethe confusa (Aurivillius, 1898)	NA	R	N	R	N
Lethe verma (Kollar, 1844)	NA	N	R	N	R
Mycalesis heri (Moore, 1858)	NA	N	R	N	N
Mycalesis visala (Moore, 1858)	NA	N	R	N	N
Ypthima baldus (Fabricius, 1775)	NA	R	R	R	R
Calinaga gautama (Moore, 1902)	NA	R	N	R	N
Acraea issoria (Hübner, 1819)	NA	N	R	N	N
Cethosia biblis (Drury, 1773)	Schedule II	N	R	N	R
Cethosia cyane (Drury, 1773)	NA	N	R	N	R
Vindula erota (Fabricius, 1793)	NA	R	N	R	N
Cirrochroa aoris (Doubleday, 1847)	NA	R	R	R	R
Moduza procris (Cramer, 1777)	NA	N	R	N	R
Auzakia danava (Moore, 1858)	Schedule II	N	N	R	N
Athyma ranga (Moore, 1858)	Schedule II	N	R	N	N
Athyma selenophora (Kollar, 1844)	NA	R	R	N	R
Athyma cama (Moore, 1858)	NA	N	N	R	N
Athyma inara (Westwood, 1850)	NA	R	N	R	N
Lebadea martha (Fabricius, 1787)	NA	N	N	N	R
Pantoporia hordonia (Stoll, 1790)	NA	R	N	R	N
Pantoporia sandaca davidsoni (Eliot, 1969)	NA	N	R	N	R
Neptis clinia susruta (Moore, 1872)	Schedule II	N	R	R	R
Neptis hylas (Linnaeus, 1758)	NA	R	N	R	N
Neptis soma butleri (Eliot, 1969)	Schedule II	R	R	N	R
Neptis nata adipala (Moore, 1872)	NA	R	N	R	R
Euthalia monina (Fabricius, 1787)	NA	N	R	N	R
Euthalia phemius (Doubleday, 1848)	NA	N	R	N	R
Euthalia aconthea (Cramer, 1777)	Schedule II	R	R	R	R
Tanaecia lepidea (Butler, 1868)	Schedule II	N	R	N	R
Tanaecia julii (Lesson, 1837)	NA	N	R	N	R
Cyrestis thyodamas (Doyère, 1840)	NA	N	N	R	N
Pseudergolis wedah (Kollar, 1844)	NA	R	R	N	R
Stibochiona nicea (Gray, 1846)	NA	N	R	R	R
Mimathyma ambica (Kollar, 1844)	NA	N	N	R	N
Rohana parisatis (Westwood, 1851)	NA	R	R	R	R
Symbrenthia hypselis (Godart, 1824)	NA	N	R	N	R

Symbrenthia lilaea (Hewitson, 1864)	NA	N	R	R	R
Vanessa indica (Herbst, 1794)	NA	N	R	N	N
Vanessa cardui (Linnaeus, 1758)	NA	R	R	N	R
Aglais caschmirensis (Kollar, 1844)	NA	R	R	N	N
Junonia iphita (Cramer, 1779)	NA	N	R	N	R
Junonia lemonias (Linnaeus, 1758)	NA	N	R	N	R
Kallima inachus (Boisduval, 1836)	NA	N	R	R	R
Doleschallia bisaltide indica (Moore, 1899)	Schedule II	N	R	R	R
Papilionidae					
Graphium sarpedon (Linnaeus, 1758)	Schedule II	N	N	R	R
Graphium agamemnon (Linnaeus, 1758)	NA	N	R	N	R
Meandrusa payeni (Boisduval, 1836)	NA	N	N	N	R
Byasa polyeuctes (Doubleday, 1842)	NA	N	R	N	R
Pachliopta aristolochiae (Fabricius, 1775)	NA	R	R	R	R
Troides helena (Linnaeus, 1758)	NA	R	R	R	R
Papilio polytes (Linnaeus, 1758)	NA	R	R	R	R
Papilio castor (Westwood, 1842)	NA	R	N	N	N
Papilio helenus (Linnaeus, 1758)	NA	R	R	R	R
Papilio nephelus (Boisduval, 1836)	NA	N	N	R	N
Papilio agenor (Linnaeus, 1758)	NA	N	R	N	N
Papilio alcmenor (Felder & Felder, 1864)	NA	R	N	R	N
Papilio paris (Linnaeus, 1758)	NA	R	R	R	R
Pieridae					
Eurema hecabe (Linnaeus, 1758)	NA	N	R	N	R
Colias fieldii (Ménétriés, 1855)	NA	R	R	N	N
Ixias pyrene (Linnaeus, 1764)	NA	R	R	R	R
Hebomoia glaucippe (Linnaeus, 1758)	NA	R	R	R	R
Appias olferna (Swinhoe, 1890)	NA	R	R	R	R
Appias lyncida (Cramer, 1777)	Schedule II	N	R	N	N
Pieris canidia (Linnaeus, 1768)	NA	R	N	N	N
Cepora nerissa (Fabricius, 1775)	NA	R	R	R	R
Cepora nadina (Lucas, 1852)	Schedule II	R	R	N	R
Prioneris thestylis (Doubleday, 1842)	NA	N	R	R	R
Prioneris clemanthe (Doubleday, 1846)	NA	N	N	N	R
Delias acalis (Godart, 1819*)*	NA	R	R	N	R
Delias descombesi (Boisduval, 1836)	NA	N	R	N	R

Delias agostina (Hewitson, 1852)	NA	N	R	N	R
Riodinidae					
Abisara fylla (Westwood, 1851)	NA	R	R	R	R
Abisara bifasciata (Moore, 1877)	NA	N	R	N	N
Abisara neophron (Hewitson, 1861)	NA	R	N	N	N
Zemeros flegyas (Cramer, 1780)	NA	R	R	R	R
Dodona eugenes (Bates, 1868)	NA	N	R	N	N

Plate 1. 1. *Badamia exclamationis*. **2.** *Burara oedipodea*. **3.** *Burara jaina jaina*. **4.** *Burara amara*. **5.** *Tagiades menaka*. **6.** *Celaenorrhinus leucocera*. **7.** *Sarangesa dasahara*. **8.** *Odontoptilum angulatum*.

Plate 2. 9. *Iambrix salsala*. **10.** *Notocrypta feisthamelii*. **11.** *Cupitha purreea*. **12.** *Zographetus satwa*. **13.** *Pelopidas assamensis*. **14.** *Oriens goloides*. **15.** *Telicota ancilla bambusae*. **16.** *Curetis bulis*.

Plate 3. 17. *Poritia hewitsoni*. **18.** *Spindasis lohita*. **19.** *Anthene lycaenina*. **20.** *Nacaduba pactolus*. **21.** *Prosotas aluta*. **22.** *Prosotas nora*. **23.** *Nacaduba kurava*. **24.** *Prosotas dubiosa*.

