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IN MEMORIAM
Profesor Doctor Tosio Kumata
(1932-2019)

Antonio Vives Moreno

El día 12 de agosto de 2019, a la edad de 87 años, murió nuestro Socio de Honor el Profesor Doctor Tosio Kumata, que lo fue de nuestra Sociedad.

Nació el 3 de julio de 1932 en la ciudad de Abasiri ubicada en la subprefectura de Ojotsk en Hokkaido, Japón. Casado con Masako Kumata, teniendo cuatro hijos Asami, Takasi, Tuyosi y Atusi.

Finalizó sus estudios preuniversitarios en 1951, pasando a continuación a la Universidad de Hokkaido, donde se especializó en Entomología en la Facultad de Agricultura y finalizando en 1955; realizó el Postgrado entre 1955 y 1957; doctorándose en 1962 con la Tesis *“Taxonomic Studies on the Lithocolletinae of Japan (Lepidoptera: Gracillariidae)*”, que posteriormente se publicaría en 1963.

Realizó diversas expediciones científicas fuera de Japón a Nepal (1986), India (1977), Taiwán (1978), Península de Malasia (1986), Borneo (1988), Sarawak (1991) y Filipinas (1993 y 1994).

Comenzó sus trabajos entomológicos realizando estudios sobre la taxonomía de los Lymantriidae japoneses, sobre la morfología de los adultos, enfocándose principalmente en los estudios larvales, pasando posteriormente al estudio de los Gracillariidae, que sería su dedicación científica para el resto de su vida. Colaboró abiertamente con la División de Entomología del CSIRO (Australia), para revisar los Gracillariidae australianos y sus estadios larvales desde 1996 a 1999, durante las diversas expediciones científicas realizadas a este país.

A lo largo de sus 53 trabajos científicos publicados, descubrió 137 especies nuevas. Se dedicó una especie en su honor *Sticholotis kumatai* Miyatake, 1985 (Coleoptera, Cocinellidae) y en el año 2000 se le concedió la **Medalla Karl Jordan**, por la Lepidopterts' Society (EE.UU.) y ese mismo año 2000, fue nombrado **Socio de Honor** por la Sociedad Hispano-Luso-Americana de Lepidopterología (España).

Durante los muchos años que nos conocimos y siempre que necesitamos su ayuda sobre los Gracillaroidea, le tuvimos dispuesto a ofrecer sus muy doctos y sabios consejos. Descanse en paz nuestro apreciado y entrañable amigo y Socio de Honor de SHILAP, el Profesor Doctor Tosio Kumata.

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Checklist of Rhopalocera fauna of District Srinagar in Jammu and Kashmir Union Territory, India (Lepidoptera: Papilionoidea)

Huma Nisar

Abstract

The survey carried out in March - December 2021 has revealed the presence of Forty-seven Rhopalocera species under the families: Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae and Pieridae, belonging to 37 genera and five families from district Srinagar.

Keywords: Lepidoptera, Papilionoidea, Rhopalocera, Srinagar, Dachigam National Park, diversity index, India.

Lista de la fauna de Rhopalocera del distrito de Srinagar en el territorio de la Unión de Jammu y Cachemira, India (Lepidoptera: Papilionoidea)

Resumen

El estudio realizado entre marzo y diciembre de 2021 ha revelado la presencia de cuarenta y siete especies de Rhopalocera de las familias Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae y Pieridae, pertenecientes a 37 géneros y cinco familias del distrito de Srinagar.

Palabras clave: Lepidoptera, Papilionoidea, Rhopalocera, Srinagar, Parque Nacional de Dachigam, índice de diversidad, India.

Introduction

Rhopalocera are members of the order Lepidoptera (which also includes moths) of the class Insecta, which means "scale wings" in Greek, as coined by Linnaeus (1758). They have long been considered as a symbol of enchantment and attractiveness since the dawn of time and are commonly referred to as "insects of the sun" due to their diurnal nature. They were a favorite for hundreds of years for bodily splendor and behavioral display. These polychromatic insects play a key function in nature and reveal outstanding diversity. The coloration of Rhopalocera wing scales is formed by minute overlapped chitin pieces pigmented with melanin, which gives them the names blacks and browns. However, blues, greens, reds, and iridescence are frequently created by the microstructure of the scales rather than pigments. The photonic crystal structure of the scales causes coherent scattering of light, resulting in this structural coloration, Prum et al. (2006), Vukusic et al. (2000).

According to Hoskins (2017), roughly 17,698 Rhopalocera species are found in all zoogeographical areas except Antarctica, including the Holarctic, Neotropical, Afrotropical, Oriental, and Australian regions. Currently, 1439 species have been identified in India, Kunte (2000), India with 308 species from Jammu and Kashmir, Sheikh et al. (2021).

Material and Methods

District Srinagar including Dachigam National Park was surveyed. Data were collected by random survey fortnightly from various fields covering almost the entire area of Srinagar. Thirty-nine specimens were photographed. The Rhopalocera species were identified by the keys given by Evans (1932), Wynter-Blyth (1957) and Kehimkar (2016). The author checked the known distribution of the species in question by consulting three available authoritative books Evans (1932), Wynter-Blyth (1957), Varshney & Smetacek (2015) as well as published papers by Qureshi et al. (2014) and Sheikh et al. (2021) to verify various new records presented in this study for the entire district of Srinagar including Dachigam National Park. The Rhopalocera diversity was studied using Simpson's diversity index. This standard diversity index lists the number of species present at a given location along with their relative abundance. The butterflies were identified with the help of available literature i.e., Evans (1932), Talbot (1947), Wynter-Blyth (1957), Kehimkar (2016) and Smetacek (2018) also cross-checked with current publications of Jammu and Kashmir Himalaya i.e., Parey & Sheikh (2021), Sheikh & Parey (2019a, 2019b) Sheikh et al. (2021), Singh & Sheikh (2021), Gupta & Sheikh (2021), Sheikh (2021), Sheikh & Gupta (2022), Khan & Sheikh (2022), Sheikh & Mishra (2022), Dar et al. (2022a, 2022b), Sheikh & Mishra (2023a, 2023b).

Table 1. Rhopalocera of District Srinagar

S. No.	Scientific Name	Authority and year
	HESPERIIDAE	
1	*Celaenorrhinus leucocera*	(Kollar, 1844)
2	*Carcharodus alceae*	(Esper, 1780)
3	*Parnara guttatus*	(Bremer & Grey, 1852)
4	*Pelopidas mathias*	(Fabricius, 1798)
	LYCAENIDAE	
5	*Aricia agestis*	([Denis & Schiffermüller], 1775)
6	*Calastrina argiolus*	(Linnaeus, 1758)
7	*Everes hugelli*	(Gistel, 1857)
8	*Heliophorus sena*	(Kollar, 1844)
9	*Lampides boeticus*	(Linnaeus, 1767)
10	*Lycaena phlaeas*	(Linnaeus, 1761)
11	*Pseudozizeeria maha*	(Kollar, 1848)
12	*Polymmatus ariana*	Moore, 1865
13	*Tarucus indica*	Evans, 1932
14	*Tarucus venosus*	Moore, 1882
	NYMPHALIDAE	
15	*Aglais caschmirensis*	(Kollar, [1844], in Hügel)
16	*Argynnis childreni*	Gray, 1831
17	*Argynnis hyperbius*	(Linnaeus, 1763)
18	*Argynnis jainadeva*	Moore, 1864
19	*Aulocera saraswati*	(Kollar, [1844], in Hügel)
20	*Callerebia nirmala*	(Moore, 1865)
21	*Danaus chrysippus*	(Linnaeus, 1758)
22	*Hipparchia parisatis*	(Kollar, [1849])
23	*Hypolimnas missippus*	(Linnaeus, 1764)
24	*Hyponephele cheena*	(Moore, 1865)
25	*Issoria lathonia*	(Linnaeus, 1758)
26	*Junonia iphita*	(Cramer, 1779)

27	*Junonia orithya*	(Linnaeus, 1758)
28	*Kaniska canace*	(Linnaeus, 1763)
29	*Lasiommata schakra*	(Kollar, [1844], in Hügel)
30	*Libythea lepita*	(Moore, 1858)
31	*Limenitis ligyes*	Hewitson, 1864
32	*Neptis mahendra*	Moore, 1872
33	*Neptis sappho*	(Pallas, 1771)
34	*Phalanta phalanta*	(Drury, 1773)
35	*Vanessa cardui*	(Linnaeus, 1758)
36	*Vanessa indica*	(Herbst, 1794)
37	*Ypthima nareda*	(Kollar, [1844], in Hügel)
38	*Ypthima nikaea*	Moore, [1875]
	Papilionidae	
39	*Papilio machaon*	(Linnaeus, 1758)
40	*Parnassius charltonius*	Gray, [1853]
	Pieridae	
41	*Catopsilia pomona*	(Fabricius, 1775)
42	*Colias erate*	(Esper, 1805)
43	*Colias fieldii*	Ménétriés, 1855
44	*Pieris ajaka*	Moore, 1865
45	*Pieris brassicae*	(Linnaeus, 1758)
46	*Pieris canidia*	(Sparman, 1768)
47	*Pontia daplidice*	(Linnaeus, 1758)

Results and Discussion

The detailed systematic description and record of forty-seven Rhopalocera species under the families: Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae, and Pieridae families, belonging to 37 genera and five families are presented in the tabulated form below (Table 1). The Simpsons diversity index was used to construct the diversity index for district Srinagar with 47 species, Nymphalidae was the most well-represented family, followed by Lycaenidae (10), Pieridae (7) and Hesperiidae (4). Previous studies on Srinagar district in the form of literature was consulted and a list was compiled to make checklist of 47 species. Among 47 species only 41 species were photographed.

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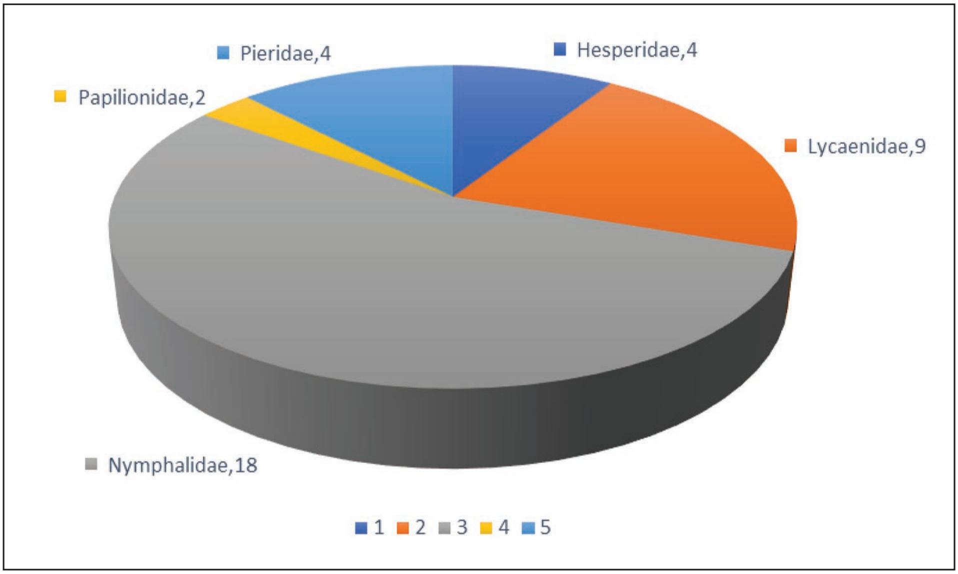

Figure 1. Number of genera distributed in district Srinagar, (J&K) under each family during study (2021).

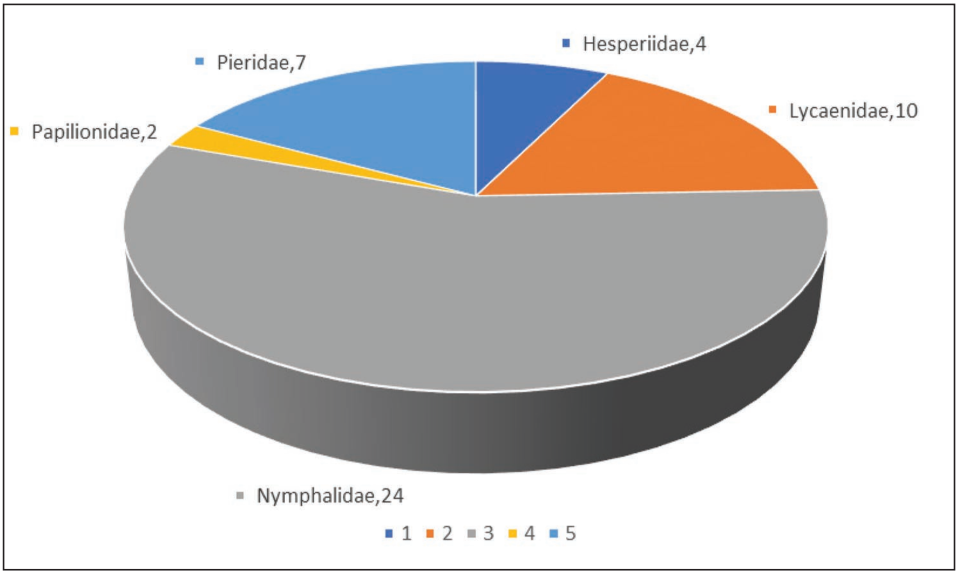

Figure 2. Number of species distributed in district Srinagar (J&K) under each family during study (2021).


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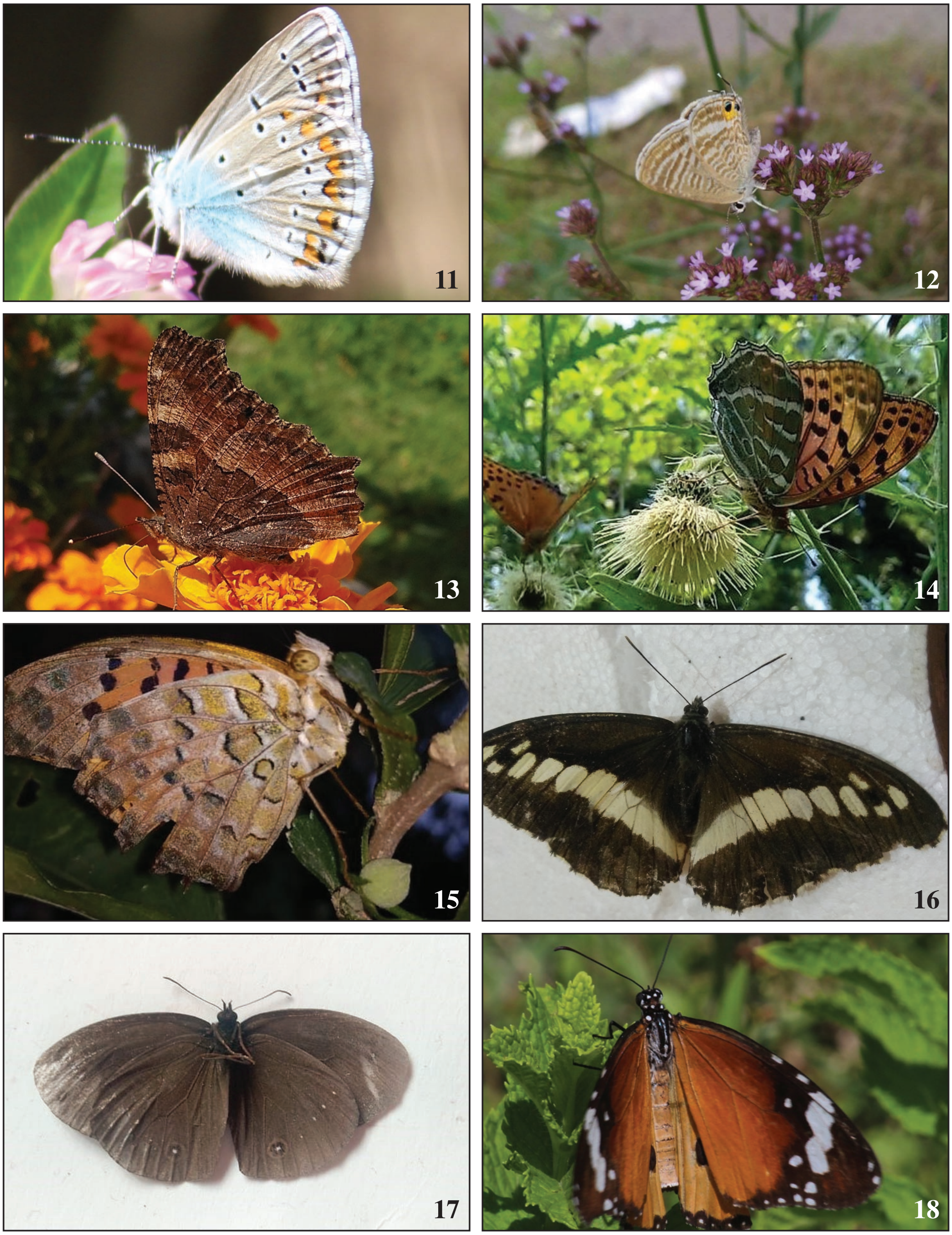
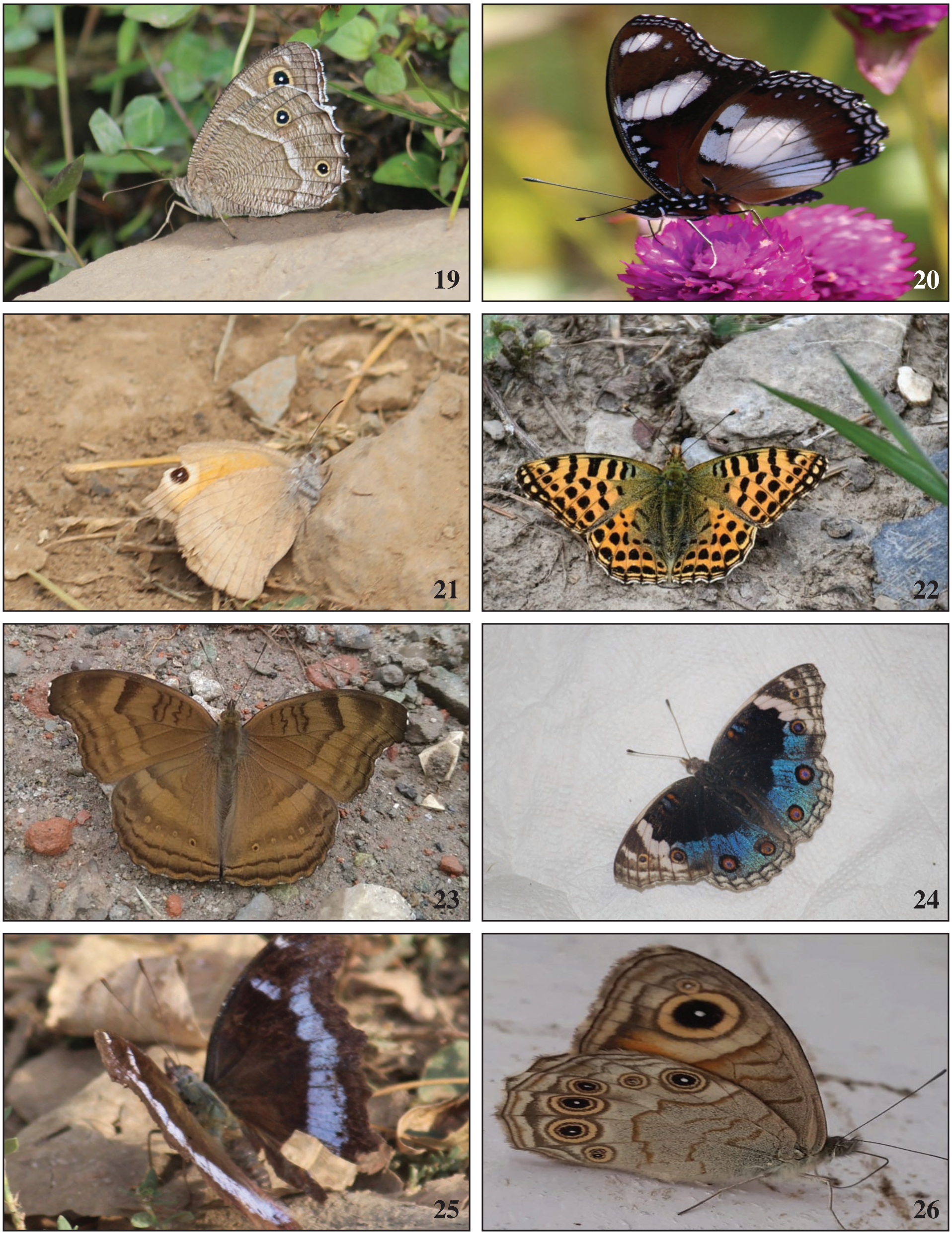
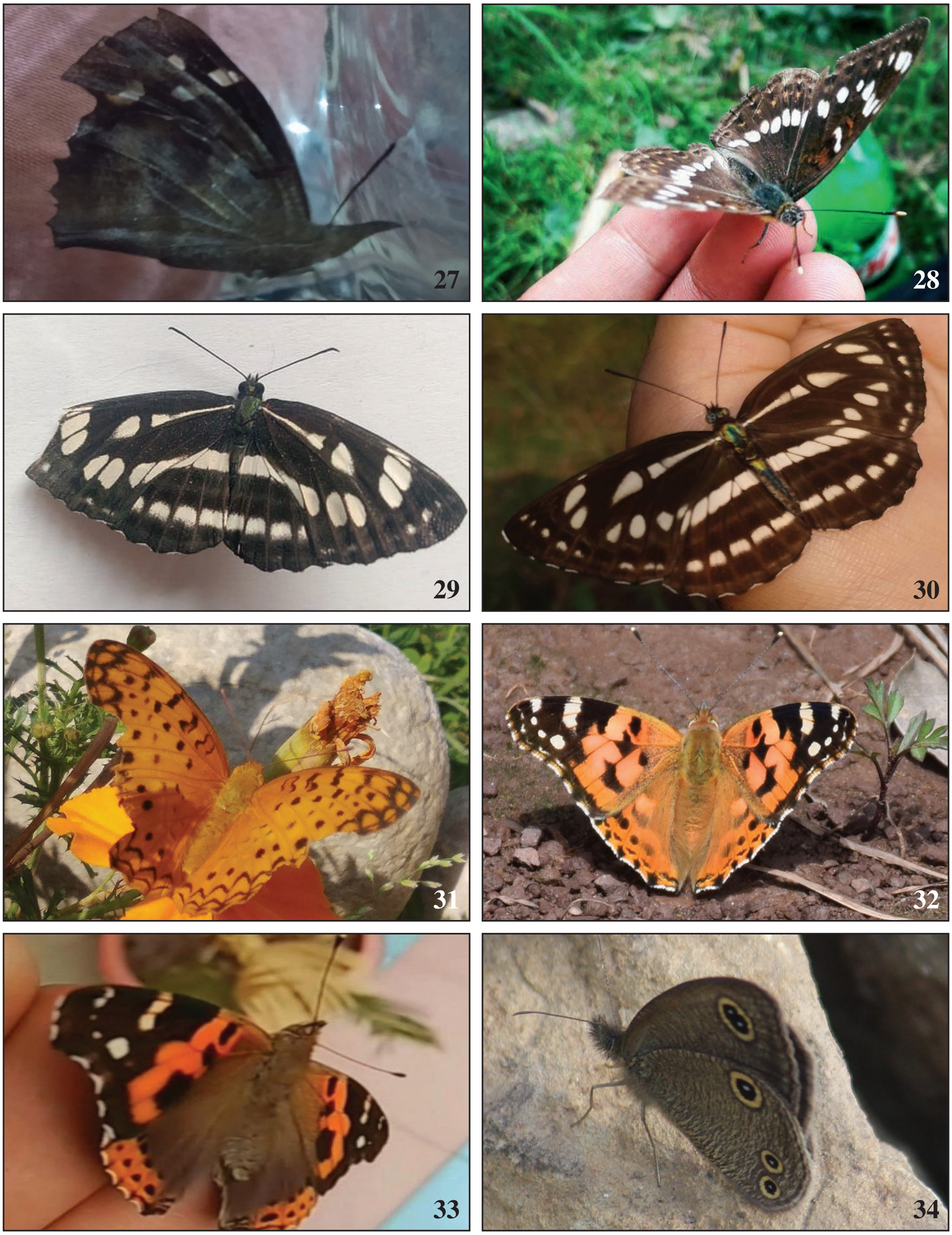
Figures 3-10. Figures 3-10. Hesperiidae 1-4. **3.** *Parnara gutta* (Bremer & Grey, 1852). **4.** *Pelopidas mathias* (Fabricius, 1798). Lycaenidae **5.** *Aricia agestis* ([Denis & Schiffermüller], 1775). **6.** *Calastrina argiolus* (Linnaeus, 1758). **7.** *Everes hugelli* (Gistel, 1857). **8.** *Celaenorrhinus leucocera* (Kollar, 1844). **9.** *Lycaena phlaeas* (Linnaeus, 1761). **10.** *Pseudozizeeria maha* (Kollar, 1848).