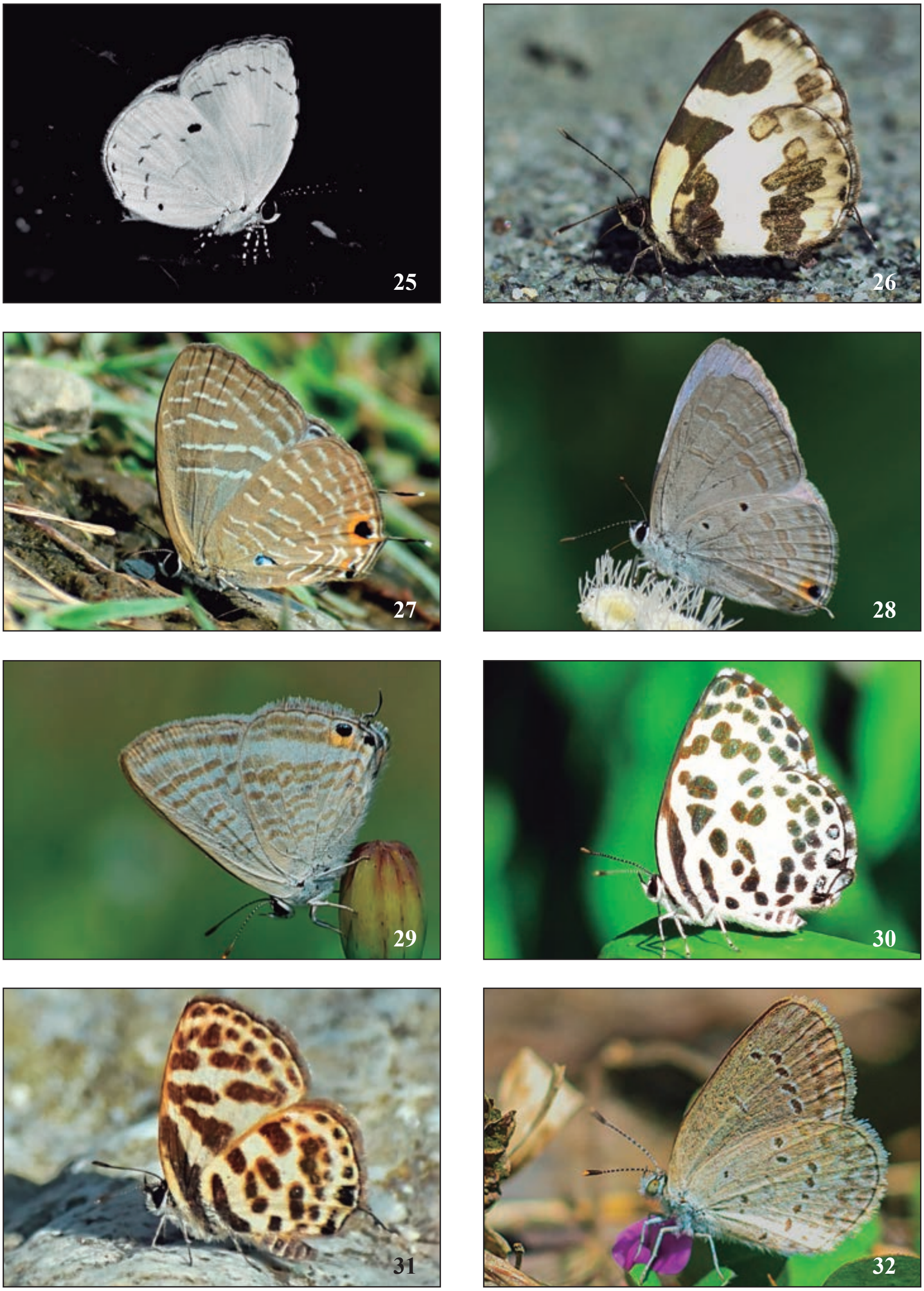

Plate 4. 25. *Neopithecops zalmora*. **26.** *Caleta elna*. **27.** *Jamides alecto*. **28.** *Catochrysops strabo*. **29.** *Lampides boeticus*. **30.** *Castalius rosimon*. **31.** *Tarucus ananda*. **32.** *Zizina otis*.

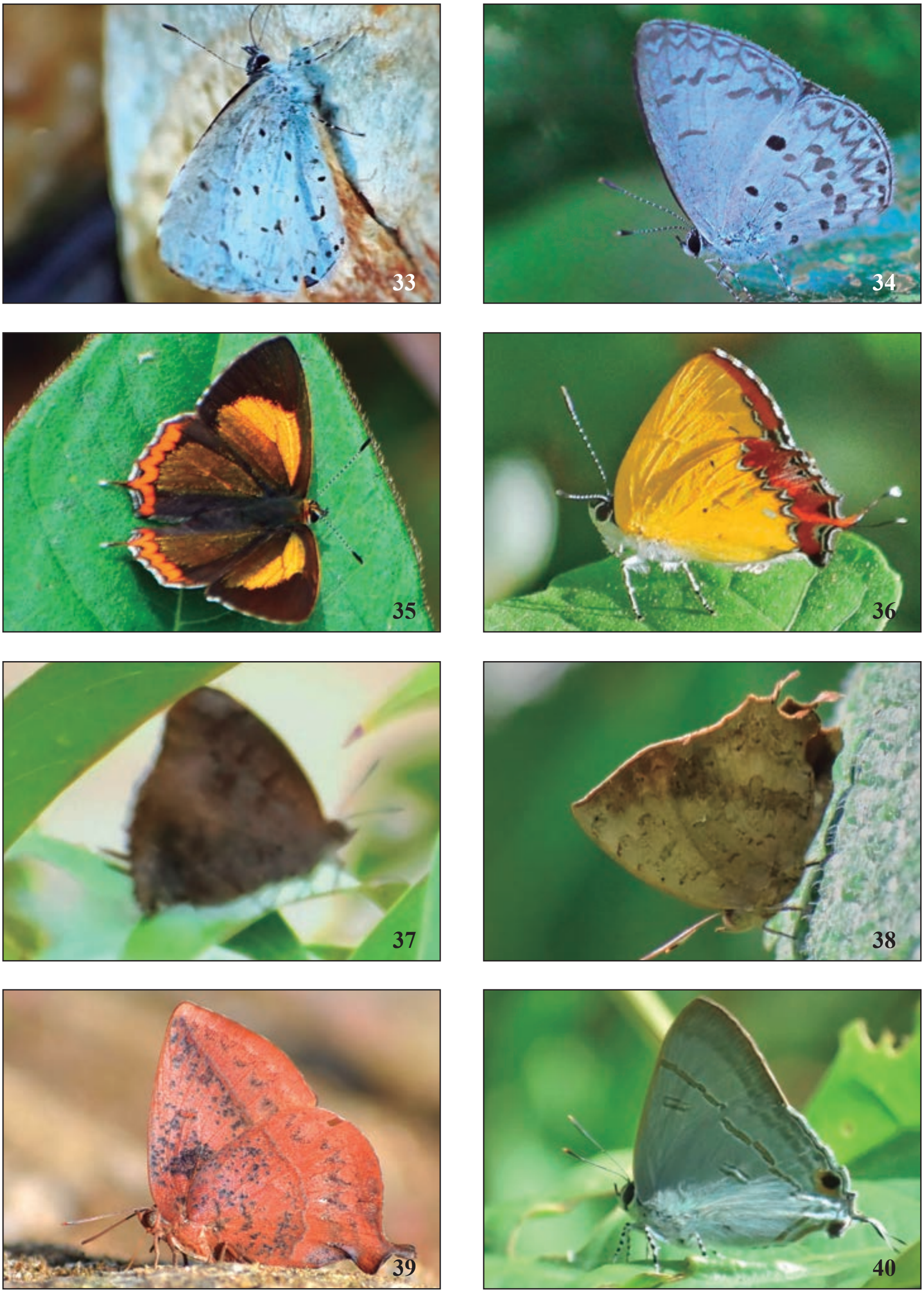

Plate 5. 33. *Udara dilecta*. **34.** *Lestranicus transpectus*. **35.** *Heliophorus brahma*. **36.** *Heliophorus epicles*. **37.** *Arhopala bazalus*. **38.** *Surendra quercetorum*. **39.** *Amblypodia anita*. **40.** *Hypolycaena erylus*.

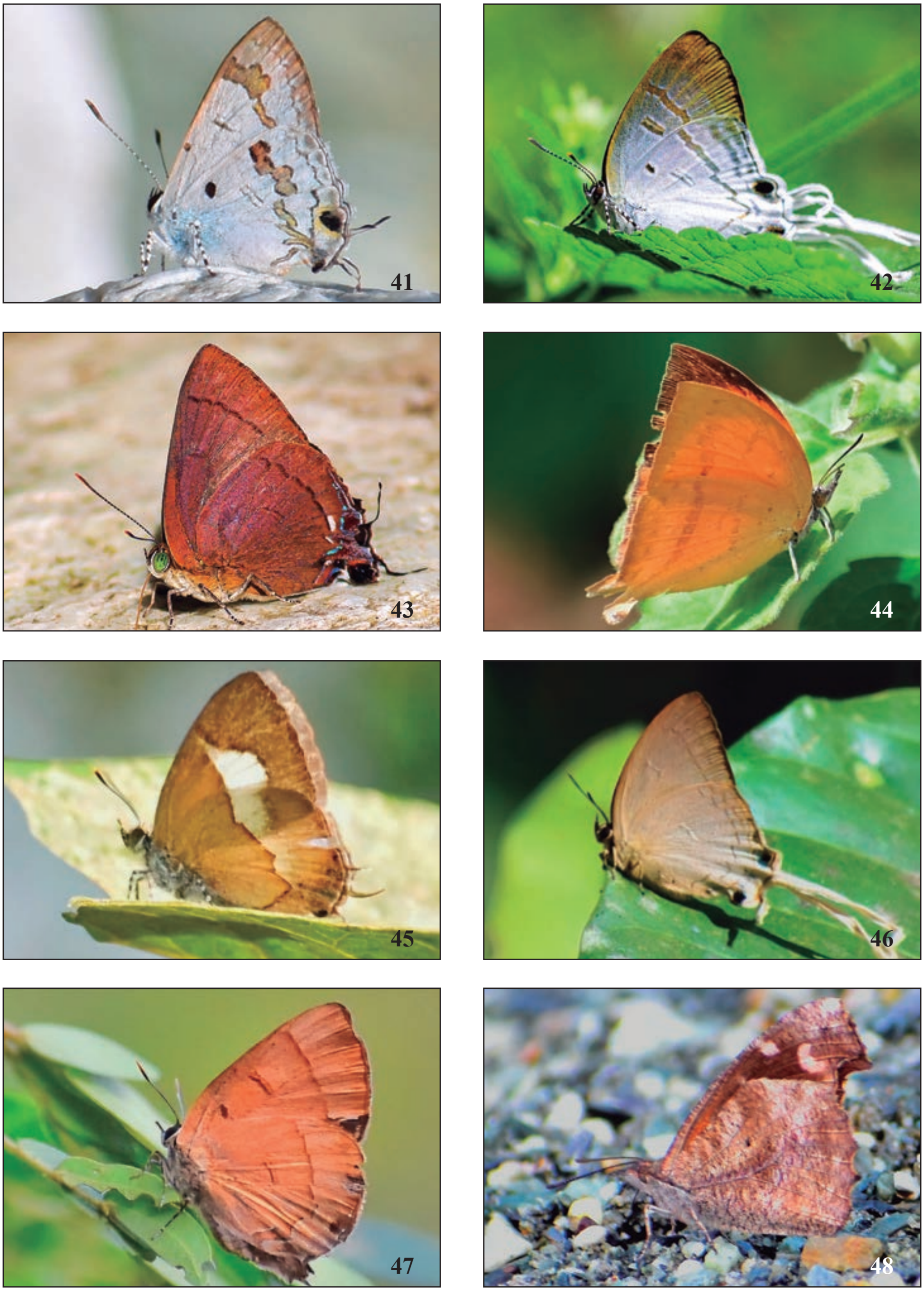

Plate 6. 41. *Chliaria othona.* **42.** *Zeltus amasa.* **43.** *Remelana jangala.* **44.** *Loxura atymnus.* **45.** *Horaga onyx.* **46.** *Cheritra freja.* **47.** *Rapala pheretima.* **48.** *Libythea lepita.*

Plate 7. 49. *Parantica aglea.* **50.** *Parantica melaneus.* **51.** *Tirumala septentrionis.* **52.** *Danaus genutia.* **53.** *Danaus chrysippus.* **54.** *Euploea mulciber.* **55.** *Polyura athamas.* **56.** *Charaxes eudamippus.*

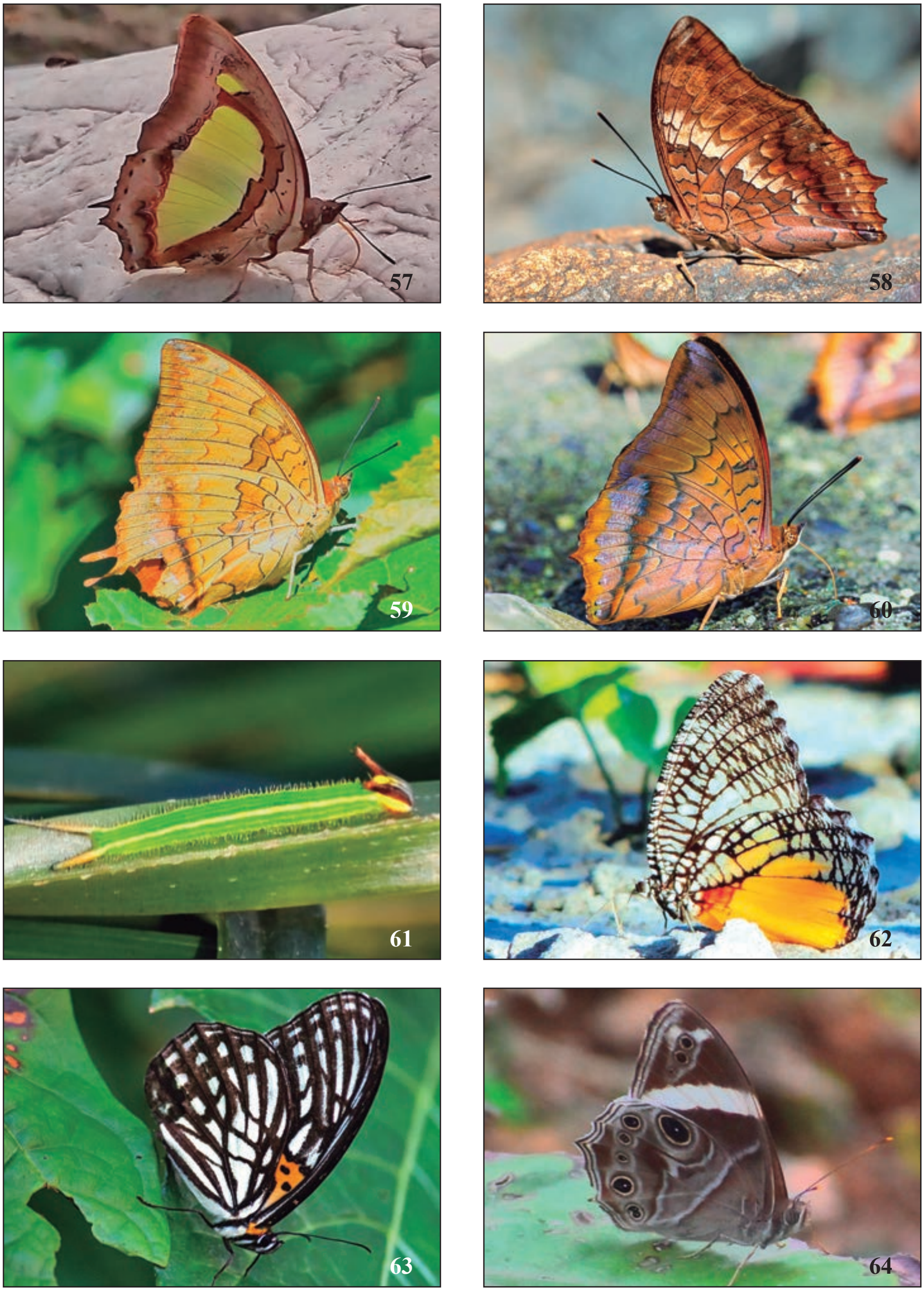

Plate 8. 57. *Charaxes arja*. **58.** *Charaxes bernardus hierax*. **59.** *Charaxes marmax*. **60.** *Charaxes psaphon imna*. **61.** *Elymnias hypermnestra*. **62.** *Elymnias vasudeva*. **63.** *Orinoma damaris*. **64.** *Lethe confusa*.

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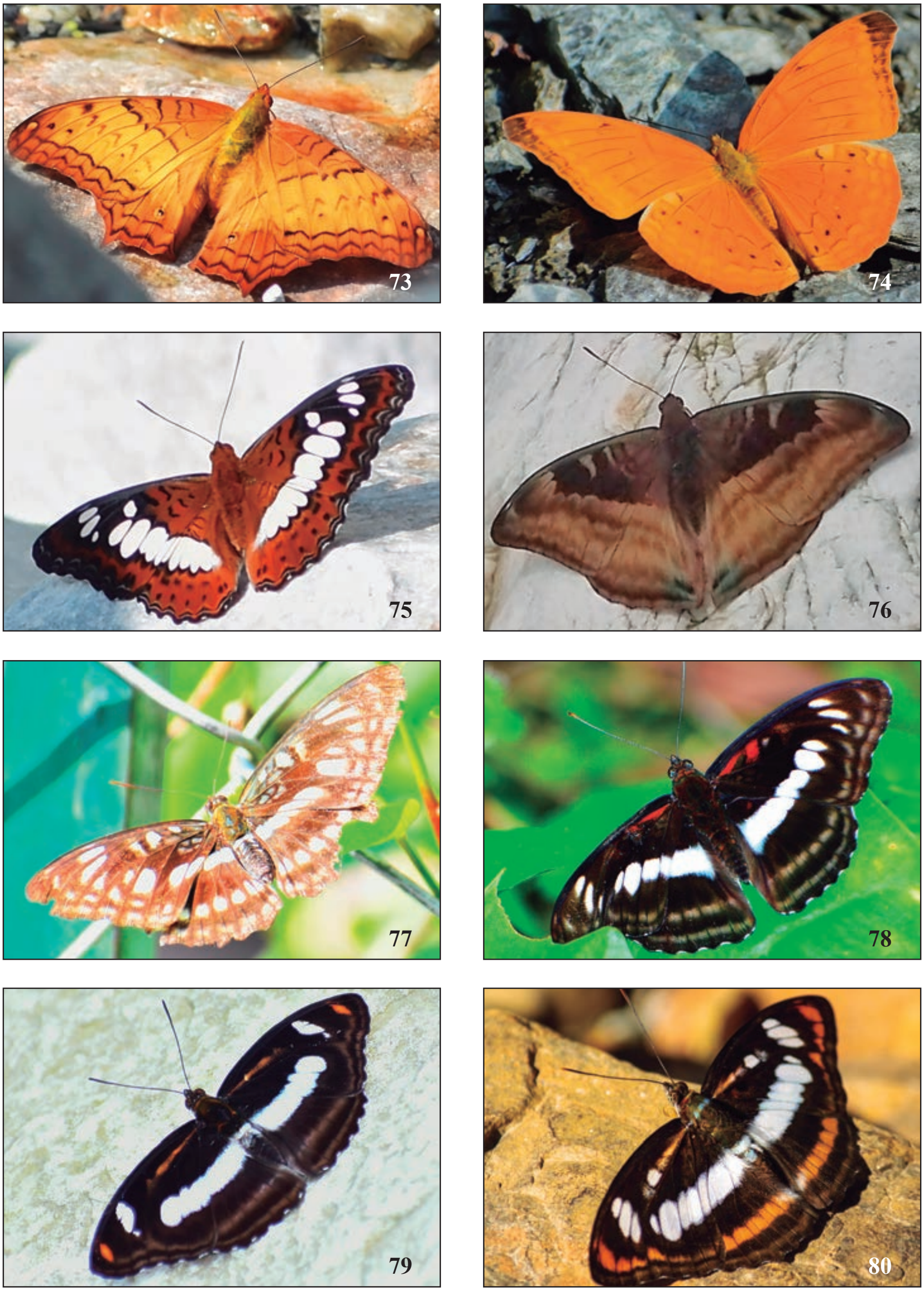