Figures 11-18. Figures 11-18. Lycaenidae 9-14. **11.** *Polymmatus ariana* (Moore, 1865). **12.** *Lampides boeticus* (Linnaeus, 1767). Nymphalidae 13-17. **13.** *Aglais caschmirensis* (Kollar, [1844], in Hügel). **14.** *Argynnis childreni* (Gray, 1831). **15.** *Argynnis hyperbius* (Linnaeus, 1763). **16.** *Aulocera saraswati* (Kollar, [1844]). **17.** *Callerebia nirmala* (Moore, 1865). **18.** *Danaus chrysippus* (Linnaeus, 1758).



Figures 19-26. Figures 19-26. Nymphalidae 19-26. **19.** *Hipparchia parisatis* (Kollar, [1849]). **20.** *Hypolimnas missipp*us (Linnaeus, 1764). **21.** *Hyponephele cheena* (Moore, 1865). **22.** *Issoria lathonia* (Linnaeus, 1758). **23.** *Junonia iphita* (Cramer, 1779). **24.** *Junonia orithya* (Linnaeus, 1758). **25.** *Kaniska canace* (Linnaeus, 1763). **26.** *Lasiommata schakra* (Kollar, [1844], in Hügel).



Figures 27-34. Figures 27-34. Nymphalidae 27-31. **27.** *Libythea lepita* (Moore, 1858). **28.** *Limenitis ligyes* (Hewitson, 1864). **29.** *Neptis mahendra* (Moore, 1872). **30.** *Neptis sappho* (Pallas, 1771). **31.** *Phalanta phalanta* (Drury, 1773). **32.** *Vanessa cardui* (Linnaeus, 1758). **33.** *Vanessa indica* (Herbst, 1794). **34.** *Ypthima nareda* (Kollar, [1844], in Hügel).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Figures 35-42. Nymphalidae 35. **35.** *Ypthima nikaea* (Moore, [1875]). Papilionidae **36.** *Papilio machaon* (Linnaeus, 1758). Pieridae 37-42. **37.** *Catopsilia pomona* (Fabricius, 1775). **38.** *Colias erate* (Esper, 1805). **39.** *Colias fieldii* (Ménétriés, 1855). **40.** *Pieris brassicae* (Linnaeus, 1758). **41.** *Pieris canidia* (Linnaeus, 1768). **42.** *Pontia daplidice* (Linnaeus, 1758).

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

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Applications must abide by the following conditions:

1.– The Society's annual fee must be paid before applying for the permits.

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

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

4.– All members of SHILAP who apply for these permits to collect Lepidoptera in 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 Macaronesian region"*.

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 (1 X 1) or GPS coordinates, province, dates of capture, collector and numbers of males and females captured (**only 5 specimens per taxon and locality, maximum**). Please, use only the *"Catálogo sistemático y sinonímico de los Lepidoptera de la Península Ibérica, de Ceuta, de Melilla y de las islas Azores, Baleares, Canarias, Madeira y Salvajes (Insecta: Lepidoptera)* (A. VIVES MORENO, 2014)". This list is necessary for this Scientific Project of SHILAP and for new authorizations.

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

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

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

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The identities of some subspecies, forms and individual specimens in museums previously classified as *Melitaea phoebe* ([Denis & Schiffermüller], 1775) (Lepidoptera: Nymphalidae)

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Abstract

The identities of further taxa associated previously with *Melitaea phoebe*: *pseudosibina* Alberti, 1969, *allophylus* Rütimeyer, 1942 and *rubialesi* Gómez Bustillo, 1973 are identified as *M. phoebe*, and *M. ornata*, respectively. Further specimens from the Gómez Bustillo collection housed in the Universidad Politécnica, E. T. S. Ingeniería de Montes, Forestal y del Medio Natural, Unidad de Entomología y Zoología, Madrid, Spain (UPM) and from the entomological reference collection of *M. phoebe* housed in the Museo Nacional de Ciencias Naturales, Madrid, Spain (MNCN), Universidad Autónoma de Madrid, Facultad de Ciencias, Departmento de Biología, Madrid, Spain (UAM) are reclassified as *M. ornata*. The distribution of *M. ornata* has been expanded to include locations in the Spanish Provinces of Cuenca, Guadalajara, Madrid, Palencia, Toledo, and Zaragoza.

Keywords: Lepidoptera, Nymphalidae, *Melitaea phoebe*, *Melitaea ornata*, Europe.

Sobre la identidad de otros taxones previamente asociados con *Melitaea phoebe* ([Denis & Schiffermüller], 1775) (Lepidoptera: Nymphalidae)

Resumen

Las identidades de otros taxones asociados previamente con *Melitaea phoebe*: *pseudosibina* Alberti, 1969, *allophylus* Rütimeyer, 1942 y *rubialesi* Gómez Bustillo, 1973 se identifican como *M. phoebe* y *M. ornata*, respectivamente. Otros especímenes de la colección Gómez Bustillo conservada en la Universidad Politécnica, E. T. S. Ingeniería de Montes, Forestal y del Medio Natural, Unidad de Entomología y Zoología, Madrid, España (UPM) y de la colección entomológica de referencia de *M. phoebe* conservada en el Museo Nacional de Ciencias Naturales, Madrid, España (MNCN), Universidad Autónoma de Madrid, Facultad de Ciencias, Departamento de Biología, Madrid, España (UAM) se reclasifican como *M. ornata*. La distribución de *M. ornata* se ha ampliado para incluir localidades de las provincias españolas de Cuenca, Guadalajara, Madrid, Palencia y Zaragoza.

Palabras clave: Lepidoptera, Nymphalidae, *Melitaea phoebe*, *Melitaea ornata*, Europa.

Introduction

Russell & Tennent (2016) allocated a number of taxa associated with *Melitaea phoebe* ([Denis & Schiffermüller], 1775) to their presumed correct species, recognizing the three species: *M. phoebe* [Type Locality (TL): environs of Vienna, Austria], *M. ornata* Christoph, 1893 [TL: Circa "Guberli", promontorium uralensium australium (Guberlya, Orenburg Province, Russian Federation)] and *M. punica* Oberthür, 1876 [TL: Tazoult-Lambèze (Lambessa), Algeria]. Further, Russell et al. (2020)

sorted out some syntypic series of western European taxa supposedly of *M. phoebe*, some of which contained two different species, and designated lectotypes, type localities and synonymising some names where necessary; this was continued by Russell et al. (2022) with those taxa from Eastern Europe and Asia, again designating lectotypes where appropriate and synonymising some names where applicable.

The distinguishing morphological features of the adult butterflies of *M. phoebe* and *M. ornata*, from sympatric populations in the Massif de la St. Baume, France (Figures 1-2), can be seen from their undersides and summarized as follows: in *M. phoebe* the forewing apices are slightly more pointed than those of *M. ornata*; the submarginal black arches on the wings underside tend not to be thickened centrally and touch the intervening veins in *M. phoebe*, whereas those of *M. ornata* tend to be thickened centrally and do not touch the intervening veins; the antennae of *M. phoebe* are club shaped but spatulate in *M. ornata*. Meanwhile, Hinojosa et al. (2022) have elevated the "tentatively named" taxon *pseudornata* Muñoz-Sariot & Sánchez-Mesa, 2019 [TL: Quéntar, Sierra Nevada, Granada, 1300 m, emerged 29-V-2018, from larva collected on 15-IV-2018] to specific status. This name has been already sunk in synonymy with *M. ornata bethunebakeri* Sagarra, 1926 by Russell et al. (2020, p. 455). The present authors do not recognise the specific status of the taxon *pseudornata* until such time as specimens of this taxon have been shown to be reproductively isolated from *M. ornata*; hence our continued use of *M. ornata* for those Spanish specimens which are distinct from *M. phoebe* sensu stricto. Some museum specimens associated with *M. phoebe* as subspecies or forms, not examined in detail previously, are identified here as *M. ornata*; others are confirmed as *M. phoebe*.

Observations on some forms, varieties and subspecies associated previously with *M. phoebe*

M. phoebe pseudosibina Alberti, 1969 [TL: Elbrus Region, Itkol, Kabardino-Balkaria, Russian Federation, 2100 m] was figured by the author (Taf. 1, figs 1c and 2c, paratypes). These monochrome Figures of the uppersides are not particularly informative but indicate this form to be lightly marked in the discal area compared with the specimens of *M. phoebe* from Kislovodsk (♂) and Pjatigorsk (♀) from circa 800 m and 550 m, respectively. The figure of a paratype of subsp, *pseudosibina* by Van Oorschot & Coutsis (2014, pl. 12, fig. 24) does somewhat support this detail but indicates lighter markings in the post-discal area only of the forewings but not on the hindwings. More detailed photographs (provided by John Tennent, see acknowledgements) of the holotype male (Figures 3-5) show it to be lightly marked in the discal and post-discal areas of the forewing upperside and the discal area of the hindwing upperside with the orange spots barely visible. The undersides of the hindwings are, however, well-marked with the orange spots clearly visible but the forewing undersides have the typical markings very thin or absent. The antennae are club shaped and the pre-marginal black arches are thin and touch the intervening veins, characters typical of *M. phoebe*. A paratype female captured at the same elevation a day previously is not so lightly marked on the upperside (Figures 6-8), also identifiable as *M. phoebe*.

Similar lightly marked forms of *M. phoebe* have been found in the south of France (www.butterfliesoffrance.com/html/Melitaea%20phoebe.htm), figured examples: female from Var, 10-V-2012, Alpes-de-Haute-Provence, 02-V-2011, also at www.gdoremi.altavista.org/Nymphalidae/Melitaea_phoebe_en.html figured example, male but with no data. Lightly marked specimens have also been found in North Macedonia, Skopje, Grupčin (♀) (Figure 9). Alberti (1969, p. 193) considered this form to be distinct from *caucasica* Staudinger 1870, to which he referred the name *sextilis* Jachontov 1909, the small second generation form of *M. phoebe* in the Caucasus. Tshikolovets (2011, p. 497) placed it as a synonym of *Melitaea phoebe ottonis* Fruhstorfer, 1917 (replacement name for *caucasica* Staudinger) as did Tshikolovets & Nekrutenko (2012, p. 293).

However, Butterfly Conservation Armenia, www.butterfly-conservation-armenia.org/melitaea-pseudosibina.html, considered this to be an endemic species of Caucasus and Transcaucasia. Tóth & Varga (2011) and Tóth et al. (2014) were unable to separate taxon *sibina* Alphéraky, 1881 (see Russell et al. 2022, p. 29, fig. 7) from *M. phoebe*, using morphometric measurements of male genitalia or molecular procedures, respectively. The only similarity between the taxa *pseudosibina* and *sibina* is the weak macular pattern in the post discal area of the forewings of *pseudosibina*, whilst *sibina* has both fore- and hindwings almost completely lacking in the black macular markings typical of *M. phoebe*. The present authors considers that the taxon *pseudosibina* is synonymous with *M. phoebe ottonis* and thus is a form of *M. phoebe* rather than of *M. ornata*. Without knowledge of the post L4 larvae it is not possible to be conclusive. It is highly possible that the difference in altitude at which the specimens figured by Alberti (1969, Tafel 1, figs 1c-4c) of the taxa *phoebe* and *pseudosibina* were taken (5-800 m and 2100 m, respectively) could well account for the differences in their forewing upperside markings.

Melitaea phoebe Knoch, var. nova *allophylus* Rütimeyer, 1942 [TL: Porté, Pyrénées Orientales, France]. The male holotype and four male syntypes (labelled as allotype and three as cotypes), all taken between 9 and 15-July-1939 are present in the Naturhistorisches Museum Bern, Switzerland. From high resolution photographs of the undersides of the type series (Figures 10-12), kindly provided by Hans-Peter Wymann (see Acknowledgements), it was noted that their wing morphology and antennal shape indicated that they were more similar to *M. ornata* rather than to *M. phoebe* but the time of capture was more akin to that of *M. phoebe*, which tend to emerge later than *M. ornata* (Verovnik et al. 2010; Russell & Tennent, 2022, p. 203). However, at high elevations in mountainous areas, the emergence of *M. ornata* has been seen to be delayed at times of deep long-lasting snowfall, which remains on the ground well into late spring. This prevents the larvae from waking from their diapause until much later than normal, in doing so the emergence of the adult butterflies may occur very much later. This scenario was observed by John Coutsis (Pers Comm.) in the Greek mountains (considerably further south than the Pyrénées); its fact it was first thought that these butterflies were of a second brood, until it was observed that the first brood of other species were also in flight (e. g. *Coenonympha pamphilus* (Linnaeus, 1758)). This record widens the distribution of *M. ornata* in France to the southwest and provides more of a continuity of distribution between France and Spain, where *M. ornata* has been present for many years. Identification labels have been placed on the pins of the five specimens: “Misident. *Melitaea ornata* Christoph, 1893, Russell 2022”.

Russell et al. (2020) stated that some of the specimens of *M. phoebe nimbula* Higgins, 1941 from the Picos de Europa at c. 1225 m showed wing morphological characters of *M. ornata*; these look very similar to var. *allophylus*. It is noted that Hinojosa et al. (2022, p. 3, fig. 1) indicated that the mountains of north central Spain were populated by *“M. pseudornata*” (= *M. ornata bethunebakeri* Sagarra, 1926, [see above]) rather than by *M. phoebe*, which appeared to occupy the Pyrenees. Thus, it is possible that Russell et al. (2020, p. 456) were in error in classifying the *M. phoebe nimbula* as a subspecies of *M. phoebe*. This adequately demonstrates the difficulties in correctly classifying museum specimens exemplifying a mixture of specific characters associated with the two species under consideration in this case.

Melitaea phoebe f. *rubialesi* Gómez Bustillo, 1973 [TL: Loeches (750 m), Province of Madrid, Spain, captured 15-May-1973]. Prior to the recognition that *M. ornata* occurs in Spain (see Russell et al. 2020), Russell & Tennent (2016) placed this name as a form of *Melitaea phoebe occitanica*. At this time the type material, which consists solely of a single female (Gómez-Bustillo, 1973, p. 36), was not examined. This specimen (the holotype by monotipy) is housed in the Universidad Politécnica de Madrid [UPM] in Madrid (E). High resolution photographs of the holotype (Figure 13) were compared with examples of *M. phoebe* and *M. ornata* females (Figures 14-15). It was concluded that this was a “form” of *M. ornata* and not of *M. phoebe*. Although the names of varieties and forms are not recognized by the ICZN, it was thought important to identify this specimen; as it extends the distribution of *M. ornata* to the Province of Madrid, from where it has not previously been reported. A label has been placed on the specimen's pin: "Misident. *Melitaea ornata* Christoph, 1893, Russell & Vives, 2023".

Apart from the holotype, AVM discovered, among the specimens in the Gómez Bustillo collection headed *M. phoebe*, two male specimens from Campo Real only some 6.5 Km to the south-southeast of Loeches, across a dry area of earthworks dating from the Spanish Civil War (1936-1939). One specimen was captured 6-VI-1971 (Figures 16-17), the other specimen is very ragged (Figures 18-19), its date of capture unknown but presumably later in the month. Both specimens resemble the form *rubialesi* and thus we classify them as *M. ornata.*

Another male specimen, also resembling *rubialesi*, was found by AVM in the same collection (Figures 20-21). It was captured also on 6-VI-1971 at Montarco (a well-known collecting site 15 km southeast of central Madrid, now in the suburb of Rivas-Vaciamadrid (Fidalgo & Paris, 2023, p. 8); this location is only some 13 km west of Loeches. Again, we classify this specimen as *M. ornata*. All three specimens have had an extra label placed on their pin: "Misident. *Melitaea ornata* Christoph, 1893, Russell & Vives, 2023".

E. García-Barros photographed two specimens originating from the Madrid University campus (a male is figured - Figure 22), which are undoubtedly also *M. ornata*, as the larvae found in this location have red-brown heads (J. Martin pers. comm. to E. García-Barros). This locality is to the northwest of the city rather than to the southeast as are the locations mentioned above.

Papilio tremulae Pillar & Mitterpacher, 1775, was synonymised with nominotypical *M. phoebe* by Russell & Tennent (2016, note 93) on the basis that there had been no reports of *M. ornata* from Croatia, the Type Locality of this taxon. *M. ornata* has since been confirmed from Croatia (Russell & Pateman, 2019); however, the specimen figured by the authorities (Tab. IV, figs 1-2) is considered still to be representative of *M. phoebe*, with the submarginal black markings touching the intervening veins.

Further Spanish specimens in the Gómez Bustillo collection in UPM previously identified as *Melitaea phoebe*

1). A male specimen originating from Sanabria, Province of Zamora (NW Spain) (Figures 23-24). The wing morphology of the specimen and the shape of its antenna suggest that it is *M. ornata*. The capture date of 4-VI-1926, however, is reminiscent of capture times of *M. phoebe*, but there are mountainous areas within the Parque Natural del Lago Sanabria y Sierras in excess of 1700 m above sea level. Thus, it is possible that the larva of this specimen suffered an elongation of diapause or, as a result of wet conditions, skipped diapause and continued feeding, producing an adult *M. ornata* in the summer of the same year (see Russell et al. 2007, p. 145; Benyamini, 2021, p. 190 [taxon *klili*] and Russell et al. 2023, pp. 187-195). Interestingly, Hinojosa et al. (2022, p. 3, fig. 1) indicated that specimens of "*M. pseudornata*" (= *M. ornata* [Russell et al. 2020, p. 455]) had been found in mountainous regions further north in the provinces of León and Asturias and further south in the province of Ávila, with no reports of *M. phoebe* from the area surrounding the National Park. They also considered that some specimens of their taxon *pseudornata* were "double brooded" with adults present at very low altitude in September possibly originating from the west coast of the province of La Coruña, NW Spain (Hinojosa et al. 2022, pp. 5-6). However, it was not stated whether this was simply some larvae skipping diapause and continuing to feed, with a proportion of adults emerging the same year (see Benyamini, 2021, p. 190), or a "complete 2nd brood", We consider that the specimen under consideration is most probably *M. ornata*, and a label indicating such has been placed on the pin: "Misident. *Melitaea ornata* Christoph, 1893, Vives, 2023".