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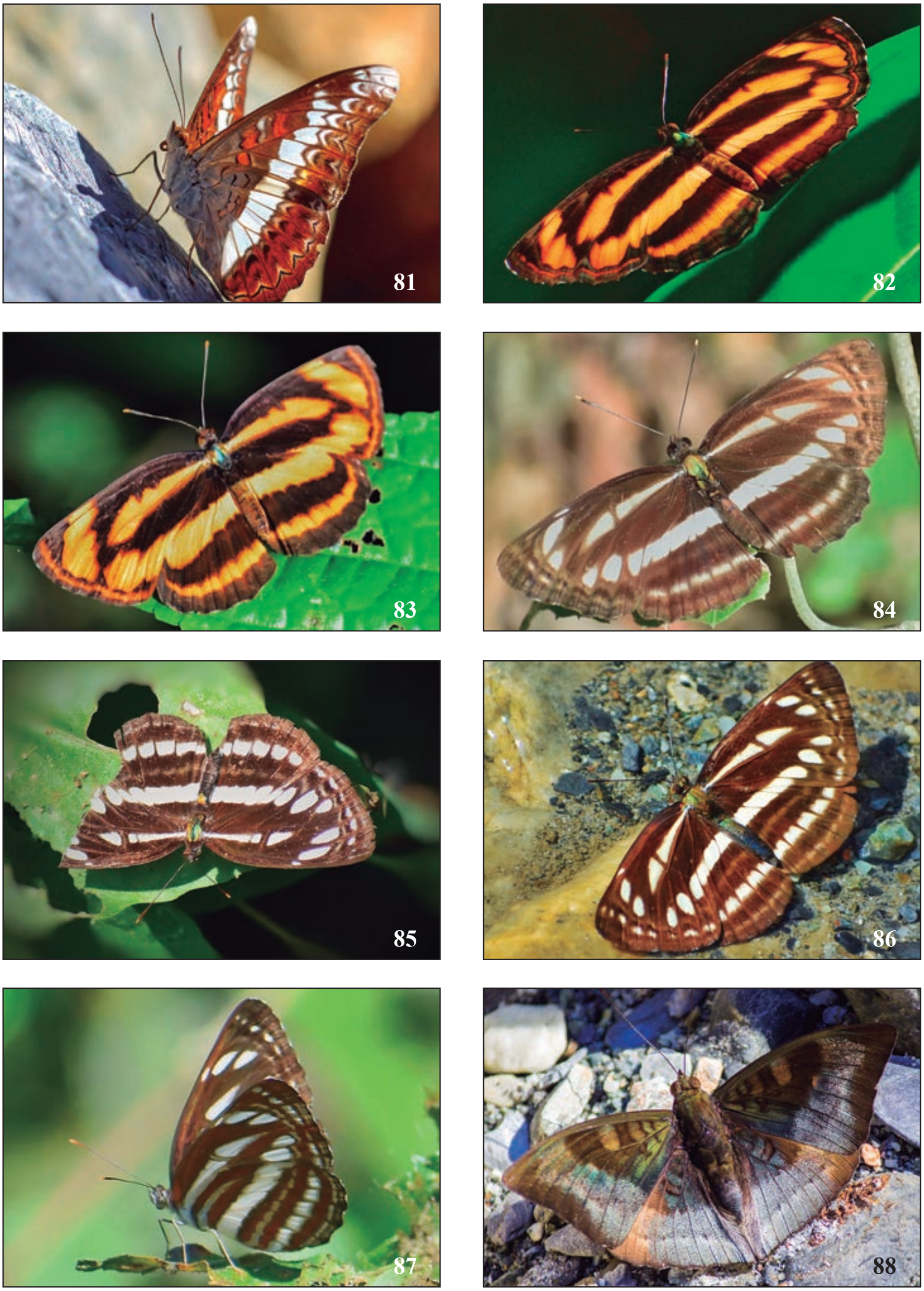

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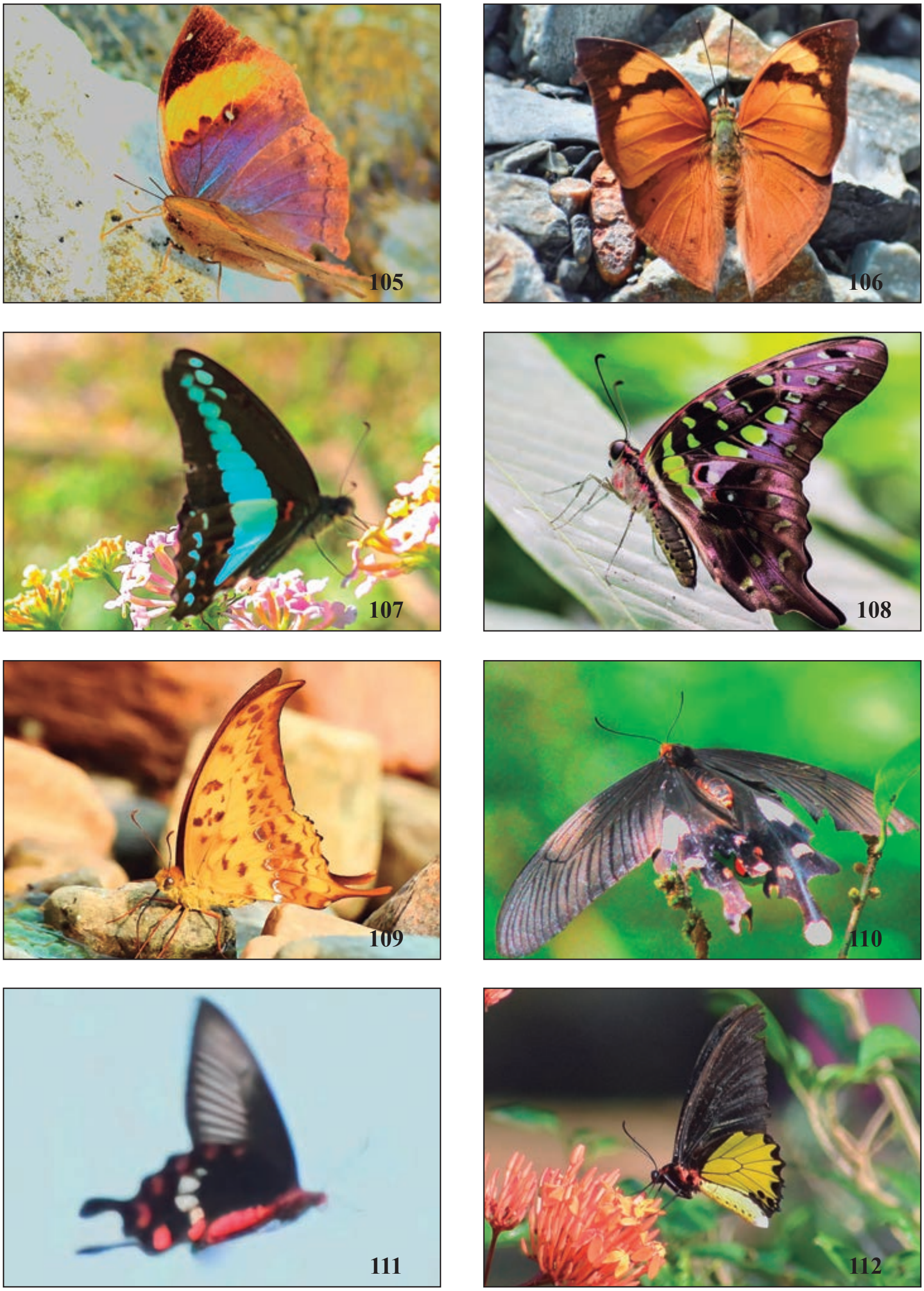

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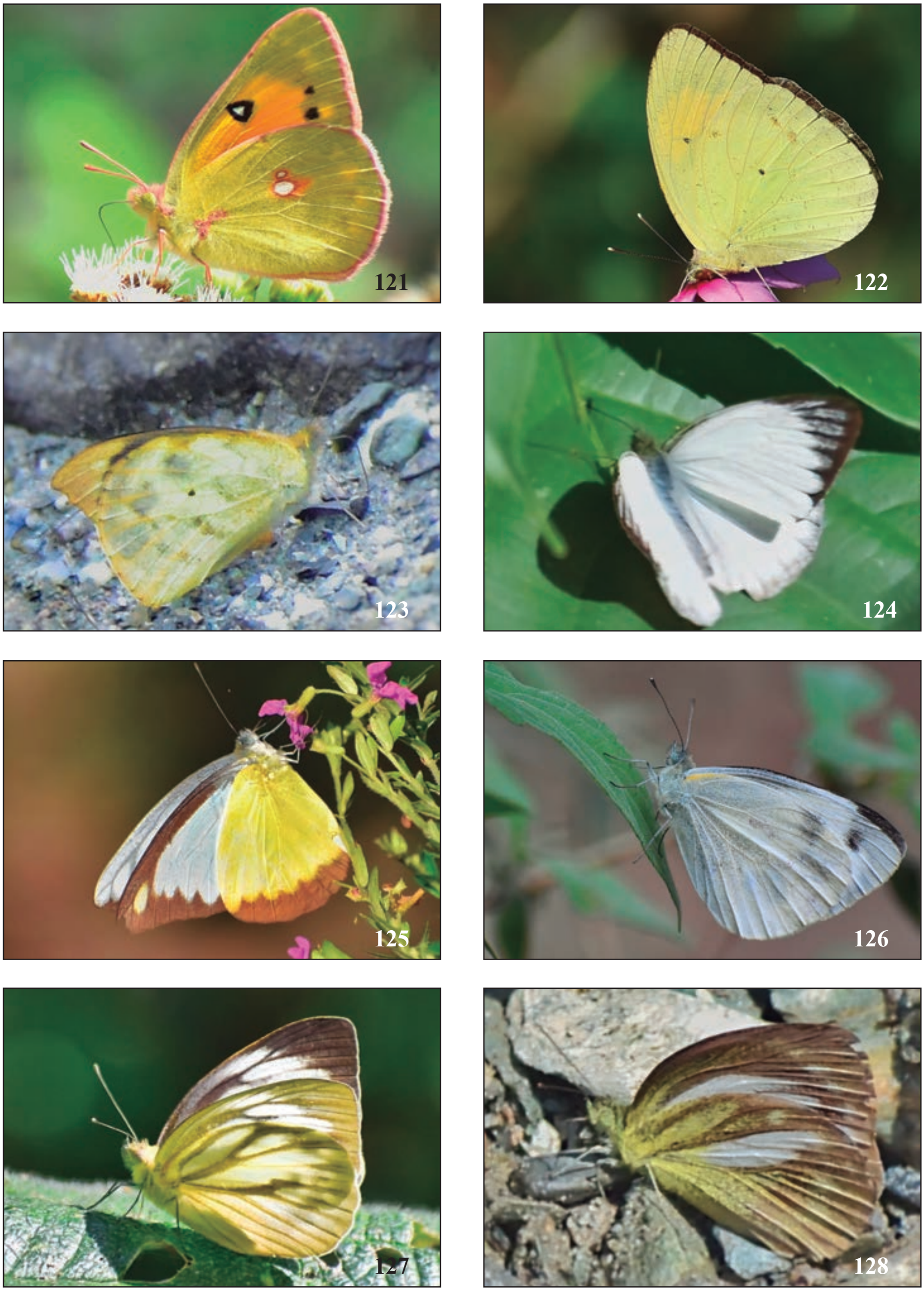

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Photographic Evidence and Confirmatory Record of *Euthalia malaccana* Fruhstorfer, 1899 from India (Lepidoptera: Rhopalocera)

Roshan Upadhaya & Taslima Sheikh

Abstract

Euthalia malaccana Fruhstorfer, 1899, a species previously thought to be dubious in its occurrence in India, is confirmed in Arunachal Pradesh through direct observation and photographic evidence. First described as a subspecies of *Euthalia adonia* (Cramer, [1780]), *Euthalia malaccana* was considered rare, with limited records from Southeast Asia. Previous studies, including Yokochi (1999), raised doubts about its presence in India, citing misidentifications. Our findings provide concrete evidence of this species' distribution in India, marking a significant extension of its range in the region.
Keywords: Lepidoptera, Rhopalocera, *Euthalia*, *Euthalia malaccana*, Arunachal Pradesh, new record, distribution, taxonomy, India.

Evidencia fotográfica y registro confirmado de *Euthalia malaccana* Fruhstorfer, 1899 en la India (Lepidoptera: Rhopalocera)

Resumen

Euthalia malaccana Fruhstorfer, 1899, una especie cuya presencia en la India se consideraba dudosa, se ha confirmado en Arunachal Pradesh mediante observación directa y pruebas fotográficas. Descrita por primera vez como una subespecie de *Euthalia adonia* (Cramer, [1780]), *Euthalia malaccana* se consideraba rara, con registros limitados en el sudeste asiático. Estudios anteriores, como el de Yokochi (1999), planteaban dudas sobre su presencia en la India, citando identificaciones erróneas. Nuestros hallazgos proporcionan pruebas concretas de la distribución de esta especie en la India, lo que supone una ampliación significativa de su área de distribución en la región.
Palabras clave: Lepidoptera, Rhopalocera, *Euthalia*, *Euthalia malaccana*, Arunachal Pradesh, nuevo registro, distribución, taxonomía, India.

Introduction

Euthalia malaccana Fruhstorfer, 1899, originally described as *Euthalia adonia malaccana* Fruhstorfer, 1899, has long been a subject of taxonomic debate. This species was initially identified as a subspecies of *Euthalia adonia* (Cramer, [1780]), and later as an independent species by Eliot (1992). *Euthalia malaccana* is found primarily in Southeast Asia, with records from North Thailand, the Malay Peninsula, and the Sunda Islands. However, its presence in India remained questionable, with earlier reports, including that of Yokochi (1999), casting doubt on its occurrence in the Indian subcontinent.

The present study documents the confirmed occurrence of *Euthalia malaccana* in Arunachal Pradesh, India. Photographs and detailed field observations confirm its presence, thus extending its known range in the Indo-Australian region. This paper aims to provide definitive evidence for its occurrence in India, clarifying previous misidentifications, and contributing to the understanding of the Papilionoidea's distribution.

Previous Studies

The presence of *Euthalia malaccana* in India has been debated in literature, with earlier records mentioning its potential occurrence in regions such as Assam and Meghalaya. Yokochi (1999) referenced this species in his revision of the *lubentina* group, suggesting that *Euthalia malaccana* could be found in Arunachal Pradesh, though this was considered doubtful due to the lack of confirmed records. The species was also frequently misidentified as *Euthalia lubentina* (Cramer, [1777]) or *Euthalia adonia*, leading to confusion in its reported distribution. Paul van Gasse (2018) acknowledged the dubious nature of the Indian records but indicated the possibility of *Euthalia malaccana* occurring in the region. Our study provides conclusive evidence of its presence in India, specifically in Arunachal Pradesh.

Materials and Methods

Study area

One of the primary sites for the survey was Lai Ho, located along the Basar-Sago Road in Arunachal Pradesh (Latitude: 28.001601, Longitude: 94.733412) (Figure 5). The survey was conducted on 30-VII-2023, at an altitude of 685 meters, within a forest community habitat (Figure 1). In addition, further fieldwork in 2024 included a GPS-captured image (Figure 4) on 14-IX-2024, further confirming the presence of the species in this area.

Methods

Fieldwork was carried out across multiple sites, with local guides assisting in navigating remote areas. The species was identified based on distinctive wing patterns, including the blue apical spot on the forewings and reduced red spots on the hindwings. A Nikon Z50 DSLR camera with a 50-250 mm lens was employed to capture high-quality photographs of the specimens, both in flight and at rest. No specimens were collected or harmed during the survey.

Photographic evidence and external morphological characteristics were cross-referenced with descriptions in the literature, including Fruhstorfer (1899) and Eliot (1992).

Results

Euthalia malaccana was observed and photographed at multiple sites in Arunachal Pradesh, including Lai Ho. In total, five individuals of this species were documented between 2023 and 2024. The first observation occurred on 30-VII-2023, and a subsequent GPS-captured image was taken on 14-IX-2024. External morphological characteristics were consistent with the original description by Fruhstorfer (1899), providing definitive evidence of its occurrence in India for the first time.

Systematic Position

Class Insecta Linnaeus, 1758
Order Lepidoptera Linnaeus, 1758
Family Nymphalidae Rafinesque, 1815
Subfamily Limenitidinae Behr, 1864

Euthalia malaccana Fruhstorfer, 1899 (Figures 2-3)
Euthalia adonia malaccana Fruhstorfer, 1899. *Berl. ent. Z., 44*(1/2), 142
TL: Malacca

Identification Features: The species is characterized by a blue apical spot on the forewings, which is prominent in males, while females display larger apical spots. The hindwings are adorned with reduced red spots. These features distinguish it from closely related species such as *Euthalia lubentina*.

Material Examined: India. Arunachal Pradesh: Lai ho, Basar-Sago Road, 28.001601, 94.733412, 1250 m, 30-VII-2023 and 14-IX-2024, observed and photographed by Roshan Upadhaya.

Distribution: India (Arunachal Pardesh: current study), Thailand, Laos, Cambodia, Vietnam, W. Malaysia.

Taxonomic Notes: *Euthalia malaccana* has been previously recognized as a subspecies of *Euthalia adonia*. However, it is now considered a distinct species (Eliot, 1992).

Synonymy and Type Materials Information

Euthalia malaccana regulus Tsukada, 1991. *Butt. Sth. East Asian Islands, 5*, 406, 549, pl. 233, figs 9 (HT, ♂, 10 (PT, ♂ Un), 11 (PT, ♀ Un), 12 (PT, ♀)

Type Locality: “Chieng Dao” [Chiang Dao, Chiang Mai], N. Thailand

Type Materials Information

malaccana
Lectotype: ♂, Malakka
Designated by: Yokochi, 1999
Repository: NHML

regulus
Holotype: ♂, Feb. 1987, “Chieng Dao” [Chiang Dao, Chiang Mai], N. Thailand
Paratypes: All from N. Thailand
4 ♂, 5 ♀: “Chieng Dao” [Chiang Dao]
2 ♀: “Chieng Rai” [Chiang Rai]
1 ♀: “Vien Pa Pao” [Wiang Pa Pao]
3 ♂: Doi Suthep, “Chiang Mai” [Chiang Mai]

Original Description

Euthalia adonia malaccana Fruhstofer, 1899
Reference: *Berl. Ent. Z., 44*(1/2), 142
Type Locality: Malacca, [W. Malaysia]
Repository: NHML

Discussion

The confirmation of *Euthalia malaccana* in Arunachal Pradesh provides significant new data on the Papilionoidea’s distribution in India. Previous literature, including Yokochi (1999) and Paul van Gasse (2018), raised the possibility of this species occurring in the region, but lacked photographic evidence. Our findings clarify the species’ presence and extend its known range in the Indian subcontinent.

The misidentification of *Euthalia malaccana* as *Euthalia lubentina* or *Euthalia adonia* may have contributed to the uncertainty surrounding its distribution. Our photographic evidence, along with detailed field observations, offers a clearer understanding of this species’ morphology and ecology.