2). A male specimen in rather poor condition and without a complete antenna (Figures 25-26), taken on an unspecified date in July 1967 at Puerto de la Ragua, Sierra Nevada, Granada at 1990 m. Russell et al. (2020, pp. 450-451) reported 5 specimens of *M. ornata* from the Sierra Nevada at 1600 m (1 in MZB, 3 in MCZHU, Harvard, U.S.A. and a pair of specimens in NHM, London). Muñoz-Sariot &

Sánchez-Mesa (2019, p. 9) reported 2 specimens of *M. ornata* from the Sierra Nevada (♂ Quéntar at 1300 m and ♀, Beas de Granada at 1350 m, Figures 2a-2b respectively [not Figures 1a-b, as indicated in their text]). The only precise reports of *M. phoebe* from the Sierra Nevada are by Muñoz-Sariot & Sánchez-Mesa (2019, p. 7): a pair of specimens from Beas de Grenada at 1460 m (indicating a mixed population?); Hinojosa et al. (2022, p. 3, fig. 1) indicated a preponderance of *M. phoebe* in the Sierra Nevada. Although worn and lightly marked, this specimen bears a resemblance to *M. ornata* with respect to the forewing underside black submarginal markings being more triangular than smooth arches in shape. However, these markings clearly touch the intervening veins, thus we consider this specimen to be *M. phoebe* rather than *M. ornata*.

A selection of specimens here classified as *M. ornata* from the entomological reference collection of the Universidad Autónoma de Madrid, Departmento de Biología (UAM)

1). A male specimen taken on 28-V-1986 at Navalguijo, Sierra de Gredos, Ávila, leg. J. L. Viejo and J. Martín Cano (Figures 27-28), showing the typical morphology of *M. ornata*: black submarginal markings on the hindwing underside not touching the intervening veins and the antennae spatulate rather than elongated club shaped. No specimen of either taxa was mentioned from this locality in the supplement of Hinojosa et al. (2022).

2). A female specimen taken on 16-VI-2001 at Camino Valdosillos, Cuenca, leg. S. Jiménez & J. I. Arce (Figures 29-30) has the black submarginal markings on the underside more triangular in shape and not touching the intervening veins, suggesting it is *M. ornata*. There is no record of this location for either taxa in the supplement of Hinojosa et al. (2022).

3). A pair of specimens from Guadalajara: male captured on 15-VI-1980 at Masegozo de Taguña at *circa* 1000 m (Figures 31-32) and the female, rather worn and taken on 7-VI-1980 only a few km. away at Auñón (Figures 33-34) at the lower altitude of *circa* 700 m, both leg. E. García-Barros, are clearly *M. ornata*.

4). A female (?), judging by its rounded forewing shape taken in 2018 [date not given] at San Felices de Castillaria, Palencia (Figures 35-36) leg. M. L. Munguira has the black submarginal markings swollen centrally, tending to triangular in the forewing, and not touching the intervening veins and spatulate antenna, identifying this specimen as *M. ornata*.

5). A male specimen taken on 28-VI-2018 by M. L. Munguira at El Vallecillo, Albarracín, Teruel (Figures 37-38) has centrally thickened submarginal markings not touching the intervening veins but rather pointed, club-shaped antenna; however, we classify this as *M. ornata*. Interestingly, Hinojosa et al. (2020, supplement p. 4) list this as a location for the taxon *pseudornata*.

6). Another male specimen taken on 18-IV-1998 at Montes de Torrero, Zaragosa at 230 m a.b.s.l. (Figures 39-40) by G. E. King has the black submarginal markings not extending to the intervening veins. This specimen is classified as *M. ornata*. Hinojosa et al. (2022) do not mention this location for either taxa.

7). A male from Yepes, Toledo taken on 13-V-2007, by J. Martin & L. Ureña (Figures 41-42), has the spatulate antennae and submarginal black arches not touching the intervening veins and thus we classify this specimen as *M. ornata*.

The locations of these specimens provide further information on the distribution of *M. ornata* apparently adding the provinces of Cuenca, Guadalajara, Palencia, Toledo and Zaragoza to its Spanish distribution.

Some comments on the observations made by Hinojosa et al. (2022)

1). PHENOLOGY AND VOLTINITY: some confusion were present concerning the voltinity of *M. ornata*. They suggested that the taxon *pseudornata* Muñoz-Sariot & Sánchez-Mesa, 2019 was double brooded (bivoltine) because it had two flight periods and that *M. ornata* was bivoltine only in captivity under laboratory conditions quoting Russell & Pateman (2013) and Russell et al. (2014) (Hinojosa et al. 2022, p. 6). Neither of these articles suggested that *M. ornata* was truly bivoltine, i. e. had two completed generations in a single year, only partially bivoltine; confusion arises from the use of the word "generation" by the former authors. What occurred during the rearing of *M. ornata* from Chios (2013) and Slovenia (2014) open to the English showery spring weather was that the larvae split into two groups: the first group instead of entering diapause at stage L4, as would have been expected, continued to feed, pupated and adults emerged in the summer of the same year; whereas the second group entered diapause with the larvae only resuming feeding in the early spring of the following year. This was merely a larval diversification due to prevailing weather conditions; those larvae reared in a greenhouse protected from the prevailing wet weather conditions all entered diapause and followed the "normal" growth pattern of *M. ornata* associated with their natural dry environments. This scenario of bypassing diapause by some larvae occurs naturally in the taxon *klili* Benyamini, 2021 (synonimised with *M. telona* (part of the super-species *M. ornata*) by Russell et al. (2023). The populations of *klili* occupy just two permanently low-lying wet areas in stream valleys in Central Galilee (© Nahal Shezor, 206 m) [TL.] and Lower Galilee (© Nahal Zippori, 90 m), Israel (Benyamini, 2021). Under these circumstances, due to the hotter temperatures experienced by the larvae in Israel, complete bivoltinity can occur because of the much shorter development time of the larvae, which allows time for the group which bypassed diapause to complete a true 2nd generation in the same year; although the larvae which enter diapause do not begin feeding again until the following spring.

Thus, the situation in Europe can be expressed as follows:

Year 1: L4 larvae emerge from diapause, feed up, pupate and produce adults (spring brood) which mate, the female lays an egg batch, larvae hatch and feed up to stage L4; some larvae then continue feeding to final instar, pupate and adult butterflies emerge (partial summer brood), the remaining larvae enter diapause and remain in that stage throughout the summer and winter to exit their web in year 2 and begin feeding to final instar, pupate and adults emerge (spring brood) but these butterflies are the same "generation" as the previous summer brood, or possibly a combination of both the Year 1 broods, if the offspring of the summer brood have been able to survive the winter, which is probably unlikely in Europe.

It is strongly suspected that the apparent bivoltinity in the taxon *pseudornata* is in reality only partial with some larvae bypassing diapause and continuing to feed to produce adults in August. The observations of adults in August detailed in the supplementary material provided by Hinojosa et al. (2022, suppl. 4) indicate observations on 26, 27 and 28-VIII (no year[s] given) at Praia de Rostro, A Grixa and N. of Cuño, respectively. These locations, at or below 200 m above sea level, are all to be found in the west of the province of La Coruña, the most northwesterly in Spain and consequently open to the humidity of the Atlantic Ocean air flow from the prevailing south-westerly winds. Thus, it is considered most likely that the apparent bivoltinity is in fact the result of a pre-diapause division of the larvae, with one group bypassing diapause, continuing to feed, pupating and producing adult butterflies in August, thus reflecting the larval behaviour when subjected to humid conditions. The lower summer temperatures experienced by the larvae in north-western Spain compared with those in Israel would preclude a complete second generation, the offspring of which would be most likely to enter diapause; any which did not reach that stage would be unlikely to survive.

2). HYBRIDISATION between *M. phoebe* and taxon *pseudornata*: this has been suggested to have occurred on a number of occasions previously by Hinojosa et al. (2022, p. 7) and more recently between *M. phoebe* and *M. ornata* by Bálint & Ilonczai (2001, p. 217) and Russell et al. (2014). There are several localities in Spain where both taxa are sympatric and at least partially synchronic - Beas 1200 m, and Monachil, 1600 m, in the province of Granada (Sánchez-Mesa & Muñoz-Sariot, 2017, pp. 315-316); La Sagra 19, 23-V taxon *pseudornata*, 21-V *M. phoebe* and Güejar Sierra, 11-V taxon *pseudornata*, 23-IV *M. phoebe* (Hinojosa et al. 2022, suppl. pp. 3-4). Thus, it is highly possible that this scenario would continue and in such cases their presence would make for difficulties in taxon determination and could well account for some larvae having black heads and the adult being determined as *pseudornata*. It could well be the cause of difficulties in the determination of adults from their wing and antenna morphology, as has been experienced by the first author.

3). LARVAL COLOUR has been shown to be variable in different Spanish locations in *M. phoebe* and the taxon *pseudornata* (Hinojosa et al. 2022, p. 6, fig. 4). Variation of larval colouring is well known and documented; in fact, the two very different larval forms of *M. phoebe* account for the subspeciation of *M. phoebe occitanica* Staudinger, 1871, which has larvae with an orange lateral stripe (Figure 43) and that of the nominate *M. phoebe phoebe*, which has no orange lateral stripe but is well covered in white spots (Figure 44). The larvae of *M. ornata* can vary also even in those larvae from the same egg batch, as was the case with an egg batch from Mamousia, Ahaia, Greece (Russell et al. 2007, p. 159, figs 16-17).

Comments on the overall distribution of *M. ornata*

Melitaea ornata adversaria Korb, Stradomsky & Kuznetsov, 2015 [TL: Kyrghyzia (= Kyrgyzstan), Kyrghyz Mts., Ala-Too settlement vicinity, 1100-1200 m]; at approximately 74.5º east, this is very much further east that previous records; i. e. the western side of the Southern Ural Mountains (Guberli [the Type Locality] and Kysylkaya [Van Oorschot & Coutsis, 2014, plate 12, figs 20-21]) are at approximately 58º East. Also the reports by Tshikolovets et al. (2016) of a number of locations in southeastern Kazakhstan, which are even further east, around 85 º East; thus this species is apparently well established in Asia. Unfortunately, Korb (2011, p. 158) had reported *M. phoebe saturate* from the Kungey Ala-Too Mountains; however, later Korb, Stradomsky & Kuznetsov (2015, p. 140) considered that *M. phoebe* did not occur in North Tian-Shan. The presence of this species very close to the border with northwest China, one must expect reports from China to be imminent.

The presence of *M. ornata allophylus* Rütimeyer, 1942 [TL: Porté, Pyrénées Orientales, France] in the eastern Pyrénées links the populations in Var (southeastern France) with the Spanish populations of *M. ornata* in the Spanish Cantabrian and Asturian mountains. It also raises the possibility of finding *M. ornata* in the intervening French departments of Aude and Hérault, particularly in xerothermic habitats.

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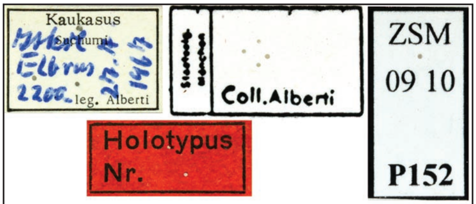
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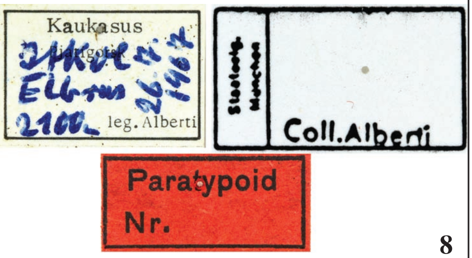
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Figures 1-8. 1. *Melitaea phoebe occitanica* male underside, Nans, Var France, 24-V-1926. © Bartolozzi. **2.** *Melitaea ornata* male underside, Nans, Var, France, 24-V-1926. © Bartolozzi. **3.** *Melitaea phoebe pseudosibina* holotype ♂ upperside, Elbrus region, Itkol, Russian Federation, 27-VII-1967. © Tennent. **4.** *Melitaea phoebe pseudosibina* holotype ♀,underside, Elbrus region, Itkol, Russian Federation. © Tennent. **5.** *Melitaea phoebe pseudosibina* holotype, labels on pin © Tennent. **6.** *Melitaea phoebe pseudosibina* paratype ♀ upperside, Elbrus region, Itkol, Russian Federation, 26-VII-1967. © Tennent. **7.** *Melitaea phoebe pseudosibina* paratype ♀ underside, Elbrus region, Itkol, Russian Federation. © Tennent. **8.** *Melitaea phoebe pseudosibina* paratype ♀, labels on pin. © Tennent.

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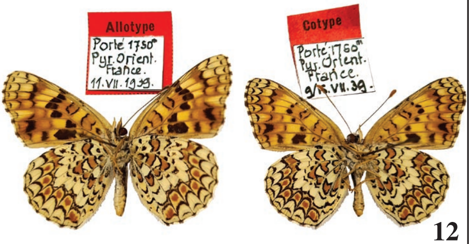

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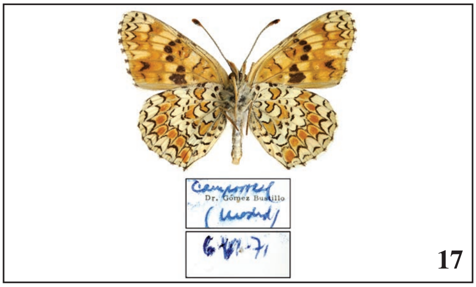
Figures 9-16. 9. *Melitaea phoebe* ♀ upperside, Grupčin, Skopje, Republic of Macedonia, 15-V-1990. © PJCR. **10.** *M. phoebe* var. *allophylus*, holotype male upperside, Porté, Pyrénées Orientales, France, 9-15-VII-1939. © Hans-Peter Wymann. **11.** *M. phoebe* var. *allophylus*, holotype male and cotype male undersides, Porté, Pyrénées Orientales, France, 9-15-VII-1939. © Hans-Peter Wymann. **12.** *M. phoebe* var. *allophylus*, allotype male and cotype male undersides, Porté, Pyrénées Orientales, France, 9-15-VII-1939. © Hans-Peter Wymann. **13.** *M. phoebe rubialesi* Bustillo ♀ holotype upperside, underside and tabels on pin, Loeches, Madrid, 15-V-1973. © AVM. **14.** *M. phoebe* reared ♀ underside, ex ova, Nedešćina, Istria, Croatia, emerged 14-IX-2011. © PJCR. **15.** *M. ornata* reared ♀ underside, ex ova 8 km southeast Trebinje, Herzegovina, emerged 07-V-2018. © PJCR. **16.** *M. ornata*, male upperside, Campo Real, Madrid, Spain, 06-VI-1972, leg. Gómez Bustillo. © AVM.



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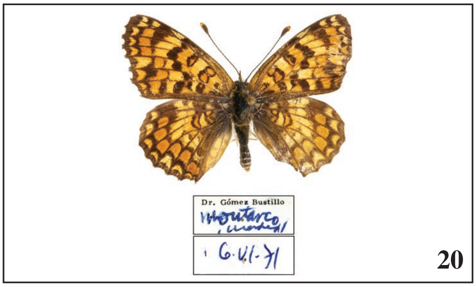

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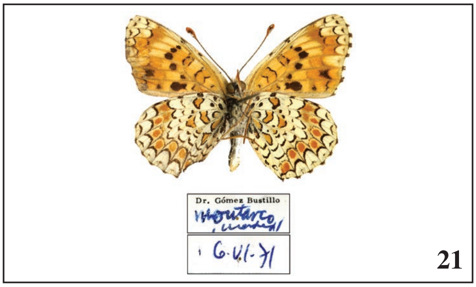

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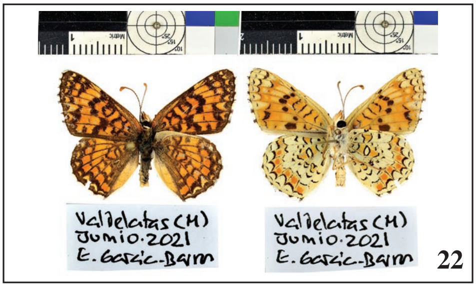

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Figures 17-24. 17. *M. ornata*, male underside, Campo Real, Madrid, Spain, 06-VI-1972, leg. Gómez Bustillo. © AVM. **18.** *M. ornata*, worn male upperside, Campo Real, Madrid, Spain, no date, leg. Gómez Bustillo. © AVM. **19.** *M. ornata*, worn male underside, Campo Real, Madrid, Spain, no date, leg. Gómez Bustillo. © AVM. **20.** *M. ornata* male upperside, Montarco, Madrid, 06-VI-1971, leg. Gómez Bustillo. © AVM. **21.** *M. ornata* male underside, Montarco, Madrid, 06-VI-1971, leg. Gómez Bustillo. © AVM. **22.** *M. ornata* male upperside (left), underside (right), Valdelatas, Madrid, Spain, leg. E. García-Barros. © EGB. **23.** *Melitaea ornata* male upperside, Sanabria, Zamora (NW Spain), 04-VII-1926, MNCM. © AVM. **24.** *Melitaea ornata* male underside, Sanabria, Zamora (NW Spain), 04-VII-1926, MNCM listed as *M. phoebe*. © AVM.

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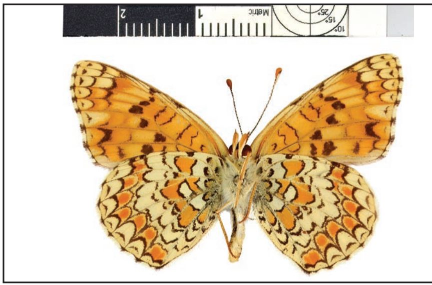

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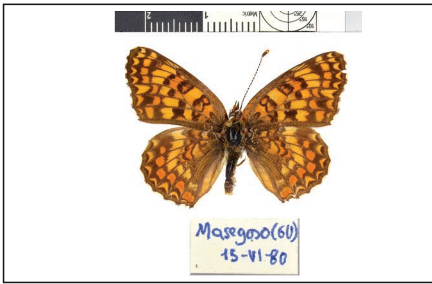

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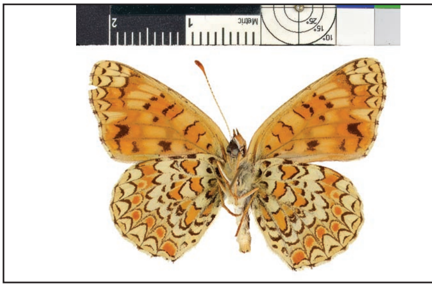

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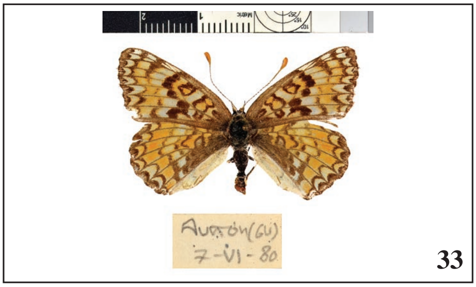
Figures 25-32. 25. *M. ornata* male upperside, Puerto de la Ragua, Sierra Nevada, Granada, Spain, VII-1967, leg. Fernández Rubio. © AVM. **26.** *M. ornata* male underside, Puerto de la Ragua, Granada, Sierra Nevada, Spain,VII-1967, leg. Fernández Rubio. © AVM. **27.** *M. ornata* male upperside, Navalguijo, Sierra de Gredos, Ávila, Spain, 28-V-1986, leg. J. L. Viejo & J. M. Cano. © EGB. **28.** *M. ornata* male underside, same data as Figure 27. **29.** *M. ornata* female upperside, Camino Valdosillos, Cuenca, Spain, 16-VI-2001, leg. S. Jiménez & J. I. Arce. © EGB. **30.** *M. ornata* female underside, same data as Figure 29. **31.** *M. ornata* male upperside, Masegozo de Taguña, Guadalajara, Spain, at *circa* 1000 m., 15-VI-1980, leg. García-Barros. © EGB. **32.** *M. ornata* male underside, same data as Figure 31.



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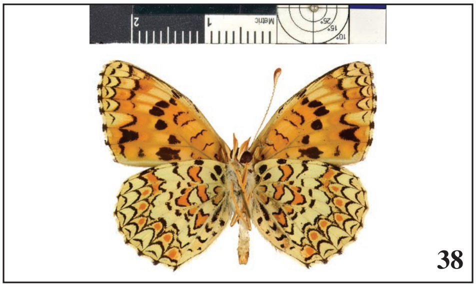

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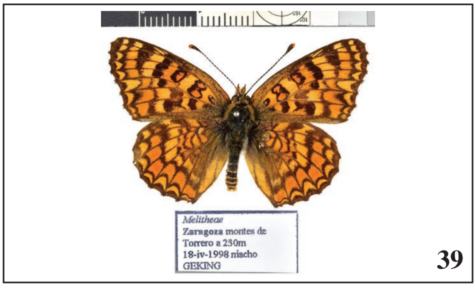

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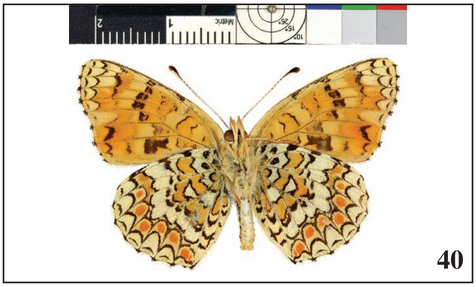

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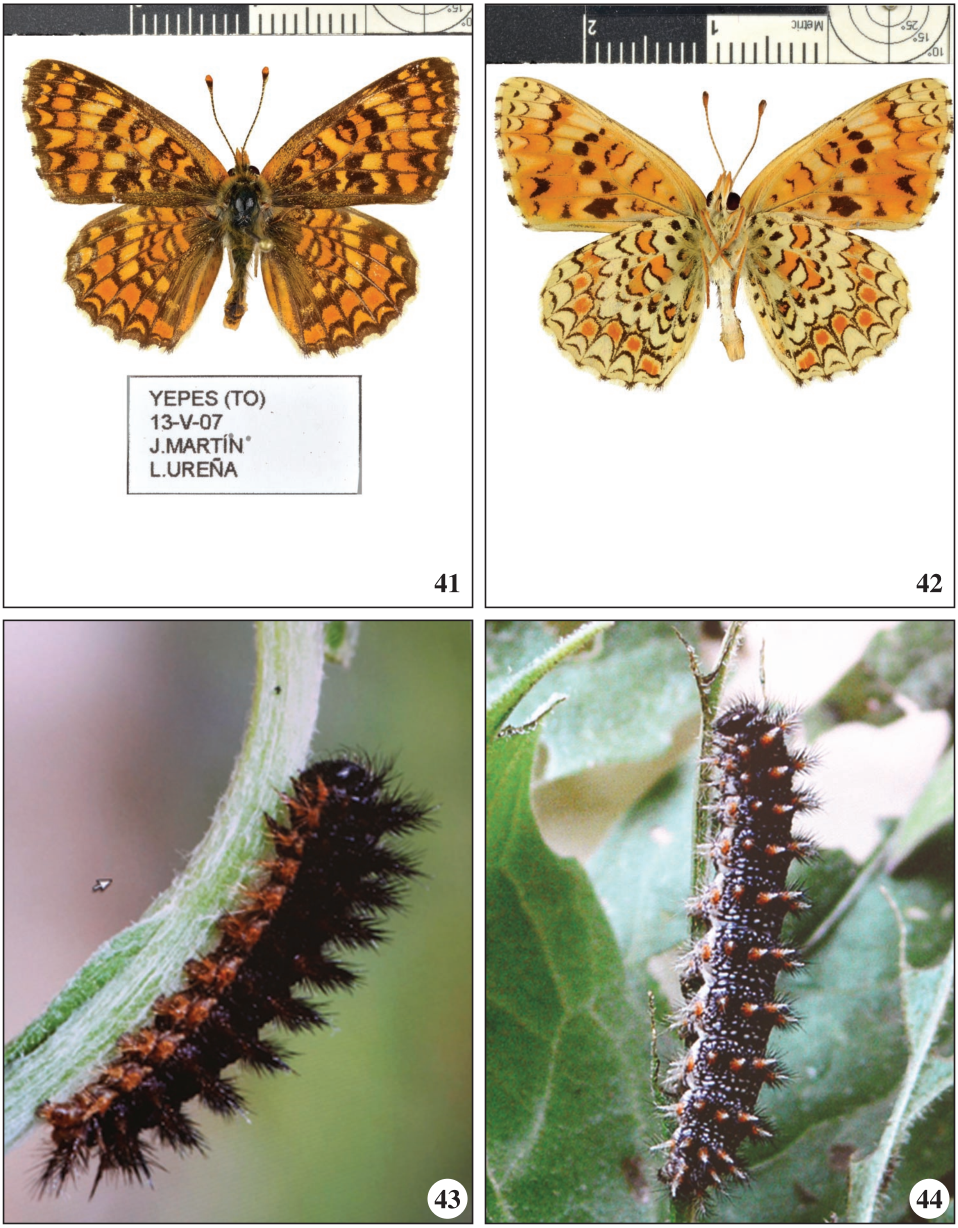

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Opogona sacchari (Bojer, 1856) a new record from the Maltese Islands (Lepidoptera: Tineidae)

Aldo Catania, Anthony Seguna, John J. Borg & Paul Sammut

Abstract

The genus *Opogona* Zeller, 1853 and the species *Opogona sacchari* (Bojer, 1856) are recorded for the first time from the Maltese Islands.

Keywords: Lepidoptera, Tineidae, *Opogona sacchari*, new record, Maltese Islands.

Opogona sacchari (Bojer, 1856) nuevo registro para Malta (Lepidoptera: Tineidae)

Resumen

El género *Opogona* Zeller, 1853 y la especie *Opogona sacchari* (Bojer, 1856) se registran por primera vez para Malta.

Palabras clave: Lepidoptera, Tineidae, *Opogona sacchari*, nuevo registro, Malta.

Introduction

In Europe the family Tineidae comprises 278 species in 52 genera (Gaedike et al. 2011). In the Maltese Islands this group is represented by 32 species and 17 genera (Sammut, 2020). Tineidae feed on anything, from vegetative matter to carcasses. The majority of the species construct cases which they carry during their larval stages and pupate within them. *Opogona sacchari* (Bojer, 1856), is a pest of plants, normally living in the crown and fruit. However, the species is polyphagous and feeds on no less than 22 different genera of plants, amongst which are greenhouse ornamentals, many times reaching pest levels (Koppert, 2022). *Opogona sacchari* (Bojer, 1856) has also been reported as feeding on pineapples, bamboo, maize, and sugarcane in the field, but also as infesting various stored tubers. In European countries, it has been recorded on various tropical or subtropical ornamentals, including Cactaceae, *Dracaena*, *Strelitzia* and *Yucca, Alpinia, Begonia*, *Bougainvillea*, Bromeliaceae, *Chamaedorea* and other palms, *Cordyline*, *Dieffenbachia, Euphorbia pulcherrima, Ficus, Gloxinia, Heliconia, Hippeastrum, Maranta, Philodendron, Sansevieria* and *Saintpaulia,* and also *Capsicum* and *Solanum melongena* L. (Cabi, 2022). Its larvae are difficult to detect as they feed inside the host plant tissue. This is especially so during the first larval instars which hide in cracks, bulbs, or other plant structures. (Van Der Gaag et al. 2013). Its spreading is attributed to imports for greenhouses and the growing of ornamental plants. *Opogona sacchari* (Bojer, 1856) is reported to adapt to outdoor climate on the Canary Islands, Madeira, and the Azores. These countries have a warm and dry climate comparable to that of the Mediterranean basin, so the possibility of it establishing itself in Malta is very likely.

In Europe, the genus *Opogona* Zeller 1853, comprises three species, namely *Opogona omoscopa* (Meyrick, 1893) recorded from the Azores in Portugal and from Sardinia in Italy; *Opogona antistacta* Meyrick, 1937, which was "bred from larva found in London feeding under slight tubular web on rind of banana" (Rennwald, 2022) and *Opogona sacchari* (Bojer, 1856) ranging across Africa, Asia, Europe and America. (Van Der Gaag et al. 2013)

Material examined: MALTA, Żebbuġ, 1 ♀, 13-II-2022 Catania leg; Gozo Island, Xaghra, 1 ♀, 14-IX-2005 at light.

Two specimens have been collected from the Maltese islands. The first, Xaghra in Gozo was recorded at a 125W MV light trap, while the second specimen was collected from Żebbuġ in Malta. This specimen must have been an accidental import with daffodil bulbs bought from a plant nursery at Burmarrad earlier in December 2021. On examining these bulbs, it was noticed that the degree of damage done by the larvae stopped the normal growth of leaves and flowers. This specimen from Żebbuġ has a wingspan of 30 mm while the specimen from Xaghra has a wingspan of 21 mm.

Discussion: *Opogona sacchari* (Bojer, 1856) was originally described from the Mascarene Islands (Africa). Later it was reported also from continental Africa and other African islands. Its presence on Madeira, Azores, the Canary Islands, and continental Europe had also been reported. It is typically an Old-World tropical species and is capable of dispersing and getting established in the tropical belt and in areas with a Mediterranean climate. We propose the Maltese name "Opogona taz-Zokkor", after the transliteration of the word sacchari.

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The authors would like to thank Mr. Jan Šumpich, Department of Entomology, National Museum, Czech Republic, for the identification of the species; Mr. Ole Karsholt, Associate curator (Lepidoptera), Natural History Museum, Denmark for his helpful suggestions, and Dr. Antonio Vives for providing the Spanish translation.

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Two new species and two new record species of the *pruinosella* species group of genus *Athrips* Billberg, 1820 from China (Lepidoptera: Gelechiidae)

Hyonju Oh & Houhun Li

Abstract

Two species, *Athrips albimacula* Oh & Li, sp. nov. and *A. lingchuana* Oh & Li, sp. nov., are described as new; two species, *A. pruinosella* (Lienig & Zeller, 1846) and *A. spiraeae* (Staudinger, 1871), are newly recorded for China. Images of adults and genitalia of the above four species are illustrated.

Keywords: Lepidoptera, Gelechiidae, taxonomy, *Athrips*, China.

Dos nuevas especies y dos nuevos registros del grupo de especies *pruinosella* del género *Athrips* Billberg, 1820 de China (Lepidoptera: Gelechiidae)

Resumen

Se describen dos nuevas especies, *Athrips albimacula* Oh & Li, sp. nov. y *A. lingchuana* Oh & Li, sp. nov.; dos especies, *A. pruinosella* (Lienig & Zeller, 1846) y *A. spiraeae* (Staudinger, 1871), se registran por primera vez para China. Se ilustran la imagen del adultos y la genitalia de las cuatro especies mencionadas.

Palabras clave: Lepidoptera, Gelechiidae, taxonomía, *Athrips*, China.

Introduction

The genus *Athrips* was established by Billberg (1820), with *Phalaena mouffetella* Linnaeus, 1758 as the type species. It is characterized by having a broad and short uncus covered with strong setae, a strongly curved long gnathos, a transtilla with strongly developed medial lobes and a saccus with X-shaped sclerotized support (Bidzilya & Li, 2009). *Athrips* species were united into eleven species groups based on the phylogenetic analysis and their phylogenetic relationships established in broad terms (Bidzilya, 2005). To date, 44 species are recorded in the Palaeartic Region (Bidzilya & Li, 2009; Junnilainen & Nupponen, 2010; Bidzilya & Nupponen, 2018).

Bidzilya & Li (2009) reviewed 22 *Athrips* species of the Chinese fauna, belonging to seven species groups. The aim of this study is to study the *pruinosella* species group from China.

The *pruinosella* group is characterized by the forewing of most species relatively broad, and grayish black with indistinct black spots; in the male genitalia by the well-developed transtilla with digitate medial lobes; in the female genitalia by the sternite VIII with well-developed patches of honeycomb pattern and wrinkles, the ostium bursae with dorsomedial sclerite, and distal part of the ductus bursae with additional lateral sclerite (Bidzilya, 2005). Nine species of the *pruinosella*-group were described from China previously. In this paper we describe two new species and to newly record two species for China.

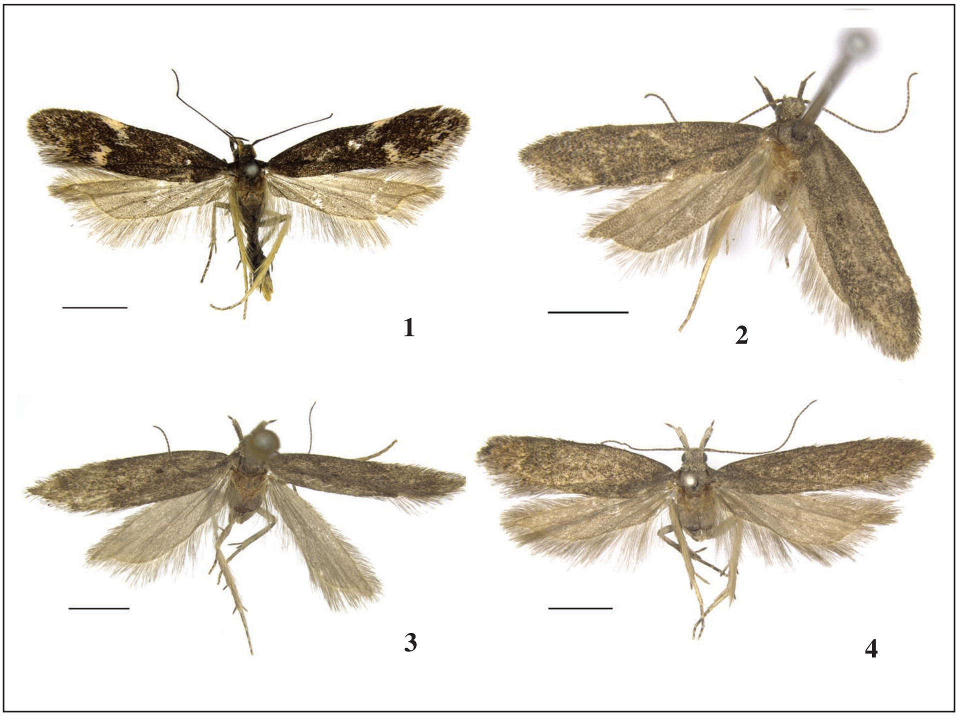
Materials and methods

Specimens were collected in China by using light traps. All the studied specimens, including the types, are deposited in the Insect Collection of Nankai University, Tianjin, China (NKU).

Morphological characteristics of adults and genitalia were observed under an Olympus SZX7 stereomicroscope and an Olympus CH30 microscope. Dissection and slide mounting of genitalia followed the methods introduced by Li (2002). Images of adults and genitalia were taken with Leica M205A and Leica DM750 microscopes respectively, coupled with a Leica Application Suite 4.2 software, and were manipulated subsequently in Adobe Photoshop CS.

Taxonomy

Athrips Billberg, 1820
Athrips Billberg, 1820, 93
Type-species: *Phalaena (Tinea) mouffetella* Linnaeus, 1758, by subsequent designation.



Figures 1-4. Adults of *Athrips* spp. **1.** *A. albimacula* Oh & Li, sp. nov., holotype, ♂. **2.** *A. lingchuana* Oh & Li, sp. nov., holotype, ♂. **3.** *A. pruinosella*, ♂. **4.** *A. spiraeae*, ♂. (scales = 2.0 mm).

Athrips albimacula **Oh & Li, sp. nov.** (Figures 1, 5)

Type material: China, Qinghai, Holotype ♂, Baiyanggou Village, Qilian County (38.22ºN, 100.26ºE), 2935 m, 24-VII-2019, leg. SL Hao & XJ Zhu, slide No. OHJ20753 (NKU). Paratypes: 8 ♂♂, other same data as holotype, slide No. OHJ20735.

Diagnosis: This species is externally similar to *A. ravida* Bidzilya & Li, 2009 in male genitalia, but differs from the latter in the forewing with distinctly large cream spot at basal 3/5 of costal margin and dorsum respectively, and in the male genitalia by the rectangular uncus, and the width of the anteriorly rounded saccus 2.5 times of its length; in the latter species, the forewing lacks a costal and a dorsal spot; the uncus is trapezoid-shaped, and the width of the anteriorly obtuse saccus is 2 times of its length in the male genitalia.

Description Adult (Figure 1): Wingspan 14.0-15.0 mm. Head grayish black, with long grayish white scales on upper margin of compound eyes. Labial palpus: second segment dark brown, with cream scales at apex, at base and on inner surface; third segment black except white at base on inner surface. Antenna: Scape black; flagellum black with dark brown rings. Thorax and tegula dark grayish brown. Forewing dark brown, with two large cream spots: one spot at basal 3/5 of costal margin, another at dorsum opposite to costal spot; fringe grayish brown. Hindwing and fringe light grayish brown. Fore- and midleg dark brown on outer surface, grayish yellow on inner surface, tarsi dark brown with grayish yellow rings; femora of hindleg grayish yellow, tibia dark brown on outer surface, grayish yellow on inner surface, tarsi dark brown and grayish yellow on outer surface, grayish yellow on inner surface.

Male genitalia (Figure 5): Uncus rectangular, anterior margin emarginated, posterior margin obtuse, with long setae. Gnathos sickle-shaped, strongly curved before middle, apex pointed, slightly hooked. Tegumen sub-triangular, anterior margin deeply emarginated. Valva straight, slightly narrowed distally, narrower than uncus; apex obtuse, exceeding tip of uncus. Sacculus narrow and short, with hair-like setae in distal part; apex pointed, beak-shaped. Transtilla lobes shorter than sacculus, digitate, with hair-like setae. Saccus short, broadly rounded, width 2.5 times of length. Phallus swollen basally, straight distally, distal 1/3 tapered.

Female: Unknown.

Distribution: China (Qinghai).

Etymology: The specific name is derived from the Latin *albus* and *macula*, referring to the large cream spots at costal and dorsal 3/5 of the forewing.

Athrips lingchuana **Oh & Li, sp. nov.** (Figures 2, 6, 9)

Type material: China, Shanxi: Holotype ♂, Xizha Shui Village, Magedang Township, Lingchuan County, Jincheng City, 900 m, 12-VII-2010, leg. HY Bai & LL Yang, slide No. OHJ20732 (NKU). Paratype: 1 ♀, other same data as holotype, slide No. OHJ20754 (NKU).

Diagnosis: This species is similar to *A. patockai* (Povolný, 1979) in both appearance and male genitalia. It can be distinguished from the latter of the forewing grayish brown with indistinct markings and in the male genitalia by the rectangular uncus, the distal end of the valva is blunt, and the transtilla lobe shorter than 2 times of its width; while in the latter species, the forewing black with distinct markings (Bidzilya, 2005, figures 53-55) and the uncus is trapezoid, the distal end of the valva is sharp, and the transtilla lobe is longer than 3 times of its width (Bidzilya, 2005, figures 120-122). The female genitalia of this species is diagnostic by the ductus bursae with sclerotized part distinctly longer than the apophyses anteriores; while in *A. patockai*, the female genitalis ductus bursae with sclerotized part approximately equal to the apophyses anteriores (Bidzilya, 2005, figures 151, 152).

Description Adult (Figure 2): Wingspan 13.0 mm. Head light grayish brown, with grayish white tipped scales. Labial palpus grayish brown except rather pale on inner surface of second segment and on both inner and ventral surface of third segment, scales tipped with whitish gray; second segment about 1.5 times length of third segment. Antenna: scape dark brown; flagellum dark brown with grayish brown rings. Thorax and tegula grayish brown, with gray tipped scales. Forewing grayish brown, with grayish white tipped scales; indistinct dark brown spot at basal 1/3 and 2/3 of fold respectively; fringe grayish brown. Hindwing and fringe light grayish brown. Fore- and midlegs grayish brown, tibia grayish brown alternated with grayish yellow; femur and tibia of hindleg brownish yellow on outer surface, grayish yellow on inner surface, tarsi grayish brown with grayish yellow rings.

Male genitalia (Figure 6): Uncus rectangular, anterior margin emarginated, posterior margin with long setae. Gnathos sickle-shaped, strongly curved at basal 2/5, apex pointed, slightly hooked. Tegumen with a large semicircular anterior emargination. Valva straight, subparallel from near base to apex; apex far exceeding top of uncus. Sacculus wide basally, narrowed towards apex, distally, slightly bent inward, pointed at apex. Transtilla lobes thumber-like, length shorter than 2 times of width. Saccus short and broad, width about twice of length. Phallus swollen basally, distal portion straight, tapered from distal 1/3 to apex.

Female genitalia (Figure 9): Papillae analis subovate, with hair-like setae. Apophyses posteriores about twice length of apophyses anteriores. Sternite VIII trapezoid, as long as apophyses anteriores, lateral patches of honeycomb pattern at base of apophyses anteriores and near ostium. Ostium bursae with a dorsomedial sclerite. Ductus bursae with sclerotized part longer than apophyses anteriores, slightly broadened towards corpus bursae, coiled once near corpus bursae, with honeycomb pattern at distal 1/5. Corpus bursae ovoid, smooth on inner surface; signum saddle shaped, placed in distal part of ductus bursae.

Distribution: China (Shanxi).

Etymology: The specific name is from the type locality.

Athrips pruinosella (Lienig & Zeller, 1846) (Figures 3, 7, 10)
Gelechia pruinosella Lienig & Zeller, 1846. *Isis von Oken*, *1846*, 288

Material examined: CHINA, Heilongjiang, Tahe County, 3 ♂♂, 29-VII-2009, leg. WC Li & JY Liu, slide Nos. OHJ20234, OHJ20251, OHJ20725 (NKU); Xinjiang: Hemu Township, Burqin County, 1114 m, 1 ♂, 23-VII-2007, leg. XP Wang, slide No. OHJ20726; Baihaba Village, Habahe County, 1264 m, 1 ♀, 27-VII-2007, leg. XP Wang, slide No. OHJ20751.

Diagnosis Adult (Figure 3): Wingspan 13.5-15.0 mm. This species is similar to *A. spiraeae* (Staudinger, 1871), but slightly differs from the latter by the rather dark grayish-brown head, thorax and tegula (Figure 3), the L-shaped gnathos with the straight distal part more than 2/5 of the total length (Figure 7), and the triangular ostium bursae (Figure 10); in the latter species, the head, thorax and tegula are rather pale grayish-brown (Figure 4), the straight distal part of the crescent-shaped gnathos is less than 1/3 of the total length (Figure 8), and the ostium bursae is conical (Figure 11).

According to Bidzilya (2005), *A. pruinosella* differs slightly in the phallus tapered only in its distal quarter whilst in *A. spiraeae* it is evenly tapered from the base to apex; the female genitalia could be separated by the shape of medially elongated lateral sclerites of sternite VIII and the length of sclerotized part of the ductus bursae.