Conclusion

This study confirms the presence of *Euthalia malaccana* in Arunachal Pradesh, India, marking the first definitive record of the species in the region. This discovery not only clarifies previous doubts about its distribution but also contributes to the broader understanding of Papilionoidea biodiversity in northeastern India. Future surveys in other parts of India and Southeast Asia may uncover additional populations, further enhancing our knowledge of this species.

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Conflict of interests

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

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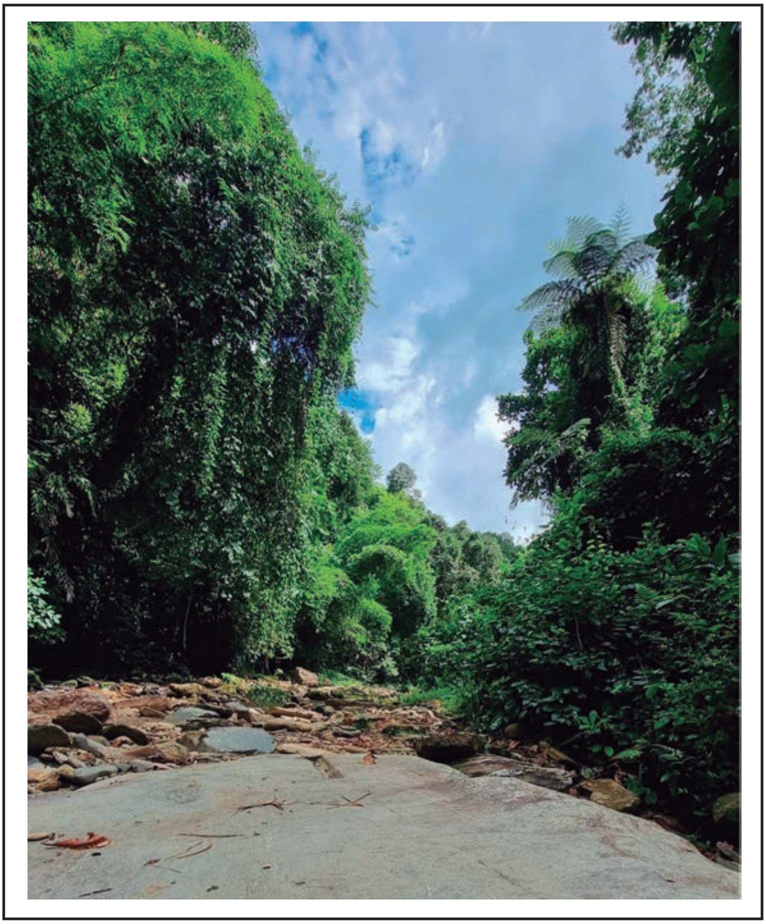
Figure 1. Habitat type.



Figures 2-3. 2. *Euthalia malaccana* Fruhstorfer, open wing male. **3.** Close wing male.

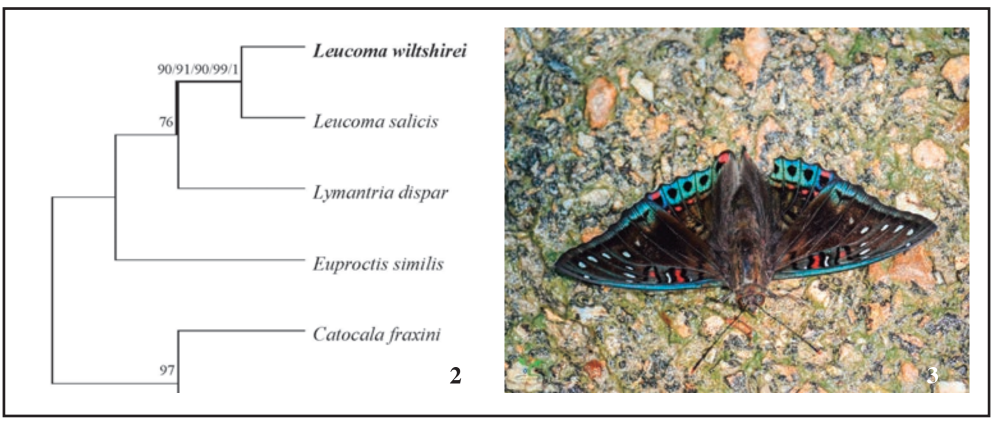
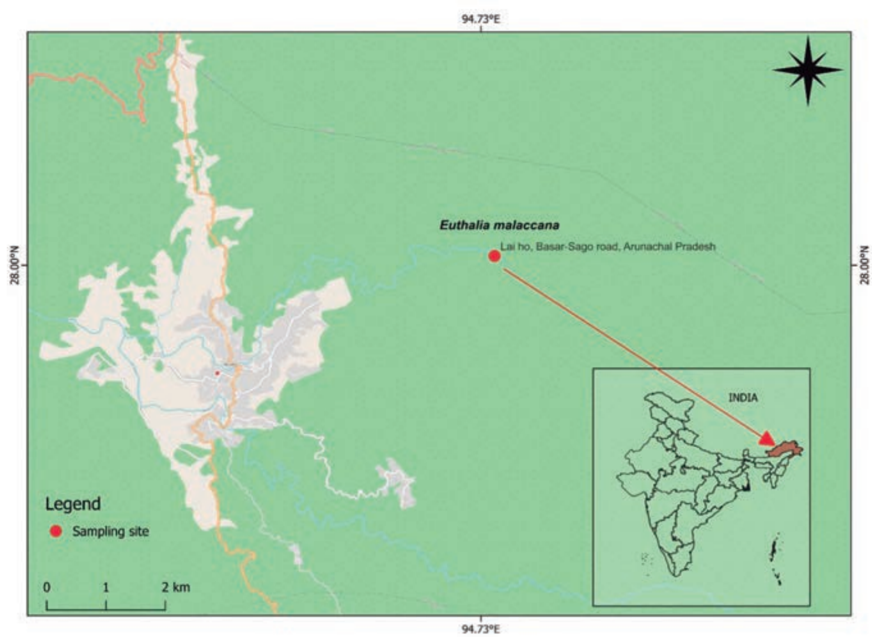


Figure 4. GPS image of *Euthalia malaccana* Fruhstorfer.

Figure 5. Map showing the sighting of *Euthalia malaccana* Fruhstorfer.



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Daphnis nerii (Linnaeus, 1758) en Galicia (España): primeras citas confirmadas en 150 años (Lepidoptera: Sphingidae)

Martiño Cabana, Rafael Vázquez-Graña &
Susana Fraga-Sanjurjo

Resumen

Se aportan las primeras observaciones confirmadas de *Daphnis nerii* (Linnaeus, 1758) en Galicia (España) después de casi 150 años sin haberse observado la especie y se pone de relevancia la importancia de las plataformas de ciencia ciudadana para detectar especies escasas.
Palabras clave: Lepidoptera, Sphingidae, ciencia ciudadana, distribución, migración, España.

Daphnis nerii (**Linnaeus, 1758) in Galicia (Spain): first confirmed records in 150 years (Lepidoptera: Sphingidae)**

Abstract

We report the first confirmed observations of *Daphnis nerii* (Linnaeus, 1758) in Galicia (Spain) after almost 150 years without having observed the species and highlight the importance of citizen science platforms to detect rare species.
Keywords: Lepidoptera, Sphingidae, citizen science, distribution, migration, Spain.

Introducción

Daphnis nerii (Linnaeus, 1758) es un Sphingidae migrador de origen Paleotropical que en algunas ocasiones alcanza la península ibérica, aunque siempre de manera esporádica, por lo que su presencia es escasa en todo el territorio (Redondo et al. 2010).

A nivel ibérico, la bibliografía y las plataformas de ciencia ciudadana muestran una mayor presencia de la especie en las provincias costeras mediterráneas (Cádiz, Málaga, Murcia, Valencia, Castellón, Barcelona, Gerona e Islas Baleares), siendo también una especie relativamente frecuente en la costa mediterránea francesa, así como en la vertiente occidental de Italia. Sin embargo, la especie ha sido citada ocasionalmente en diversas provincias cántabro-atlánticas como A Coruña, Cantabria, Álava, Vizcaya y Navarra, así como en el interior ibérico como Extremadura (Alday & Gainzarain, 2020; Monasterio-León et al. 2018; Oliver-Ruiz, 2021; Pardo de Santayana Sanz & Pardo de Santayana Trueba, 2019; Truyols-Henares et al. 2019). Sin embargo, no se ha detectado la presencia de la especie en Portugal continental (Corley, 2015).

En Galicia la especie solo ha sido citada en una ocasión en la ciudad de Santiago de Compostela en el año 1875 sin aportar una descripción detallada de la observación y sin haber llegado hasta nuestros tiempos la colección del autor debido a su pérdida (Macho-Velado, 1893; Pino-Pérez et al. 2009). En posteriores publicaciones se ha reproducido esta observación sin aportar información más detallada sobre ella (Gómez-Bustillo & Fernández-Rubio, 1976; Pérez de Gregorio et al. 2001; Pino-Pérez et al. 2009; Viedma & Gómez-Bustillo, 1985).

La observación que detallamos en este artículo sería la segunda registrada en Galicia, después de ser observada en Santiago de Compostela hace casi 150 años, confirmando la cría de la especie en la región.

Las plataformas de ciencia ciudadana son portales web que permiten la recogida directa de observaciones por parte del público general, como iNaturalist, Observation.org o Biodiversidad Virtual. Los datos generados, además de estar disponibles en estas plataformas, pueden consultarse a través de grandes repositorios de biodiversidad como GBIF, que integran información procedente de múltiples fuentes, incluyendo colecciones científicas, literatura especializada y plataformas colaborativas. En los últimos años, el uso cada vez más extendido de estas plataformas ha generado un amplio volumen de datos que resulta de gran utilidad para el estudio de la biodiversidad.