Distribution: China (Heilongjiang, Hebei, Xinjiang), Finland, Russia, Europe, Canada, USA.

Note: This species is **newly recorded in China**.

Athrips spiraeae (Staudinger, 1871) (Figures 4, 8, 11)
Gelechia spiraeae Staudinger, 1871. *Berl. Ent. Ztschr., 14*, 303

Material examined: CHINA, Shanxi, Luya Mountain, Ningwu County, 1450 m, 1 ♂, 1 ♀, 19-VII-2011, leg. SL Hao, JY Liu, slide No. OHJ20729, OHJ20730 (NKU).

Diagnosis Adult (Figure 4): Wingspan 13.5-14.5 mm. *Athrips spiraeae* is diagnostic in the male genitalia by the sub-rectangular uncus, the crescent-shaped gnathos strongly curved at basal 2/3, the valva with apex exceeding tip of the uncus, the sacculus gradually narrowed towards beak-shaped apex, the digitate transtilla lobes, and the phallus evenly tapered to apex (Figure 8). *Athrips spiraeae* is characterized in the female genitalia by the trapezoid sternite VIII as long as the apophyses anteriores and with lateral patches of honeycomb pattern, the conical ostium bursae with a narrow sclerite, and the rounded corpus bursae with spinules on the inner wall and with a saddle-shaped signum (Figure 11).

Athrips spiraeae is similar to *A. pruinosella* internally and externally. The differences between them are stated in the diagnosis of the latter species.

Distribution: China (Shanxi), Russia, Kazakhstan, Ukraine.

Note: This species is **newly recorded in China**.

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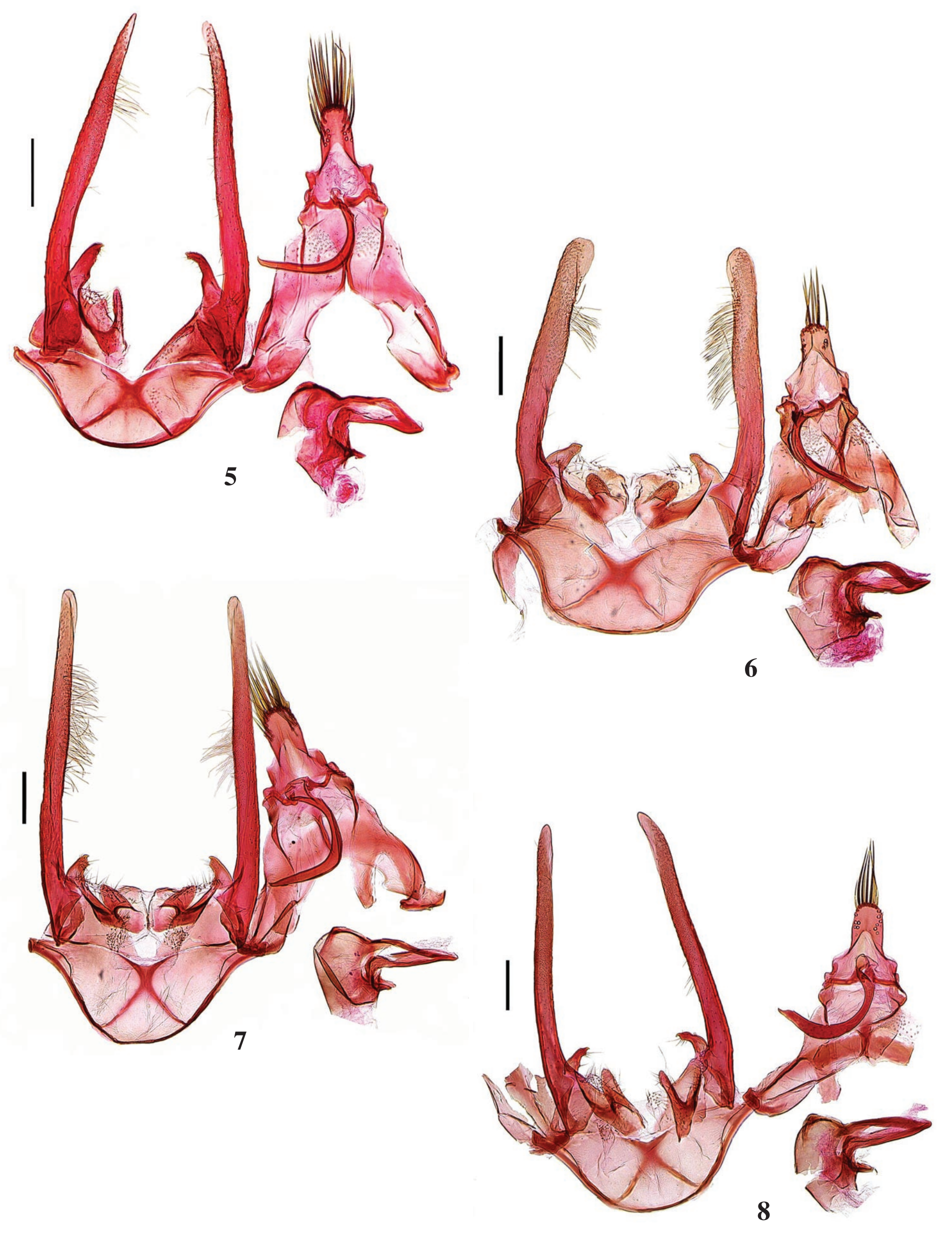
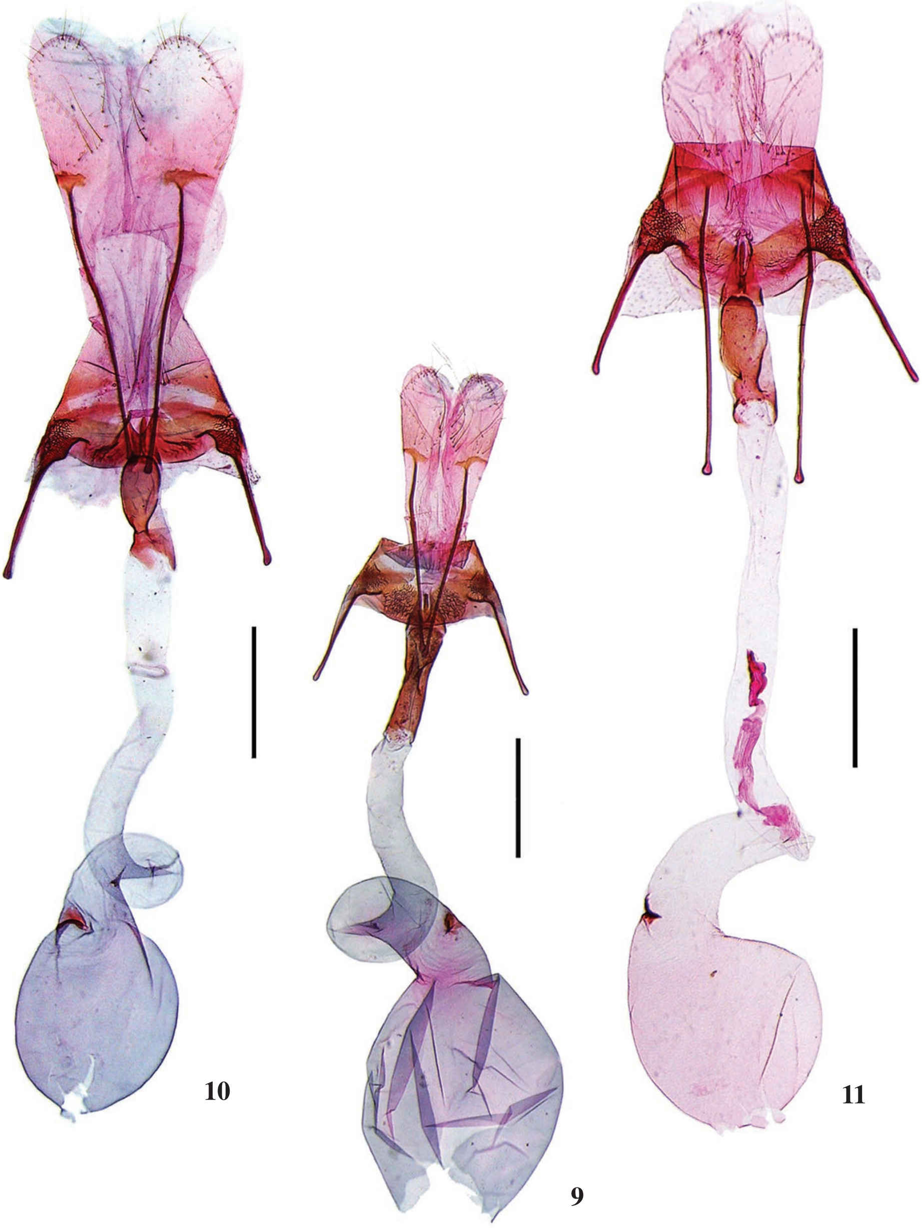


Figures 5-8. Male genitalia of *Athrips* spp. **5.** *A. albimacula* Oh & Li, sp. nov., holotype, slide No. OHJ20753. **6.** *A. lingchuana* Oh & Li, sp. nov., holotype, slide No. OHJ20732. **7.** *A. pruinosella*, slide No. OHJ20726. **8.** *A. spiraeae*, slide No. OHJ20729. (scales = 0.2 mm).



Figures 9-11. Female genitalia of *Athrips* spp. **9.** *A. lingchuana* Oh & Li, sp. nov., paratype, slide No. OHJ20754. **10.** *A. pruinosella*, slide No. OHJ20751. **11.** *A. spiraeae*, slide No. OHJ20730. (scales = 0.5 mm).

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The Jordanian Coleophoridae, with description of two new species: *Coleophora iordanica* Baldizzone, sp. nov. and *C. ratamensis* Baldizzone, sp. nov. Contribution to the knowledge of Coleophoridae CLIV (Lepidoptera: Coleophoridae)

Giorgio Baldizzone

Abstract

The publication deals with the Coleophoridae known for Jordan, a country of which very few species of this family are known. The study of undetermined specimens preserved in the NHMUK allowed the discovery of two new species, which are described in the publication: *Coleophora iordanica* Baldizzone, sp. nov. and *C. ratamensis* Baldizzone, sp. nov. Furthermore, on the basis of the examination of the male genitalia of the holotype of *C. ghorella* Amsel, 1955 it is hypothesized that it is probably a junior synonym of *C. hospitiella* Chrétien, 1915, but the conditions of the genital preparation made by Amsel do not allow to establish it with certainty.
Keywords: Lepidoptera, Coleophoridae, *Coleophora*, new species, Jordan.

Los Coleophoridae jordanos, con la descripción de dos nuevas especies: *Coleophora iordanica* Baldizzone, sp. nov. y *C. ratamensis* Baldizzone, sp. nov. Contribución al conocimiento de Coleophoridae CLIV (Lepidoptera: Coleophoridae)

Resumen

La publicación trata de los Coleophoridae conocidos para Jordania, país del que se conocen muy pocas especies de esta familia. El estudio de ejemplares indeterminados conservados en el NHMUK permitió descubrir dos nuevas especies, que se describen en la publicación: *Coleophora iordanica* Baldizzone, sp. nov. y *C. ratamensis* Baldizzone, sp. nov. Además, sobre la base del examen del examen dela genitalia del macho holotipo de *C. ghorella* Amsel, 1955, se plantea la hipótesis de que probablemente sea un sinónimo menor de *C. hospitiella* Chrétien, 1915, pero las condiciones de la preparación genital realizada por Amsel no permiten establecerlo con certeza.
Palabras clave: Lepidoptera, Coleophoridae, *Coleophora*, nuevas especies, Jordania.

Introduction

The current knowledge on the Coleophoridae of Jordan is very limited, as well as the material present in the museums. There are few reports of entomological expeditions in that region and all dating back to the twentieth century and not in recent years. There are also few publications dealing with Jordanian species (Amsel, 1935, 1955; Baldizzone, 1994) and only two species have been described from that country: *C. jordanella* Amsel, 1935 (junior synonym of *C. serinipennella* Christoph, 1872) and *C. ghorella* Amsel, 1955. The following publication aims to present the annotated list of known species for Jordan and the description of two new species: *Coleophora iordanica*

Baldizzone, sp. nov. and *C. ratamensis* Baldizzone, sp. nov. based on specimens found in the undetermined material of the NHMUK. Following the study of the holotype of *C. ghorella* Amsel, 1955 preserved in the RBINS, it is hypothesized that it is probably a junior synonym of *C. hospitiella* Chrétien, 1915, but the conditions of the genital preparation made by Amsel do not allow to establish it with certainty. In all, therefore, the species of Coleophoridae known for Jordan are only 13, a very low number compared to its faunal potential. It is hoped that new research in the field will finally make it possible to increase the knowledge.

Material and methods

The Euparal slide mounts of dissected genitalia of the new species were photographed with a Bresser 5.0 camera attached to a Bresser BioScienze 40-1000x trinocular microscope, using a Leitz PL Fluotar 6.3 / 0.20 objective. The slide of the male genitalia of *C. incultella* Toll, was photographed with an old Miranda camera body fitted with an adaptor tube to an old “Galileo” microscope equipped with Aus Jena 3:1-0.10 and 6.3:1-0.18 objectives. Black-and-white Ilford PAN F film was used to obtain images with high contrast between the structures and the background. Film negatives were digitized with a scanner. The images were edited in Corel PaintShop Pro. The habitus of the two new species was photographed with a Canon EOS 5D Mark II digital camera equipped with a Canon MP-E 65 mm objective, with lighting provided by two circular neon lamps OSRAM L 32W / 8400 C (cool white).

The species are listed in alphabetical order. In the geographical distribution, after the word “Jordan” the bibliographic reference relating to the citation of its presence in the country is indicated. Morphological terms follow Baldizzone (2019).

Abbreviations

Bldz = Giorgio Baldizzone
GP = genitalia preparation
MfN = Museum für Naturkunde, Berlin, Germany
NHMUK = The Natural History Museum, London, U.K. (formerly British Museum of Natural History = BMNH)
RBINS = Royal Belgian Institute of Natural Sciences, Brussels, Belgium

Taxonomy

Coleophora aleramica Baldizzone & Stübner, 2007

Distribution: France, Italy, Austria, Croatia, Slovakia, Hungary, Montenegro, Macedonia, Greece, Turkey, Jordan (Stübner, 2007).

Coleophora amasiella Stainton, 1867

Distribution: North Macedonia, Turkey, Palestine, Syria, Jordan (Baldizzone, 1994), Iraq, Iran, Afghanistan.

Coleophora changaica Reznik, 1975

Distribution: Portugal, Spain, Ukraine, Crimea, Russia (Southern Ural), Turkmenistan, Turkey, Morocco, Algeria, Jordan (Baldizzone, 1997), Afghanistan, Mongolia, China.

Coleophora derbendella Baldizzone, 1994

Distribution: Iran, Syria, Jordan (Baldizzone, 1994).

Coleophora dubiella Baker, 1888

Distribution: France, Spain, Bulgaria, North Africa, Caucasus, Russia (Lower Volga), Turkey, Azerbaijan, Jordan (Baldizzone, 1994), Iraq, Iran, Afghanistan.

Note: Under the name of *C. dubiella* there is probably a complex of species (Tabell com. pers.) which it is hoped to be able to clarify with genetic and morphological studies, restoring the status of bona species to some species considered junior synonyms in the World Catalogue of Coleophoridae (Baldizzone et al. 2006).

Coleophora galligena Falkovitsh, 1970

Distribution: Turkmenistan, Uzbekistan, Jordan (Baldizzone, 1994), Pakistan.

Coleophora ghorella Amsel, 1955 (Figures 1-2, 5-6)

Holotype ♂ "TYPE" [pink label]; "Ain Etturaba | Mer Morte, alt. 390 m. | 16-III-1953 | Ph. Lippens"; "R. I. Sc. N. B. I. B."; "GU 2257"; "Coleophora ghorella" [red label]; "Coleophora ghorella Ams. | det. H. G. Amsel 1954", coll. RBINS.

The species was described by Amsel from a single male specimen collected in Ain Etturaba near the Dead Sea. The description is rather short and not complete according to the current standard. The adult is not represented in the publication in which there is only a schematic drawing of the genitalia. Thanks to the kind collaboration of Willy de Prins and Stefan Kerkhof, curator of the RBINS, I was able to study the specimen through some good photographs of the adult (Figure 1) and the genitalia slide that was sent to me. The specimen is in fair condition, while the genitalia were not perfectly prepared, with the abdomen full of opaque organic substance and the vesica is missing (Figures 2, 5-6). Amsel in the original description had written that his new species was close to *C. asiaeminoris* Toll, 1952, a species known only from Turkey, which belongs to the group of *C. fringillella* Zeller, 1839. The examination of the genitalia however revealed that the species is most probably a junior synonym of *C. hospitiella* Chrétien, 1915, species known from Canary Islands, North Africa, Saudi Arabia, Iran, Afghanistan, Uzbekistan (Baldizzone & Tabell, 2005). The genitalia of both sexes of *C. hospitiella* were first published by Baldizzone (1979) and subsequently by Nel (2001) and by Baldizzone & Tabell (2005). In an attempt to obtain a more adequate view of the genital preparation of the holotype of *C. ghorella*, I rearranged the photo with a photo editing program (Figure 5) and inserted it on a plate below the photo of the male genitalia of a specimen of *C. hospitiella* Chrétien, 1915 from Tunisia (Figure 3). The analogies are evident, but out of prudence I do not proceed to establish the new synonymy, hoping that in the future we can obtain other material of this species recently collected in Jordan, which will allow to obtain a definitive answer.

Coleophora jerusalemella Toll, 1942

Distribution: Spain, Greece, Crete, Cyprus, Turkey, Lebanon, Palestine, Syria, Jordan (Baldizzone, 1996), Iran, Algeria, Morocco, Oman, United Arab Emirates.

Coleophora parthenica Meyrick, 1891

Distribution: Romania, Greece, Crete, Cyprus, Lebanon, Egypt, Algeria, Morocco, Russia (Lower Volga), Caucasus (Armenia, Azerbaijan), Transbaikalia, Iran, Turkmenistan, Jordan (Baldizzone, 1994), Mongolia, U.S.A. (introduced).

Coleophora serinipennella Christoph, 1872 (= *Coleophora jordanella* Amsel, 1935)

Distribution: Portugal, Spain, France, Southern and Central Europe, Romania, Balkans, Caucasus, North Africa, Jordan (Baldizzone, 1994) to Japan, Australia.

Coleophora tamesis Waters, 1929

Distribution: Europe, Morocco, Turkey, Caucasus, Jordan (Baldizzone, 1994), Turkmenistan, Afghanistan, Russian Far East, China.

Description of new species:

Coleophora iordanica Baldizzone, sp. nov. (Figures 7, 10-12)

Holotype ♂ (GP Bldz 16966) “9.3.1955 | Jordan Valley | Zerqa R.[iver] Colony | c. 100 m. below S.[ea] L.[evel] at light | Trevor Trought”; “Brit.[ish] Mus.[eum] 1963-255”; “QR code NHMUK 010897653”, coll. NHMUK.

Diagnosis: Due to the structure of the male genitalia, *C. iordanica* is close to *C. incultella* Toll, 1952, a species known only from Algeria and to *C. hinnula* Baldizzone, 1995, species described from Morocco. Of both species only the male is known. In the original description of *C. incultella*, in French, Toll illustrated the male genitalia with a drawing, while in his posthumous volume of 1962 written in German, the head, the forewing and the abdominal structures were illustrated in addition to the male genitalia.

C. iordanica is a medium-sized species, with overall appearance brownish grey, with brown streaked veins. As for the differences with *C. incultella*, the difference in the habitus of the adult is evident: *C. iordanica* (Figure 7) is much darker than *C. incultella* (Figure 8) which has an overall white appearance, with white forewing streaked light ochre along the veins. In the abdominal structures the difference is evident in the transverse strut, which in *C. iordanica* (Figure 12) is much thicker and more curved, with the distal edge narrower and thicker than that of *C. incultella* (Figure 15), which is straight and wider. In the male genitalia of *C. iordanica* (Figures 10-11) the gnathos knob is more rounded, compared to those of *C. incultella* (Figures 13-14) the tegumen is a little shorter and robust, less constricted medially, the valvula is larger without a characteristic blunt triangular protuberance at the apex on the outer edge of *C. incultella*, the cucullus is more curved and robust, while that of. *C. incultella* is straight and thinner, the sacculus has a more curved ventral edge, the phallotheca is shorter than that of *C. incultella*, of which the apex extends beyond the upper edge of the valve. As for the differences with *C. hinnula* the most evident are the following: in *C. hinnula* the general colour is white and not brown; in the male genital the transtilla is shorter and more robust than that of *C. iordanica*, the cucullus is shorter and curved, the outer edge of the valvula is much more inclined in the part above the cucullus and more prominent at the base of the cucullus, the sacculus is wider and sharper.

Description (Figure 7): Wingspan 15 mm. Head dirty white, brown suffused on the dorsum. Antenna: scape white, ochre suffused on the outside, brown on the inner side, with a short tuft of erect scales; flagellum dirty white, brown ringed. Labial palpus brown, dirty white suffused dorsally; the second segment is about twice the length of the third. Proboscis of normal shape. Thorax and tegula brown. Forewing brownish grey, veins streaked with brown, cilia brownish grey. Hindwing light grey, cilia grey. Abdomen brown.

Abdominal structures (Figure 12): No posterior lateral struts. Transverse strut very thick, curved, more sclerified on the distal edge. Tergal discs (3rd tergite) length about 4.5 times their width, covered with about 45 conical spines. The abdomen was partially destroyed by parasites.

Male genitalia (Figures 10-11): Gnathos knob globular. Tegumen medially constricted, pedunculus slightly expanded externally. Transtilla straight, rather short, wider at the base. Valvula large suboval, with a narrow recurved fold on the outer edge that does not cross the valva margin. Cucullus robust, more expanded ventrally in the middle, slightly narrowed at the base. Sacculus narrow, its apex expands to about the middle of the cucullus, thick and slightly curved ventral edge and subtriangular dorsal angle with a small rounded tooth-like protuberance. Phallotheca short, conical, completely sclerified in basal half and only dorsally in distal half. Vesica long and narrow, without cornuti.

Bionomy: Unknown.

Distribution: Jordan. The locality indicated in the original label is “Zerqa, Jordan R. Colony”, whose geographical location was indicated in a drawing by Amsel inserted in his 1955 publication as “Zerqa river colony” (op. cit.). The current name is Zarqa.

Etymology: The name derives from the Latin *iordanicus* (*-a*, *-um*) which indicates the correlation with the Jordan River.

Coleophora ratamensis Baldizzone, sp. nov. (Figures 9, 16-19)

Holotype ♂ (GP Bldz 16961) “JORDAN: Wadi er Ratam. 24.iv.- 10.v.1966. D. S. Fletcher”; “International Jordan Exped[itio]n. 1966. B. M. 1966-298”; “QR code NHMUK 010897746”, coll. NHMUK. Paratype ♂ (GP Bldz 17024) same labels, QR code NHMUK 010897743, coll. NHMUK.

Diagnosis: The new species belongs to the group of *C. involucrella* Chrétien, 1905 and due to the habitus and structure of the male genitalia, *C. ratamensis* is close to *C. celsa* Baldizzone, 1994, a slightly smaller (wingspan 15 mm) species known only from Iran. In the male genitalia *C. ratamensis* (Figures 16-18), compared to those of *C. celsa* (Figures 20-21), the transtilla is more robust, the lateral edge of the valvula, covering the base of the cucullus, is shorter in the area between the lower edge of the cucullus and the dorsal edge of the sacculus. The sacculus is more inclined and longer on the outer edge, where it ends in the dorsal angle with a small tooth, smaller than that of *C. celsa*, and the ventral edge is thicker than that of *C. celsa* with a deeper incision. The cornuti are less numerous than in *C. celsa* and the claw-like structure in which they are gathered is inserted on a laminar base absent in *C. celsa*.

Description (Figure 9): Wingspan 17-18 mm. Head glossy white. Antenna glossy white, scape with long tuft of erect scales, slightly yellow-tinged. Labial palpus short, completely glossy white, the second segment is about twice the length of the third. Proboscis of normal shape. Thorax glossy white, yellow-tinged in middle. Tegula white, yellow-tinged on internal side. Forewing with four glossy white stripes: the widest along the costa, a short and slightly curved one on the lower edge of the cell, a thin one along the anal fold, and a short and thin one along the dorsum; the colour between the costal and anal stria is ochre, which becomes yellowish in the direction of the anal stria, and even lighter in the part between the anal and dorsal stria; costal cilia white, ochre at the apex, dorsal cilia yellowish grey. Hindwing grey, yellowish grey cilia. Abdomen white.

Abdomen (Figure 19): Posterior lateral struts about 2/3 length of the anterior. Transverse strut thick, straight on the proximal edge, with a small sclerified line only in the middle and slightly curved on the distal edge, which is thicker and more sclerified. Tergal discs (3rd tergite) length about 3 times their width, covered with about 50 small conical spines.

Male genitalia (Figures 16-18): Gnathos knob globular. Tegumen large and squat, pedunculus short. Transtilla curved and elongated, wider at the base. Valvula with rounded ventral edge and curved outer edge, protruding between the base of the cucullus and the dorsal part of the sacculus. Cucullus short, narrower at the base in the shape of an ear. Sacculus curved, very hollow on the inner side of the ventral edge, ends with a small triangular tooth-like protuberance in the dorsal corner. Phallotheca conical, more sclerified in the basal part. About 10 cornuti shaped like spines of different length, gathered in a claw-like formation inserted on an irregular base of laminar shape.

Bionomy: Unknown.

Distribution: Jordan, Wadi ar Ratam [31º51’N 36º48’E]. Information on the geographic coordinates of this locality was obtained from a publication by Mahasneh & Katbeh-Bader on the Orthoptera, Tettigoniidae of Jordan (2004).

Etymology. The name derives from the place where the species was collected.

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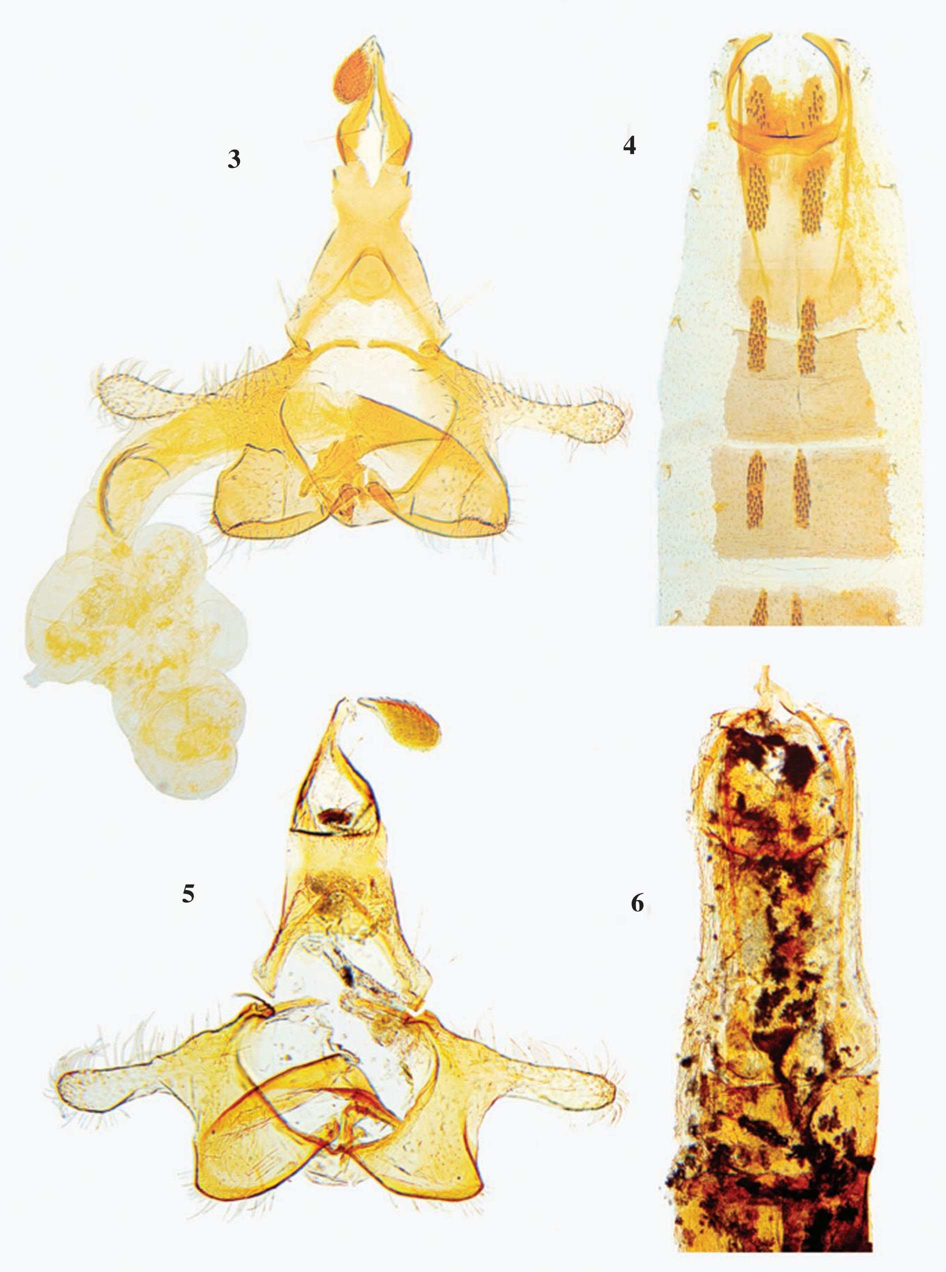
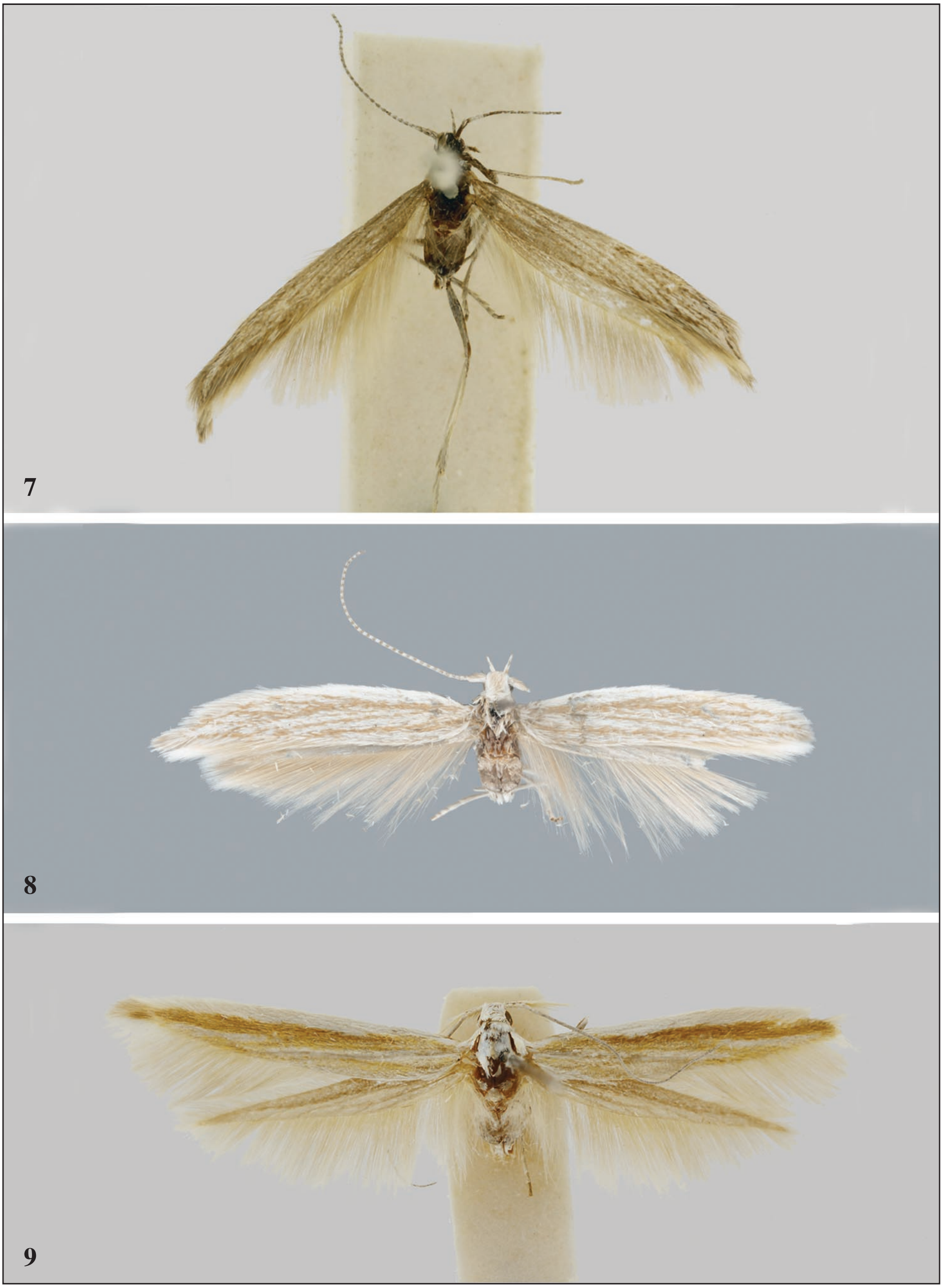
Figures 1-2. 1. *Coleophora ghorella* Amsel, 1955 - holotype (wingspan 19 mm). **2.** Male genitalia (GP Amsel 2257).



Figures 3-6. 3. *C. hospitiella* Chrétien, 1915 - male genitalia (GP Bldz 13659) Tunisia, Bou Hedma, 28-II-1929, C. Dumont leg., coll. Baldizzone. **4.** Abdomen. **5.** *Coleophora ghorella* Amsel, 1955 - photo of male genitalia rearranged with photo editing program. **6.** Abdomen.



Figures 7-9. 7. *C. iordanic*a Baldizzone, sp. nov. - holotype (wingspan 15 mm). **8.** *C. incultella* Toll, 1952 - holotype (wingspan 14 mm). **9.** *C. ratamensis* Baldizzone, sp. nov. - holotype (wingspan 18 mm).

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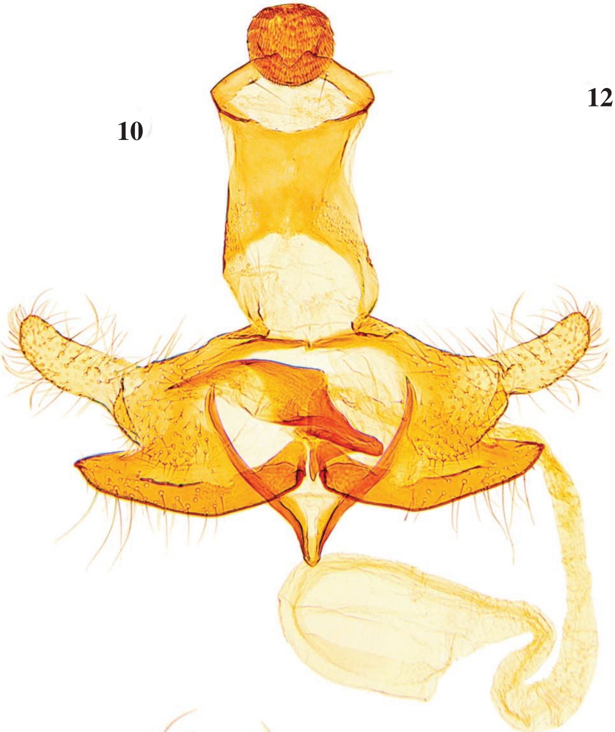

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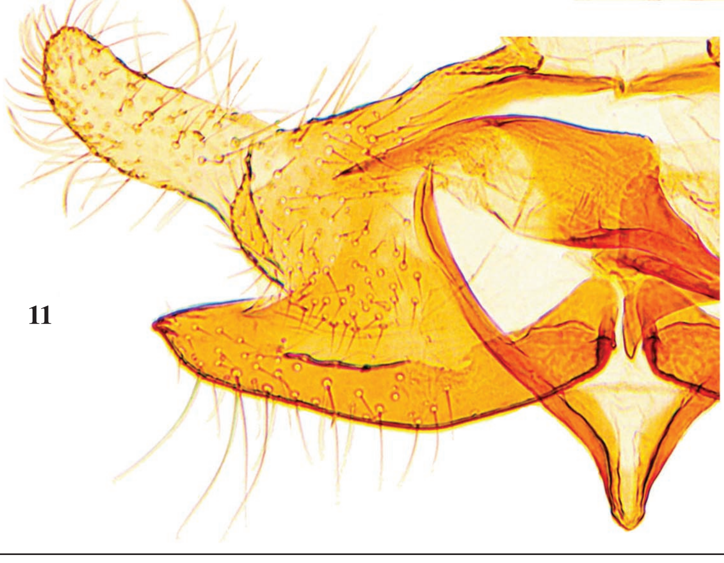
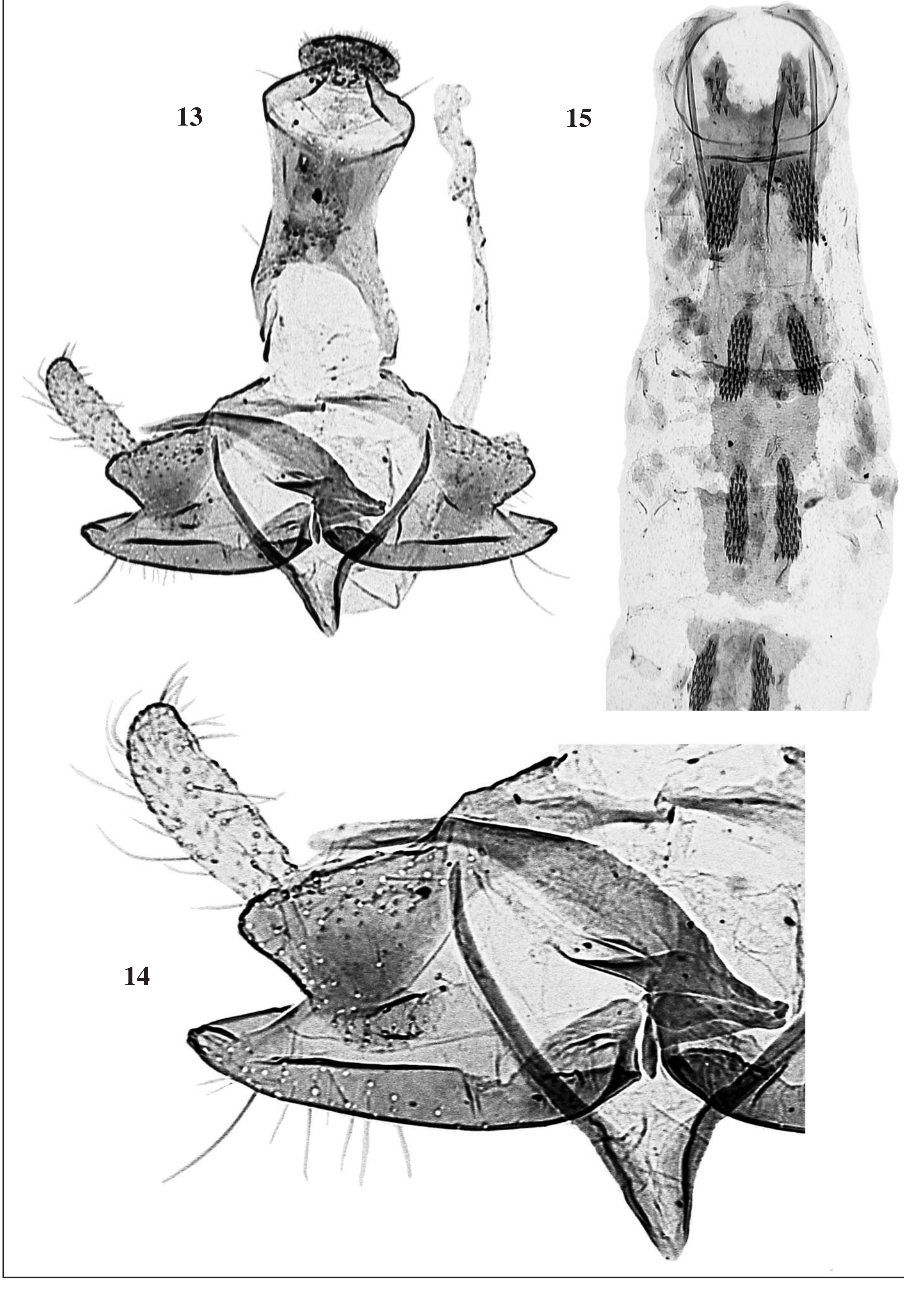
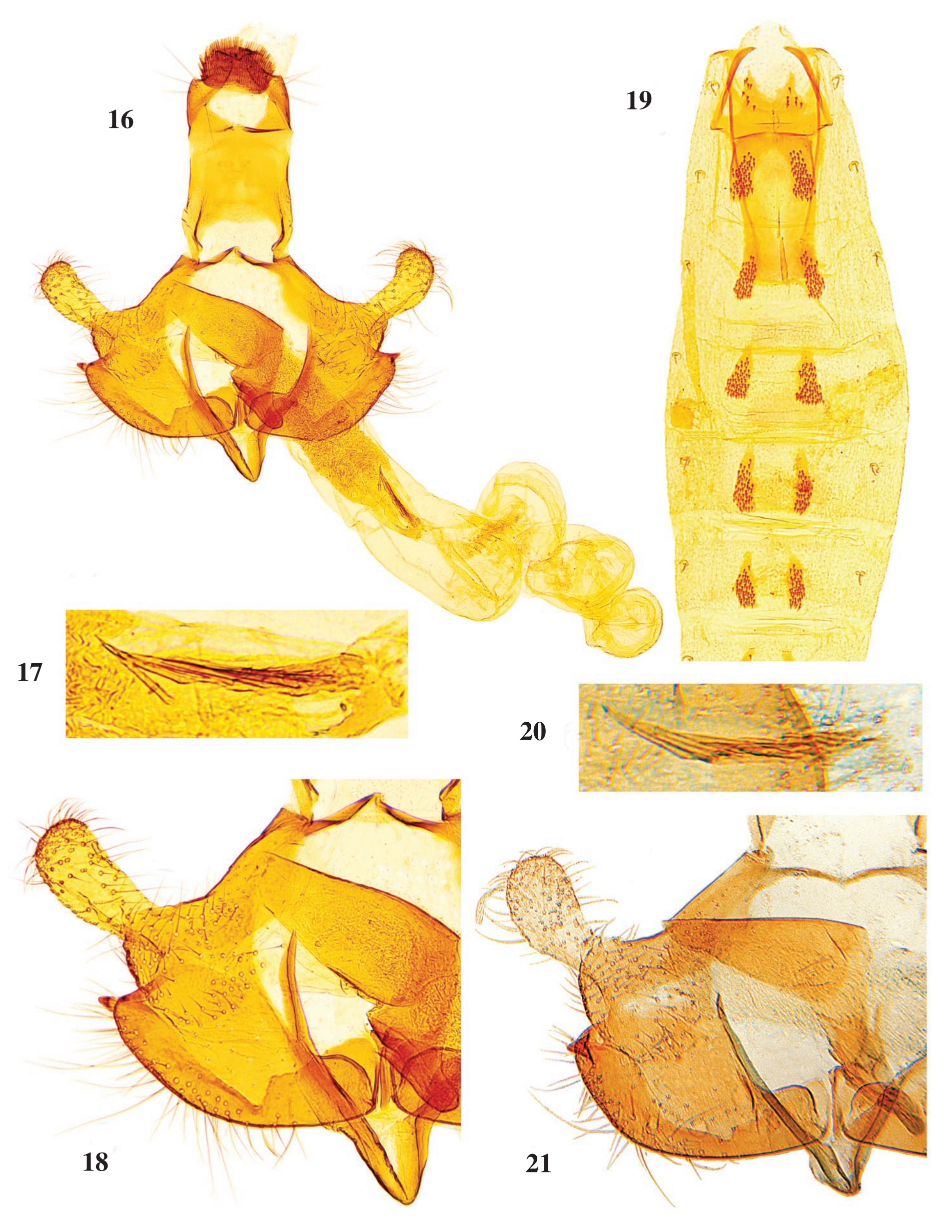


Figures 10-12. 10. *C. iordanica* Baldizzone, sp. nov. - male genitalia, holotype (GP Bldz 16966). **11.** Enlarged detail of valva and phallotheca. **12.** Abdomen.