Material y métodos

Uno de los autores (MC) ha creado un proyecto en iNaturalist para la recopilación de las observaciones de Macroheterocera del portal situadas en el territorio gallego (Cabana, 2024); realizando todos los autores revisiones habituales sobre las diferentes observaciones subidas a la plataforma, detectando aquellas de mayor relevancia, principalmente debido a su rareza en territorio gallego y/o ibérico. Esta revisión se completa con la realizada en GBIF con menor regularidad para revisar la posible presencia de especies de interés en otras plataformas como Biodiversidad Virtual, Observation.org o Biodiversidade.eu.

Tras la detección de *Daphnis nerii* en Galicia a través de un registro en iNaturalist, se ha procedido a visitar la zona de la observación mediante la revisión de todo tipo de refugios que pudieran ser utilizados por los adultos, larvas y pupas, centrándonos en tejas, ladrillos y cualquier otro objeto situado en el suelo susceptible de ser utilizado como refugio, así como de los diferentes ejemplares de adelfas, *Nerium oleander* L., existentes.

Resultados

La revisión de la plataforma iNaturalist ha permitido la detección de una oruga de *Daphnis nerii* (identificador 242657253) observada el 18-IX-2024 en Maniños, municipio de Fene, provincia de A Coruña y coordenadas geográficas según el datum WGS84 latitud: 43.459108, longitud: -8.195044 (Figura 1). No se han registrado observaciones adicionales en otras plataformas de ciencia ciudadana integradas en GBIF.

Figura 1. Oruga de *Daphnis nerii* observada en Maniños (Fene, La Coruña).

Posteriormente, el 20-IX-2024 se visitó la zona y se realizó una prospección detallada que permitió la observación de otra oruga de *Daphnis nerii* debajo de unas conchas de vieira utilizadas como decoración del jardín (Figura 2a). No se han encontrado más ejemplares pese a la intensa búsqueda realizada. La oruga fue mantenida en condiciones controladas, emergiendo el 21-X-2024 y siendo liberada luego de haber realizado las correspondientes fotografías (Figura 2b).

Figura 2. Segundo ejemplar de *Daphnis nerii* observado en Maniños (Fene, La Coruña).

Discusión

Daphnis nerii es una especie muy escasa en territorio ibérico, aunque en la costa mediterránea parece presentar una mayor abundancia debido a la existencia de un mayor número de referencias bibliográficas que citan a la especie en esa franja costera (Monasterio-León et al. 2018), así como al mayor número de observaciones presentes en plataformas de ciencia ciudadana como iNaturalist (9 de las 11 observaciones ibéricas de la plataforma).

La especie es muy rara en el occidente ibérico, donde apenas existen registros confirmados. En Galicia, no se había documentado su presencia desde el siglo XIX. La observación que aquí se presenta constituye la primera evidencia reciente de la especie en la región y, además, confirma su cría en territorio gallego, lo que aporta un dato de gran relevancia para el conocimiento de su distribución actual en la península ibérica.

La primera observación gallega actual de la especie pone en relevancia la importancia de las plataformas de ciencia ciudadana para la detección de especies raras o escasas, pero de fácil identificación a través de fotografías o grabaciones acústicas (van der Heyden, 2022), para la realización de estudios ecológicos que necesitan de un volumen de información elevada (Fritz & Ihlow, 2022) o como inicio para la descripción de nuevas especies para la ciencia (Franzini et al. 2024). Sin embargo, para taxones de difícil identificación fotográfica o acústica debido a su similitud con otras especies, o por la necesidad de complementar la información aportada con otras fuentes -como resultados de reacciones químicas en los ejemplares o mediciones de alguna de sus partes (McMullin & Allen, 2022)-, la información contenida en estas plataformas debe analizarse con precaución. Siempre que sea posible, es recomendable realizar muestreos que permitan confirmar la información existente, tal y como hemos hecho en la presente publicación. En este sentido, consideramos que la ciencia ciudadana debe entenderse como una herramienta complementaria que, si bien aporta un valor significativo a la investigación en biodiversidad, no puede sustituir el trabajo de campo ni la verificación sistemática realizada por especialistas.

Agradecimientos

A Daniela Otero subir su observación de *Daphnis nerii* a la plataforma iNaturalist y permitirnos realizar los muestreos en su jardín.

Conflicto de interés

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A new species of the genus *Ceratoxanthis* Razowski, 1960 from the East Caucasus (Lepidoptera: Tortricidae)

Eugene V. Tsvetkov

Abstract

A new species, *Ceratoxanthis intermedia* Tsvetkov, sp. nov., is described from Dagestan (East Caucasus), based on a series of males. *C. intermedia* has no visible external differences from *C. externana* (Eversmann, 1844) and *C. rakosyella* Wieser & Huemer, 2000 and can be separated from these two species by details in the male genitalia structure. Illustrations of the male genitalia of the new species are provided as well as of four compared species: *C. externana, C. rakosyella, C. saratovica* Trematerra, 2010 and *C. giansalottii* Bassi, 2014.
Keywords: Lepidoptera, Tortricidae, *Ceratoxanthis*, new species, East Caucasus, Dagestan.

Una nueva especie del género *Ceratoxanthis* Razowski, 1960, del Cáucaso Oriental (Lepidoptera: Tortricidae)

Resumen

Se describe una nueva especie, *Ceratoxanthis intermedia* Tsvetkov, sp. nov., procedente de Daguestán (Cáucaso Oriental), basada en una serie de machos. *C. intermedia* no presenta diferencias externas visibles con respecto a *C. externana* (Eversmann, 1844) y *C. rakosyella* Wieser & Huemer, 2000 y puede distinguirse de estas dos especies por detalles en la estructura de la genitalia del macho. Se proporcionan ilustraciones de la genitalia del macho de la nueva especie, así como de las cuatro especies comparadas: *C. externana, C. rakosyella, C. saratovica* Trematerra, 2010 y *C. giansalottii* Bassi, 2014.
Palabras clave: Lepidoptera, Tortricidae, *Ceratoxanthis*, nueva especie, Cáucaso Oriental, Daguestán.

Introduction

The genus *Ceratoxanthis* Razowski, 1960 includes seven species inhabiting the southern regions of the western part of the Palaearctic (Razowski, 2009; Trematerra, 2010; Bassi, 2014). The biology of the species of the genus has been unstudied: their preimaginal stages and host plants are unknown. Many species are known only by males, and only three species, *C. externana* (Eversmann, 1844), *C. argentomixtana* (Staudinger, 1871) and *C. giansalottii* Bassi, 2014, have females described (Bidzilya & Budashkin, 2005; Razowski, 2009; Bassi, 2014). Biotopes of *Ceratoxanthis* spp. are open grassy areas (Razowski, 2009).

Representatives of the genus have a bright yellow forewing, often with a characteristic brown pattern of an oblique line and a pair of small spots on the opposite sides of the line (Figures 1, 7). Similar colouration of the forewing is found in the genera *Agapeta* Hübner, [1825] and *Fulvoclysia* Obraztsov, 1943: diagnosis of the genus and species usually requires examination of the genitalia. To distinguish species based on the male genitalia, differences in the structure of the socii, the juxta, and, especially, the basal process of the sacculus are usually used. A key to the five species of the genus (Elsner & Jaroš, 2003) indicates interspecific differences in the length of the sacculus process relative to the length of the aedeagus, as well as differences in the details of the structure of this process.

The material for this article was collected by the author during expeditions to the Republic of Dagestan in spring and summer of 2022, 2023 and 2024. A new species of the genus *Ceratoxanthis* was discovered in two localities quite distant from each other. One locality is in the vicinity of the village Talgi and another is near Gubden. Almost all specimens were collected by a net in the evening time, with the exception of two specimens that were attracted by light near the village of Gubden.

The genitalia of three paratypes of the new species were dissected (including the specimen collected nearby of Talgi). After studying and photographing the structures, the preparations were preserved in syrup.

The photographs of genitalia structures were also obtained based on additional material on the genus *Ceratoxanthis* preserved in the author's collection (*C. externana* from Orenburg Province, *Ceratoxanthis saratovica* Trematerra, 2010 from Volgograd Province).

The descriptive terminology of genitalia structures generally follows Kuznetsov (1978). All type material of *Ceratoxanthis intermedia* is deposited in the collection of Zoological Institute of Russian Academy of Sciences, St Petersburg (ZIN).

***Ceratoxanthis intermedia* Tsvetkov, sp. nov.** (Figures 1-3)
https://zoobank.org/7B8AD618-BB5F-41E3-97E0-DAC670AE3C7E

Type material: Holotype ♂, Russia, Dagestan, 4 km SE vill[age]. Gubden, 560 m, 31-V-2024, leg. E. Tsvetkov. Paratypes 6 ♂: the same labels as for holotype, but 3 ♂, 12-VI-2023 and 2 ♂, 31-V-2024; Russia, Dagestan, 3 km W vill. Talgi, 600 m, 1 ♂, 15-VI-2022, leg. E. Tsvetkov. Type material is deposited in the collection of Zoological Institute of Russian Academy of Sciences, St Petersburg (ZIN).