Figures 13-15. 13. *C. incultella* Toll, 1952 - male genitalia, holotype (GP Toll 431). **14.** Enlarged detail of valva and phallotheca. **15.** Abdomen.



Figures 16-21. 16. *C. ratamensis* Baldizzone, sp. nov. - male genitalia, holotype (GP Bldz 16961). **17.** Enlarged detail of cornuti. **18.** Enlarged detail of valva and phallotheca. **19.** Abdomen. **20.** *C. celsa,* Baldizzone, 1994 - male genitalia, holotype (GP Bldz 5749) enlarged detail of cornuti. **21.** Enlarged detail of valva and phallotheca.

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Hyphantria cunea (Drury, 1773) new for the Maltese Islands (Lepidoptera: Erebidae, Arctiinae, Arctiini)

Anthony Seguna, Aldo Catania, Paul Sammut & John J. Borg

Abstract

The genus *Hyphantria* Harris, 1841 and the species *Hyphantria cunea* (Drury, 1773) are recorded for the first time from the Maltese Islands. Notes on the distribution, habits of the adult and larval host plant are included. A Maltese name is proposed for this new record.

Keywords: Lepidoptera, Erebidae, Arctiinae, Arctiini, *Hyphantria cunea*, new records, Maltese Islands.

Hyphantria cunea (Drury, 1773) nueva para Malta (Lepidoptera: Erebidae, Arctiinae, Arctiini)

Resumen

El género *Hyphantria* Harris, 1841 y la especie *Hyphantria cunea* (Drury, 1773), se registran por primera vez para Malta. Se incluyen datos sobre su distribución, hábitat del adulto y la planta nutricia de la larva. Se propone un nombre maltés para esta nueva cita.

Palabras clave: Lepidoptera, Erebidae, Arctiinae, Arctiini, *Hyphantria cunea*, nuevo registro, Malta.

Introduction

To date the Subfamily Arctiinae, tribe Arctiini in Malta is represented by four other species, *Phragmatobia fuliginosa* (Linnaeus, 1758) ssp. *melitensis* O. Bang-Haas, 1927, *Cymbalophora pudica* (Esper, 1785), *Arctia villica* (Linnaeus, 1758) and *Utethesia pulchella* (Linnaeus, 1758) (Sammut, 2020).

Hyphantria cunea (Drury, 1773) is native to North America, ranging from Canada to Mexico and has been introduced into other continents. The species was introduced to Central Europe (Hungary) in the forties of the last century from where it has rapidly spread into large areas of Europe except the Iberian Peninsula (Witt et al. 2011).

Apart from Europe this species range now extends into Central and Far East Asia from Turkmenistan, Uzbekistan, Kyrgyzstan, and southeastern Kazakhstan. Introduced into Japan in 1945 it adjusted its number of generations per year since its arrival (GomiI & Takeda, 1996). It has also found its way into China, southern Mongolia, Korea and southern Russia.

Discussion

The adult moth lays clusters of a few hundred “hair-covered” eggs on the underside of leaves (Douce, 2006). Larvae feed and live inside self-created large webs made of silk until the late instars.

Very young larvae feed only on the upper surfaces of leaves. Later, they consume entire leaves. The larval stage lasts about four to six weeks (Hyche, 1999).

The larvae are polyphagous feeding on a wide variety of deciduous trees, sometimes causing entire defoliation of the host plant. To date the larvae have been recorded on over 600 different species of trees and it is among the most polyphagous of insects (Warren & Tadic, 1970).

In the authors' opinion this species may have been introduced accidentally through the importation of ornamental and fruit trees by local garden centres.

Material examined

MALTA, 1 ♂ Naxxar. Tas-Sgħajtar, 12-V-2022, (35º 54' 35.3"N, 14º 26' 29.4"E, Alt. 108 m). Actinic Moth Trap, A. Seguna leg.

The collecting site at Naxxar is a residential area with some mature and fully grown *Quercus ilex* L. trees, planted for landscaping in a public garden opposite the site. A search by the first author on these above-mentioned trees to see if there are larvae on them have resulted in the negative.

We propose the Maltese name "in-Nissieġa", being the transliteration of the Greek word *Hyphantria* meaning "a female weaver".

Hyphantria cunea (Drury, 1773) male, Naxxar. Underside showing the bright yellow colour of the front legs.

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The authors would like to thank Dr Antonio Vives for the Spanish abstract.

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Two new records of Rhopalocera from Union Territory of Jammu and Kashmir, India (Insecta: Lepidoptera)

Talisma Sheikh & Muhammad Asghar Hassan

Abstract

Chilades parhassius (Fabricius, 1793) and *Choaspes benjaminii japonica* Murray, 1875, are first time reported from Jammu and Kashmir Union Territory, India.

Keywords: Insecta, Lepidoptera, *Chilades*, *Choaspes*, Jammu, Kashmir, India.

Dos nuevos registros de Rhopalocera en el territorio de la Unión de Jammu y Cachemira, India (Insecta: Lepidoptera)

Resumen

Chilades parhassius (Fabricius, 1793) y *Choaspes benjaminii japonica* Murray, 1875, se citan por primera vez en el Territorio de la Unión de Jammu y Cachemira, India.

Palabras clave: Insecta, Lepidoptera, *Chilades*, *Choaspes*, Jammu, Cachemira, India.

Introduction

In India there are two subspecies of *Chilades parhassius* (Fabricius, 1793): *Chilades parhassius parhassius* (Fabricius, 1793) and *Chilades parhassius minuta* (Evans, 1932) and two subspecies of *Choaspes benjaminii* (Guérin-Méneville, 1843): *Choaspes benjaminii japonica* Murray, 1875 and *Choaspes benjaminii benjaminii* (Guérin-Méneville, 1843).

Chilades parhassius parhassius (Fabricius, 1793) has the range extension from Rajasthan to Kerela and eastward to Uttar Pradesh, Himachal Pradesh, and Uttarakhand. While *Choaspes benjaminii japonica* Murray, 1875 has the range extension from Himachal Pradesh to Northeast India and *Choaspes benjaminii benjaminii* (Guérin-Méneville, 1843) has the range extension from Karnataka to Kerela (Varshney & Smetacek, 2015).

Chilades parhassius parhassius (Fabricius, 1793) is uncommon in peninsular and northwestern India. Can be found in Western Ghats but at low elevations from Kerela and Tamil & Nadu, northern part of Karnataka, Telangana, Goa and from Maharashtra up to Gujarat, also found in Rajasthan, Haryana, southern part of Uttar Pradesh, Madhya Pradesh and Chhatisgarh and also distributed to Himachal Pradesh (Shimla at an altitude of 2050 m, fide Wynter-Blyth) and from Nepal where there is an old record from terai. *Chilades parhassius minuta* is recorded in Northwestern India in Punjab east to Chandigarh. There is no record of it from Jammu and Kashmir (Gasse, 2018).

Choaspes benjaminii benjaminii (Guérin-Méneville, 1843) is fairly common in Southwestern Ghats that too above 1000 m i.e., in Kerela, West Tamil Nadu and in Kodagu area of Southwest Karnataka. Whereas *Choaspes benjaminii japonica* Murray, 1875 is fairly common in Himalayas from 300-2700 m, seen West of Kangra in Himachal Pradesh and Eastern part of Uttarakhand, Nepal, Sikkim, Northwest Bengal and from Bhutan to Arunachal Pradesh and the remaining Northeast India but not recorded from Mizoram. There is no record of it from Jammu and Kashmir.

From decade, some researchers have made research in some parts of the Union Territory and have added many new sightings of Rhopalocera fauna of Jammu and Kashmir, India i.e., (Qureshi *et al*., 2013a, 2013b, 2014; Sharma & Sharma, 2017a, 2017b, 2018a, 2018b, 2020) and many other articles by Sharma & Sharma (2017a, 2017b, 2018), Sheikh & Parey (2019a, 2019b), Sharma & Sharma (2020), Gupta & Sheikh (2021), Sheikh (2021), Singh & Sheikh (2021), Parey & Sheikh (2021), Dar et al. (2022a, 2022b), Sheikh et al. (2021), Sheikh & Gupta (2022), Sheikh & Mishra (2022a, 2022b), Sheikh & Dar (2022).

Choaspes benjaminii japonica Murray, 1875

On 15-IV-2022, author observed the Rhopalocera in Bani tehsil, and she found the *Choaspes benjaminii japonica* Murray, 1875 (Figure 1) belonging to Hesperiidae family nectarine on flowers of *Melia azedarach* L. for half an hour and later on she found three to four individuals' nectarine on the same tree. The author photographed this Rhopalocera with the help of Canon Eos 1300 D, and noted down the coordinates of the area (32º42'42.8'' N, 74º48'58.1'' E) at an altitude of around 1350 m a.s.l. The vegetation around was *Alnus nitida* Spach, *Rubus niveus* Thunb, *Rubus ellipticus* Sm., *Berberis lycium* Royle*, Ficus carica* L., *Juglans regia* L., etc.

Chilades parhassius parhassius (Fabricius, 1793)

On 11-V-2022, author has done survey on the Rhopalocera of Bani area of Kathua district (Figure 2) of Jammu and Kashmir Union Territory where she found *Chilades parhassius parhassius* (Fabricius, 1793) (Figure 1) belonging to Lycaenidae family nectarine on *Trifolium repens* where author photographed this butterfly with the help of Canon Eos 1300 D, and noted down the coordinates of the area (32º42'26.7'' N, 74º48'43.8'' E) at an altitude of around 1350 m a.s.l. After this sighting author found the same species in many areas of Bani like in Duggan, Dalangal, Sida etc. The study was carried out in Kathua district of Jammu and Kashmir. It is located between 75.5173º E longitude and 32.3865º N latitude. The average annual rainfall is 1360 mm. The study area experiences a sub-tropical climate. The Kathua district has its border with Pakistan, Punjab and Himachal Pradesh. The vegetation around the sighting was; *Rhododendron arboretum* Sm., *Prinsepia utilis* Royle, *Quercus leucotrichophora* A. Camus, *Melia azedarach* L., *Alnus nitida* Spach, *Rubus niveus* Thunb, *Rubus ellipticus* Sm., *Berberis lycium* Royle, etc.

Identification

Identification was done with the help of following to Evans (1932), Wynter-Blyth (1957), Kehimkar (2016) and Smetacek (2018).

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Figures 1-2. 1. *Choaspes benjaminii japonica* Murray, underwings. **2.** *Chilades parrhasius* (Fabricius), nectarine of *Trifolium repens*.

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Noctuidae of Khabr National Park, part II. A new species of the genus *Polymixis* Hübner, [1820] from Iran (Lepidoptera: Noctuidae, Xyleninae)

Asghar Shirvani

Abstract

Present paper includes the result of the new expeditions carried out in order to collect Noctuidae from Khabr National Park, Kerman, south of Iran. The description of a new *Polymixis* species, *Polymixis* (*Eremophysa*) *fakherehsabae* Shirvani, sp. nov. is given. The new species is compared with its close relatives, besides, bionomic and distribution of *P. fakherehsabae* are presented together with the adult and the male genitalia illustrations. Provincial distribution of the species belonging to the subgenus *Eremophysa* Boursin, 1958 in Iran is provided.
Keywords: Lepidoptera, Noctuidae, Xyleninae, *Polymixis*, new species, taxonomy, Iran.

Noctuidae del Parque Nacional de Khabr, parte II. Una nueva especie del género *Polymixis* Hübner, [1820] de Irán (Lepidoptera: Noctuidae, Xyleninae)

Resumen

El presente trabajo incluye el resultado de las nuevas expediciones realizadas para recolectar Noctuidae en el Parque Nacional de Khabr, Kerman, al sur de Irán. Se describe una nueva especie de *Polymixis*, *Polymixis (Eremophysa) fakherehsabae* Shirvani, sp. nov. La nueva especie se compara con sus parientes cercanos, además, se presenta la bionomía y la distribución de *P. fakherehsabae* junto con el adulto y las ilustraciones de la genitalia del macho. Se proporciona la distribución provincial de las especies pertenecientes al subgénero *Eremophysa* Boursin, 1958 en Irán.
Palabras clave: Lepidoptera, Noctuidae, Xyleninae, *Polymixis*, nueva especie, taxonomía, Irán.

Introduction

At the first attempt to explore and identify the noctuid moths s. l. of Khabr National Park (KNP) (Kerman, Iran), Shirvani (2012a) reported 42 species including one new record for the country. After a decade, new expeditions were conducted again to investigate the biodiversity of this territory. One of the results of these efforts is describing a new species belonging to the subgenus *Eremophysa* Boursin, 1958 the genus *Polymixis* Hübner, [1820] of subtribe Antitypina Forbes & Franclemont, 1954 (Keegan et al. 2021; Lafontaine & Fibiger, 2006). The genera associated with the subtribe Antitypina differ from those in Xylenina Guenée, 1837 in having a short ampulla on the clasper (Fibiger & Lafontaine, 2005). The genus *Polymixis*, one of the largest paraphyletic genera of trifine Noctuidae, comprises more than seventy described species in the Palearctic region (Ronkay et al. 2001). With new discoveries during the last decades, the taxonomic interpretation of the species-groups of *Polymixis* is debatable due to the lack of recognized autapomorphies and may be resolved using comprehensive molecular phylogenetic analysis (Benedek et al. 2021).

Eremophysa was first established by Boursin (1958) as a genus for *Polymixis gracilis* (Brandt, 1941), *Polymixis hedygramma* (Brandt, 1941), *Polymixis scrophulariae* (Wiltshire, 1952), *Polymixis acharis* (Püngeler, 1901) and *Polymixis calamistis* (Hampson, 1906). Dividing the large complex genus *Polymixis* into 11 subgenera, Hacker & Ronkay (1992) downgraded *Eremophysa* to a subgenus of *Polymixis* that includes large and relatively light colored species whit tubular vesica constituted of several diverticula armed with a bundle of cornuti (distal diverticulum) and large cornuti (proximal diverticula). The subgenus *Eremophysa* with mainly autumnal flying adults comprises, so far, 11 species and three subspecies in the Palearctic (Hacker & Ronkay, 1992; Ronkay & Gyulai, 2006; Gyulai et al. 2014) none of them occurring in the Europe.

Five *Polymixis* species of the subgenus *Eremophysa*, all with Iranian type locality have been described from Iran (Shirvani, 2012b). The present paper describes a new species, *Polymixis* (*Eremophysa*) *fakherehsabae* Shirvani, sp. nov. from south of Iran, Khabr National Park, Kerman. The new species is compared with its close relatives and the information on the bionomic and distribution of *P. fakherehsabae* are presented together with the adult and the male genitalia illustrations. Provincial distribution of the species belonging to the subgenus *Eremophysa* in Iran is provided.

Material and Methods

Abbreviations used:

KNP = Khabr National Park, Kerman, Iran
SHBUK = Shahid Bahonar University of Kerman, Kerman, Iran

Adult moths were collected by LED light trap (a handmade structure including 24 UV, one blue, one green and one white LEDs arranged on a three-dimension structure, powered by 12-V batteries) in October 2021. The specimens were photographed by a Canon digital camera (Power Shot A710) and the photographs of the genitalia were taken by an Olympus SZH stereomicroscope with an Omax (18 Mp) A35180U3 digital camera.

Results

“Palearctic species of the genus *Polymixis* Hübner, [1820], subgenus *Eremophysa* Boursin, 1958:”

P. colluta (Draudt, 1934)
  = *parka* Sukhareva, 1976
  subsp. *apotheina* Brandt, 1938
  = *laristana* Brandt, 1941
  subsp. *exspectata* Hacker, 1987
P. argillosa Boursin, 1970
P. scrophulariae (Wiltshire, 1952)
P. acharis (Püngeler, 1901)
  = *intermissa* Boursin, 1944
  subsp. *afghana* Boursin, 1963
P. calamistis (Hampson, 1906)
P. gracilis (Brandt, 1941)
P. rohrei Boursin, 1961
P. omanensis Boursin, 1970
P. hedygramma (Brandt, 1941)

P. pirkadatka Ronkay & Gyulai, 2006
P. fakherehsabae Shirvani, sp. nov.
P. serratilinea Gyulai, Ronkay & Ronkay, 2014

Polymixis colluta apotheina (Brandt, 1938)
Sidemia apotheina Brandt, 1938, *Ent. Rdsch., 55*, 522
L.T.: IRAN, Karaj

Distribution in Iran: Fars, Sistan-va-Balouchestan, Lorestan (Brandt, 1941), Kerman (Shirvani et al. 2012), Hormozgan (Lehmann et al. 2009), Khuzestan, Golestan, Khorasan-e-Shomali, Kohgiluyeh-va-Boyerahmad, Kurdistan (Shahreyari-Nejad et al. 2018). Golestan, Khorasan (Wieser & Stanselmaier, 2005), Tehran, Azarbayjan-e-Gharbi (Ebert & Hacker, 2002).

Polymixis scrophulariae (Wiltshire, 1952)
Sidemia scrophulariae Wiltshire, 1952. *Bull. Soc. Fouad 1er Ent., 36*, 194
L.T.: IRAN, Fars

Distribution in Iran: Fars (Wiltshire, 1952).

Polymixis gracilis (Brandt, 1941)
Sidemia gracilis Brandt, 1941. *Mitt. münch. ent. Ges., 31*, 849
L.T.: IRAN, Laristan, Sistan-va-Balouchestan

Distribution in Iran: Lorestan, Sistan-va-Balouchestan (Brandt, 1941; Ebert & Hacker, 2002)

Polymixis hedygramma (Brandt, 1941)
Sidemia hedygramma Brandt, 1941. *Mitt. münch. ent. Ges., 31*, 849
L. T.: IRAN, Laristan, Sistan va Balouchestan

Distribution in Iran: Lorestan, Sistan-va-Balouchestan (Ebert & Hacker, 2002), Khorasan-e-Jonubui (Shahreyari-Nejad et al. 2018).

Polymixis pirkadatka Ronkay & Gyulai, 2006
Polymixis pirkadatka Ronkay & Gyulai, 2006. *Esperiana, 12*, 217
L. T.: IRAN, Esfahan.

Distribution in Iran: Esfahan (Ronkay & Gyulai, 2006).

Polymixis fakherehsabae **Shirvani, sp. nov.**

Holotype: 1 ♂, Iran, Prov. Kerman, Baft, Khabr National Park, 2360 m., 28º51‘0“N 56º22‘22“E, 7-8-X-2021, leg. Asghar Shirvani, Slide No. AS806m (coll. SHBUK). Paratype: 1 ♂, same date and location, Slide No. AS818m (coll. SHBUK).

Diagnosis: *Polymixis fakherehsabae* Shivani, sp. nov. is the closest relatives of *P. pirkadatka* and *P. hedygramma.* The new species differs externally from *P. pirkadatka* by the narrower and greyish forewing and from *P. hedygramma* by the smaller size. The male genitalia of the three species are quite different, *P. fakherehsabae* has semi-globular penicular lobes, longer sacculus, shorter vesica, a strong thorn like cornutus and just one cornutus situated on the median diverticulum.

Description: Wingspan 38-44 mm (Figure 1). Length of forewing 19-22 mm. male, antennae finely bipectinate with fasciculate cilia. Palpi porrect, third segment very long, upturned, with brown scales. Head small, eyes large, globular. Head, collar, tegulae and thorax unicolorous grey-ochreous. Forewings long and narrow, costal margin slightly arched apically. Ground colour pale ochreous, basal dash absent, antemedial and postmedial lines present, fine, sinuous, greyish light brown, median area marked with brown scales forming a semi rectangle posteriorly, subterminal and terminal lines indistinct. Orbicular and reniform stigmata small, with bright outlines, claviform stigma obsolescent, fringes as ground colour. Hindwings small, whitish ochreous, discal spot absent, crosslines missing, fringes white. Underside of wings white, shining.