Imago: Frons and vertex yellow, antennae covered with whitish scales. Labial palps yellow on the inside and above, golden brown on the outside, directed forward, slightly less than two eye diameters in length. Antennae not much more than half the length of forewing. Cilia white and short (nearly the diameter of flagellomere). Legs brown (hind legs noticeably lighter), tarsus bicoloured: brown with small yellowish spots at the ends of segments dorsally and lighter coloured (pale yellow) ventrally.

Wings (Figure 1): Forewing 8-9 mm, subtriangular with slightly convex costal margin and posterior margin convex in basal half; costal fold not expressed. Forewing lemon yellow with fine punctures (more noticeable in the apical half) formed by specks of shiny light-yellow scales. Brown pattern has a rufous tint and consists of an oblique narrow band and a pair of small spots, basal and subapical, separated by the band. Sometimes there is a noticeable widening of the band at the inner margin of the wing and narrowing in the middle part; outer edge of the band always with small protrusion at M_1 base. Basal spot and band along some extent (from its middle to inner margin of the wing) covered with darker, purplish-brown scales. Costal reddish-brown streaks are sometimes visible in the apical part (1-2 small streaks) and in the basal part (usually one streak or variable pattern along costa). Fringe dark grey. Forewing brown on the underside, usually with 1-2 yellow spots at costal margin. Hindwing brownish, sometimes pale brown; fringe brownish with dark brown basal line along the edge of the wing. Underside pale brown, often whitish with traces of reticulated brown pattern.

Male genitalia (Figures 2-3): Socii relatively wide, triangular, ventral edge acute-angled. Ventrocaudal edge of valva rounded, cucullus of valva quite variable. Base of cucullus bears a well sclerotized short process covered with spiny setae. Process of sacculus is from 2/3 to 3/4 of valva, arcuate (almost evenly curved along its entire length), slightly thickened apically, directed dorsocaudally and reaches the edge of valva; apical part bears a cluster of microspines (acanthae) in the form of longitudinal stripe, which continues as a thinner stripe along the process towards its middle. Aedeagus small, approximately 1.5 times as short as process of sacculus; distal half thin, cylindrical, proximal part thickened; vesica armed with very small needle-shaped cornutus. Lateral processes of juxta relatively short, flat triangular and sharply pointed dorsally.

Diagnosis: The new species resembles *C. saratovica* Trematerra, 2010 in the structure of the genitalia, but differs well from the latter in the colouration of the forewing. In *C. intermedia*, the oblique brown band is solid, a pair of small brown spots on the sides of the band is present. The brown pattern of the forewing is greatly reduced in the compared species: the oblique band is absent or (more often) only a thin trace is noticeable as 1-2 brown specks. In male genitalia of *C. saratovica*, the process of the sacculus with the apical part bent downward (Figures 5-6). Males of *C. intermedia* are with evenly curved sacculus process that does not have an apical bend.

C. argentomixtana (Staudinger, 1871) has the same differences from *C. intermedia* in wing colouration and male genitalia as *C. saratovica*.

Species of the genus such as *C. externana* and *C. rakosyella* do not have external differences from the described species *C. intermedia*, and comparison of the genitalia is required for diagnosis.

Males of *C. externana* are with a shorter sacculus process reaching approximately the centre of the valva (Figures 8-9) (the process is about 1/2 of the valva), whereas in *C. intermedia* the process of the sacculus reaches the edge of the valva and it is from 2/3 to 3/4 of the valva.

Males of *C. rakosyella* are distinguished by a much longer process of the sacculus, noticeably protruding beyond the edge of the valva (Figures 11-12). In males of this species, the length of the process is not less than the valva, while in *C. intermedia* the process is from 2/3 to 3/4 of the valva.

The sacculus process is significantly shorter in *Ceratoxanthis giansalottii* Bassi, 2014 than in the new species (almost half as long as the valva), also apical part of the process is different (Figure 10).

Males of *C. iberica* Baixeras, 1992 have a more strongly curved process of the sacculus; in addition, in males of this species, ventral edge of the socii is rounded. In *C. intermedia*, ventral edge of the socii is acute-angled.

Biology: In two discovered populations of *C. intermedia*, the species occurs at altitudes of 500-600 meters above sea level. These habitats are bushy dry gaps with the participation of *Cotinus coggygria* Scop., *Spiraea crenata* L., *Pyrus salicifolia* Pall. Adults are active in the evening and at night. In the vicinity of the village Gubden, they were found in the lower reaches of the gap among shrub vegetation, as well as in small isolated areas of herbaceous vegetation.

Etymology: The species name is a Latin adjective, meaning “intermediate”: the sacculus process in male genitalia is of medium length compared to closely related species of the genus.

Remarks: For the Caucasus, there were not any reports on the occurrence of *Ceratoxanthis* spp., with the exception of *C. externana*. According to the authors, the range of the latter species includes the Southern Urals, the Caucasus, Transcaucasia, Türkiye, Kazakhstan and Turkmenistan (Kuznetsov, 1978; Razowski, 2009). However, it is worth noting that the occurrence of *C. externana* in the Caucasus is doubtful due to previously possible mixing this species with *C. intermedia*. There is no doubt about the presence of *C. externana* in the type locality of this species (Southern Urals), as well as in Middle and Lower Volga. So, *C. intermedia* is the only reliably known *Ceratoxanthis* species in the Caucasus region.

Conflict of Interest

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

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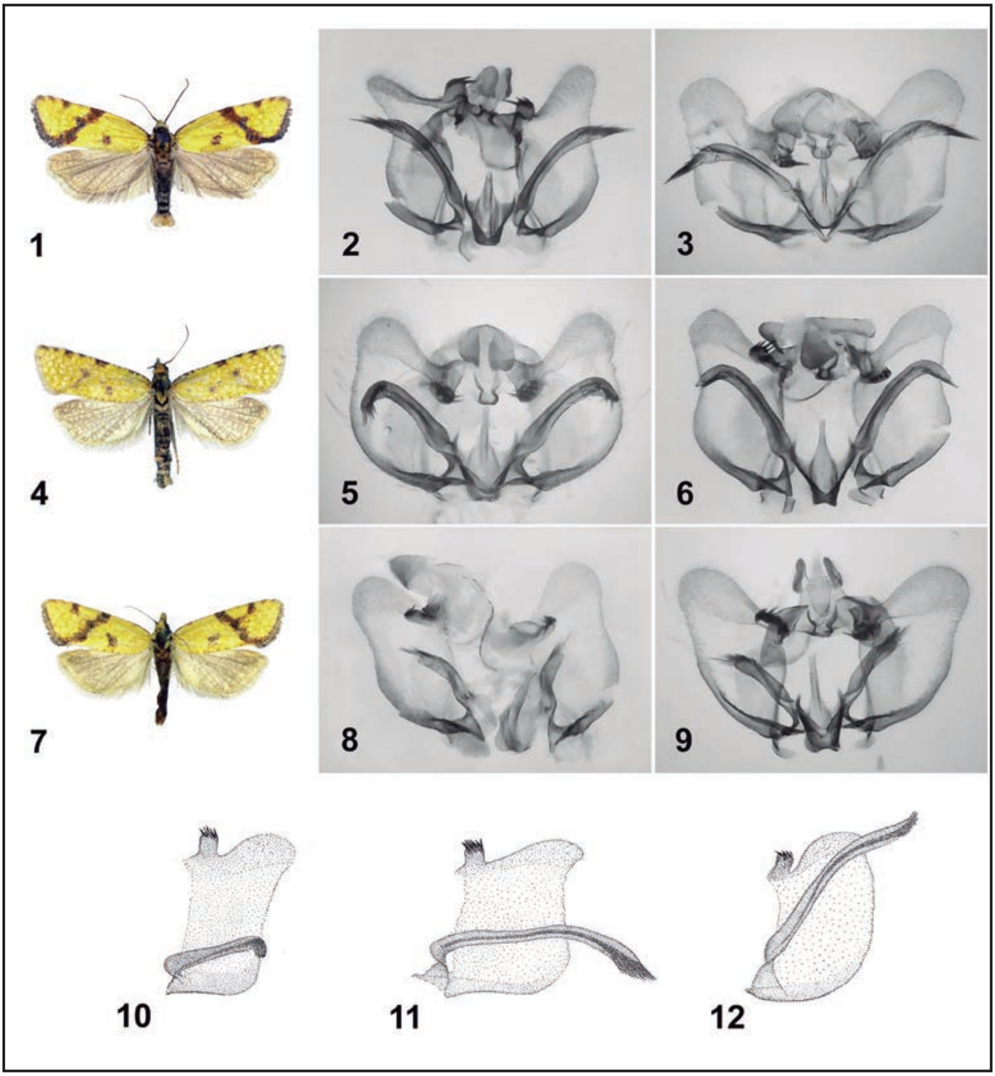
Figures 1-12. Imago and genitalia of *Ceratoxanthis* spp. **1.** *C. intermedia* Tsvetkov, sp. nov., holotype. **2-3.** Idem, male genitalia (paratypes). **4.** *C. saratovica*, male, Volgograd Prov., Lake Bulukhta, 25-V-2017. **5-6.** Idem, male genitalia. **7.** *C. externana,* male*,* Orenburg Prov., riv. Kinderlya, 26-VI-2011. **8-9.** Idem, male genitalia. **10.** Male genitalia of *C. giansalottii* after Bassi (2014). **11-12.** Male genitalia of *C. rakosyella.* **11.** after Zlatkov & Sivilov (2023). **12.** after Wieser & Huemer (1999).



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