Figure 1. *Polymixis fakherehsabae* Shirvani, sp. nov., male adults. **A.** Holotype, Iran, Kerman, Baft, Khabr National Park. **B.** Paratype, Iran, Kerman, Baft, Khabr National Park.

Male genitalia (Figure 2): Uncus short, chevron-shaped, more, or less hairy. Tegumen short, penicular lobes semi globular, densely hairy. Vinculum short, V-shaped, juxta large, long, subdeltoidal, sclerotized. Valva elongate, symmetrical, finely constricted at basal one-third. Sacculus longer than wide, clavus as a short lobe. Harpe narrow, clasper very long, sclerotized, slightly asymmetrical, with acute apical section and finely rounded triangular sub-apical process. Cucullus small, rounded corona present. Aedeagus cylindrical, carina with small sclerotized ventro-lateral plate, longer and weaker dorso-lateral bar present. Vesica long, tubular, everted dorso-laterally, narrow basally, with a fine basal cornutus. Distal two third broad, curved, medially with long and strong thorn-like cornutus, terminal section with small conical diverticulum covered with long setiform cornuti, median diverticulum (opposite to setiform cornuti) saccate, armed with terminal thorn-like cornutus.

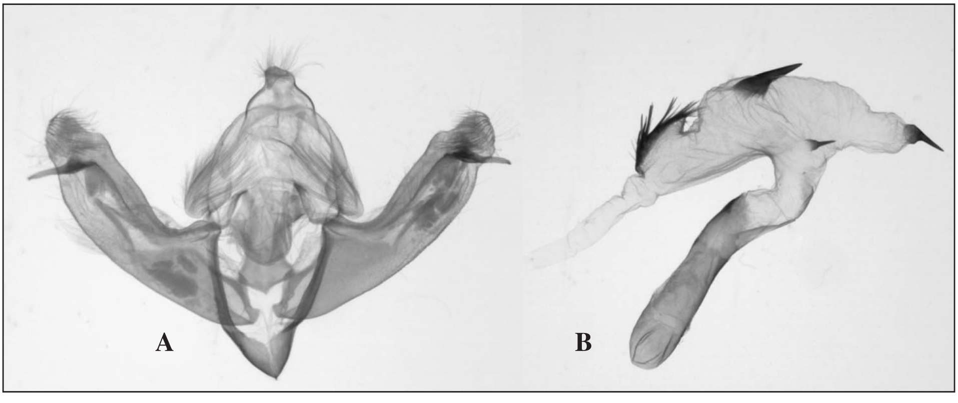

Figure 2. *Polymixis fakherehsabae* Shirvani, sp. nov., male genitalia. **A.** Armature. **B.** Aedeagus and everted vesica.

Bionomics: The two known specimens were collected by the light trap in the mountain slope with short hills covered by *Artemisia* spp., *Astragalus* spp. and sparsely by *Pistacia atlantica* Desf. (Anacardiaceae) plants. The larval food plant and their biology is unknown.

Etymology: The new species named in honor of Fakhereh Saba (1920-2007). Saba and her husband, Alireza Afzalipour (1909-1993), were founders of Shahid Bahonar University of Kerman.

Discussion: The subgenus *Eremophysa* comprises the species/subspecies mostly inhabiting Central Asia. Of them, *P. omanensis* and *P. colluta exspectata* are recorded from Oman and Turkey respectively. Univoltine species with autumnal adults (adult *P. argillosa* and *P. acharis* fly in July) that majority of them are rather restricted to certain areas and known based on one sex. This subgenus is characterized by the light-ochreous colored adults with tubular vesica consisted of diverticula, thorn-like cornuti and terminal field of fine cornuti (Boursin, 1958; Hacker & Ronkay, 1992). With the increase in the number of new species discoveries, new molecular and morphological phylogenetic analyses are needed, in order to make monophyletic groups, to revise and redefine the large and complex polyphyletic noctuid genera (e.g.: the genus *Polymixis*). The elements of the wing pattern and the genitalia of *P. fakherehsabae*, *P. pirkadatka* and *P. hedygramma* show the close relationship among these three species making a distinct lineage within the subgenus *Eremophysa* of *Polymixis.*

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The Symmocinae and Holcopogoninae in the Canary Islands and Madeira, with descriptions of 13 new species (Lepidoptera: Autostichidae)

Per Falck & Ole Karsholt

Abstract

We recognize 20 species of Symmocinae, concluding that all belong in the genus *Chersogenes* Walsingham, 1908 with the synonyms *Epanastasis* Walsingham, 1908, syn. rev., *Ambloma* Walsingham, 1908, syn. nov. and *Thanatovena* Gozmány, 1957. Thirteen species are described as new: *Chersogenes variabilis* Falck & Karsholt, sp. nov. (Spain: Gran Canaria), *Chersogenes pseudocanariensis* Falck & Karsholt, sp. nov. (Spain: Gran Canaria), *Chersogenes subextricata* Falck & Karsholt, sp. nov. (Spain: Tenerife), *Chersogenes gomerae* Falck & Karsholt, sp. nov. (Spain: La Gomera), *Chersogenes nigra* Falck & Karsholt, sp. nov. (Spain: Gran Canaria), *Chersogenes hermiguae* Falck & Karsholt, sp. nov. (Spain: La Gomera), *Chersogenes mercedella* Falck & Karsholt, sp. nov. (Spain: Tenerife), *Chersogenes duabusalis* Falck & Karsholt, sp. nov. (Spain: Fuerteventura and Lanzarote), *Chersogenes aguiari* Falck & Karsholt, sp. nov. (Portugal: Selvagens Islands), *Chersogenes coxi* Falck & Karsholt, sp. nov. (Spain: Fuerteventura), *Chersogenes lanzarotae* Falck & Karsholt, sp. nov. (Spain: Lanzarote), *Chersogenes fuerteventurae* Falck & Karsholt, sp. nov. (Spain: Fuerteventura), *Chersogenes indistincta* Falck & Karsholt, sp. nov. (Spain: Fuerteventura and Lanzarote). *Chersogenes extricata* (Gozmány, 1964), sp. rev., comb. nov. is removed from synonymy of *Chersogenes* (*Epanastasis*) *canariensis* (Rebel, 1906) and reinstated as a distinct species. *Chersogenes excellens* (Gozmány, 1977), syn. nov., comb. nov. is synonymized with *Chersogenes klimeschi* (Gozmány, 1975), comb. nov. *Symmoca canariensis* Rebel, 1906 and *Epanastasis eupracta* Gozmány, 1988 are newly combined as *Chersogenes canariensis* (Rebel, 1906), comb. nov. and *Chersogenes eupracta* (Gozmány, 1988), comb. nov. The following North African species are formally transferred from *Epanastasis*: *Chersogenes arenbergerorum* (Gozmány, 1988), comb. nov., *Chersogenes enigmatica* (Gozmány, 1964), comb. n., *Chersogenes eremicola* (Gozmány, 1988), comb. nov., *Chersogenes erroris* (Gozmány, 1962), comb. nov., *Chersogenes friedeli* (Gozmány, 1988), comb. nov., *Chersogenes tunesica* (Gozmány, 1988), comb. nov., and *Chersogenes vetustella* (Zerny, 1935), comb. nov. Two species of Holcopogoninae, *Turatia iranica* Gozmány, 2000 and *Hesperesta hartigi* (Turati, 1934) are recorded as new to the Canary Islands. Two of the new species, *C. duabusalis*, sp. nov. and *C. aguiari*, sp. nov. have brachypterous males. Photographs of the adults of all species are shown. Photographs of the genitalia of the new species are provided. All of the new species are barcoded. Analyses of DNA barcodes show that the identifications and distinctiveness of each species as well-supported and genetically isolated.

Keywords: Lepidoptera, Autostichidae, new species, new records, brachyptery, DNA barcodes, Canary Islands, Spain, Madeira, Selvagens Islands, Portugal.

Los Symmocinae y Holcopogoninae en las Islas Canarias y Madeira, con descripción de 13 especies nuevas (Lepidoptera: Autostichidae)

Resumen

Reconocemos 20 especies de Symmocinae, concluyendo que todas pertenecen al género *Chersogenes* Walsingham, 1908 con las sinonímias de *Epanastasis* Walsingham, 1908, syn. rev., *Ambloma* Walsingham, 1908, syn. nov. y Thanatovena Gozmány, 1957. Trece especies se describen como nuevas: *Chersogenes variabilis* Falck & Karsholt, sp. nov. (España: Gran Canaria), *Chersogenes pseudocanariensis* Falck & Karsholt, sp. nov. (España: Gran Canaria), *Chersogenes subextricata* Falck & Karsholt, sp. nov. (España: Tenerife), *Chersogenes gomerae* Falck & Karsholt, sp. nov. (España: La Gomera), *Chersogenes nigra* Falck & Karsholt, sp. nov. (España: Gran Canaria), *Chersogenes hermiguae* Falck & Karsholt, sp. nov. (España: La Gomera), *Chersogenes mercedella* Falck & Karsholt, sp. nov. (España: Tenerife), *Chersogenes duabusalis* Falck & Karsholt, sp. nov. (España: Fuerteventura y Lanzarote), *Chersogenes aguiari* Falck & Karsholt, sp. nov. (Portugal: Islas Salvajes), *Chersogenes coxi* Falck & Karsholt, sp. nov. (España: Fuerteventura), *Chersogenes lanzarotae* Falck & Karsholt, sp. nov. (España: Lanzarote), *Chersogenes fuerteventurae* Falck & Karsholt, sp. nov. (España: Fuerteventura), *Chersogenes indistincta* Falck & Karsholt, sp. nov. (España: Fuerteventura y Lanzarote). *Chersogenes extricata* (Gozmány, 1964), sp. rev., comb. nov. se retira de la sinonimia de *Chersogenes (Epanastasis) canariensis* (Rebel, 1906) y se reintegra como especie distinta. *Chersogenes excellens* (Gozmány, 1977), syn. nov., comb. nov., es sinonimizada con *Chersogenes klimeschi* (Gozmány, 1975), comb. nov., *Symmoca canariensis* Rebel, 1906 y *Epanastasis eupracta* Gozmány, 1988, se combinan de nuevo como *Chersogenes canariensis* (Rebel, 1906), comb. nov. y *Chersogenes eupracta* (Gozmány, 1988), comb. nov. Las siguientes especies norteafricanas se transfieren formalmente de *Epanastasis*: *Chersogenes arenbergerorum* (Gozmány, 1988), comb. nov., *Chersogenes enigmatica* (Gozmány, 1964), comb. n., *Chersogenes eremicola* (Gozmány, 1988), comb. nov., *Chersogenes erroris* (Gozmány, 1962), comb. nov., *Chersogenes friedeli* (Gozmány, 1988), comb. nov., *Chersogenes tunesica* (Gozmány, 1988), comb. nov., y *Chersogenes vetustella* (Zerny, 1935), comb. nov. Dos especies de Holcopogoninae, *Turatia iranica* Gozmány, 2000 y *Hesperesta hartigi* (Turati, 1934) se registran como nuevas para las Islas Canarias. Dos de las nuevas especies, *C. duabusalis*, sp. nov. y *C. aguiari*, sp. nov., tienen machos braquípteros. Se muestran fotografías de los adultos de todas las especies. Se proporcionan fotografías de la genitalia de las nuevas especies. Todas las nuevas especies tienen el código de barras. Los análisis de los códigos de barras del ADN muestran que las identificaciones y los caracteres distintivos de cada especie están bien fundamentados y aislados genéticamente.

Palabras clave: Lepidoptera, Autostichidae, nuevas especies, nuevos registros, braquipteria, ADN código de barras, Islas Canarias, España, Madeira, Islas Salvages, Portugal.

Introduction

The Autostichidae, as currently understood, is a medium-sized family of gelechioid moths with about 800 described species. It includes six or seven subfamilies (Heikkilä et al. 2014, p. 585; Wang & Li, 2020, pp. 323-324), three of which (Oegoconiinae, Symmocinae and Holcopogoninae) occur in the West Palaearctic region, including the Canary Islands and Madeira. In a previous paper (Falck et al. 2021) we dealt with the Oecogoniinae, and here we treat the Symmocinae and Holcopogoninae of these islands.

The Symmocinae are distributed mainly in dryer areas of the western Palaearctic. In his revision Gozmány (2008) recognized 230 species, and relatively few additional species are known from the Afrotropical and Oriental regions. Holcopogoninae are a smaller subfamily with less than 40 species distributed in Eurasia and Africa.

Although the Autostichidae, and especially the two first mentioned subfamilies, are diverse in the Canary Islands they have received surprisingly little attention in the lepidopterological literature. Rebel (1896, 1906) described two species of Symmocinae, and Walsingham (1908) two further species, and then very little happened until Gozmány (1964, 1975, 1988) described four additional symmocine species. Klimesch (1985) reviewed the then known species, and they were again revised by Gozmány (2008) in the "Microlepidoptera Palaearctica" series.

In the present paper we revise the taxonomy at both genus and species level of the Symmocinae of the Canary Islands and Madeira, reducing the number of genera from three to one, and raising the number of species from seven (Vives Moreno, 2014, pp. 109-110) to 20, by describing 13 new species.

The Holcopogoninae of the Canary Islands have received even less attention. Only one species was previously recorded from the islands. We add here the records of two additional species.

Material and methods

Most of the specimens were attracted to an 8-watt super actinic light, and some were caught during the day. Genitalia were dissected following Robinson (1976). Adults were photographed with a Canon EOS 700D camera equipped with a Canon EF 100 mm objective. The genitalia slides were photographed using a Soptop CX40T Trinocular microscope in conjunction with a Toup Tek P10500A-E3 / E3ISPM05000KPA-E3 / 5.0MP USB3 camera.

DNA samples were prepared from dried legs according to the accepted standards and processed at the Canadian Centre for DNA Barcoding (CCDB, Biodiversity Institute of Ontario, University of Guelph) to obtain the 658 base-pair long barcode fragment of the mitochondrial COI gene (cytochrome c oxidase I). Intra- and interspecific distances of DNA barcode fragments were calculated using analytic tools of BOLD with the Kimura 2-parameter model of nucleotide substitution. Genetic clusters are presented with their barcode index number (BIN; cf. Ratnasingham & Hebert, 2013). Details of successfully sequenced voucher specimens are publicly available through the dataset DS-EPAMCA at www.boldsystems.org and at dx.doi.org/10.5883/DS-EPAMCA.

We examined the morphology of all species and the DNA barcodes from new and cryptic species.

The terminology used for description of the genitalia mostly follows Gozmány (2008) supplemented with advice from Lauri Kaila (in litt.). The use of phallus (instead of aedeagus) follows Kristensen (2003, p. 103) who argued that only very few Lepidoptera (males) have an aedeagus.

The present paper is mainly based on specimens collected by the first author. We also include material (including type specimens) kept in the collections listed below.

Abbreviations used

AFA	Collection of António M. Franquinho Aguiar, Funchal, Madeira, Portugal
JJ	Collection of Jari Junniainen, Vantaa, Finland
PF	Collection of Per Falck, Neksø, Denmark
MMF	Museu Municipal do Funchal, Madeira, Portugal
MNCN	Collection of Antonio Vives, Museo Nacional de Ciencias Naturales, Madrid, Spain
NHMUK	Natural History Museum, London, United Kingdom
TL	Type locality
ZMUC	Zoological Museum, Natural History Museum of Denmark, Copenhagen, Denmark

Checklist

AUTOSTICHIDAE
SYMMOCINAE

Chersogenes variabilis **Falck & Karsholt, sp. nov.**
Chersogenes sophroniellus (Rebel, 1894), **comb. rev.**
Chersogenes pseudocanariensis **Falck & Karsholt, sp. nov.**
Chersogenes canariensis (Rebel, 1906), **comb. nov.**
Chersogenes subextricata **Falck & Karsholt, sp. nov.**
Chersogenes extricata (Gozmány, 1964), **sp. rev.**, **comb. nov.**
Chersogenes gomerae **Falck & Karsholt, sp. nov.**
Chersogenes nigra **Falck & Karsholt, sp. nov.**
Chersogenes eupracta (Gozmány, 1988), **comb. nov.**
Chersogenes hermiguae **Falck & Karsholt, sp. nov.**
Chersogenes mercedella **Falck & Karsholt, sp. nov.**
Chersogenes duabusalis **Falck & Karsholt, sp. nov.**
Chersogenes aguiari **Falck & Karsholt, sp. nov.**

Chersogenes klimeschi (Gozmány, 1975), **comb. nov.**
= *Chersogenes excellens* (Gozmány, 1977), **syn. n., comb. nov.**
Chersogenes brachyptera (Walsingham, 1908)
***Chersogenes coxi* Falck & Karsholt, sp. nov.**
***Chersogenes lanzarotae* Falck & Karsholt, sp. nov.**
Chersogenes victimella Walsingham, 1908
***Chersogenes fuerteventurae* Falck & Karsholt, sp. nov.**
***Chersogenes indistincta* Falck & Karsholt, sp. nov.**

HOLCOPOGONINAE

Turatia iranica Gozmány, 2000
Hesperesta hartigi (Turati, 1934)
Oecia oecophila (Staudinger, 1876)

Results

Chersogenes Walsingham, 1908. *Proc. zool. Soc. Lond., 1907*, 947
Type species *Chersogenes victimella* Walsingham, 1908, 947, pl. 51, fig. 17.
= *Epanastasis* Walsingham, 1908. *Proc. zool. Soc. Lond., 1907*, 948, **syn. rev**.
Type species *Holcopogon sophroniellus* Rebel, 1894, 89
= *Ambloma* Walsingham, 1908. *Proc. zool. Soc. Lond., 1907*, 946, **syn. nov**.
Type species *Ambloma brachyptera* Walsingham 1908, 947, pl. 51, fig. 18.
= *Thanatovena* Gozmány, 1957. *Annls hist.-nat. Mus. natn. hung., n. s., 8*, 343, fig. 2E 8I.
Type species *Symmoca aegrella* Walsingham, 1908, 949, pl. 52, fig. 2.

The three first mentioned genera were described as monotypic from three species occurring in the Canary Islands. Meyrick (1925, p. 202) synonymized *Epanastasis* with *Chersogenes*, but they were again treated as separate genera by Gozmány (1964, p. 118, 2008, p. 188, 259, 261). As explained below we consider all symmocine species occurring in the Canary Islands as belonging to one genus. *Epanastasis* and *Chersogenes* were described in the same paper (Walsingham, 1908), and by treating the former as a synonym of the latter Meyrick (op. cit.) made a "first reviser's action" (ICZN, 1999, article 24.2) by which *Chersogenes* has priority over *Epanastasis* when these two genera are treated as synonyms.

Thanatovena is another monotypic genus from the Canary Islands. It was synonymized with *Epanastasis* by Gozmány (1963, p. 453).

The classification of the Symmocinae is largely based on the research by the late Lázló A. Gozmány (e. g. 1957, 2008). He used wing venation as the most important character: "These [newly erected] genera are also well definable on the basis of their venation, whilst the genitalic structure justifies the general view that we are dealing with closely related aggregations" (Gozmány, 1957, p. 325). We are of the opinion that the Symmocinae (and Oecogoninae - see Falck et al. 2021, p. 276), with their many small or monotypic genera, are over-split. Focusing here on the species occurring in the Canary Islands all species of Symmocinae there have similar genitalia, indicating a close relationship, and variable wing venation, which is a result of a more or less pronounced brachyptery. There is no correlation between wing venation and genitalia characters in these species. This is also true for another character used by Gozmány in his classification of these taxa: the form of the labial palps. This is a characteristic feature of many gelechioid moths, and in former days the shape of the labial palps was considered an important character in their systematics. Today the classification of the Gelechioidea is mainly based on structures of the genitalia and on molecular data, and it has been shown that species with different shapes of the labial palps may still be closely related (e. g., Li & Sattler, 2012, p. 8; Huemer & Karsholt, 2018, p. 17).

As well as the species occurring in the Canary Islands and listed above, Gozmány (2008, pp. 188-195) placed the following North African species in the genus *Epanastasis*. By synonymizing *Epanastasis* with *Chersogenes* these species are here formally transferred to the latter genus: *Chersogenes tunesica* (Gozmány, 1988), **comb. nov.**, *Chersogenes eremicola* (Gozmány, 1988), **comb. nov.**, *Chersogenes enigmatica* (Gozmány, 1964), **comb. nov.**, *Chersogenes vetustella* (Zerny, 1935), **comb. nov.**, *Chersogenes friedeli* (Gozmány, 1988), **comb. nov.**, *Chersogenes erroris* (Gozmány, 1962), **comb. nov.**, and *Chersogenes arenbergerorum* (Gozmány, 1988), **comb. nov.**

Chersogenes variabilis **Falck & Karsholt, sp. nov.** (Figures 1-6, 56, 56a, 76)

Holotype ♂: SPAIN, Carreteria, 455 m, 8-20-VIII-2020, leg. P. Falck, DNA sample Lepid Phyl 0683PF/CILEP682-20 (ZMUC).

Paratypes: SPAIN, Gran Canaria, Pie de la Cuesta, 500 m, 15 ♂♂, 4 ♀♀, 17-30-IX-2018, leg. P. Falck, genitalia slide 2829PF, DNA samples Lepid Phyl 0043PF/CILEP43-19, 0139PF/CILEP138-19, 0140PF/CILEP139-19, 0142PF/CILEP141-19, same data but, 11 ♂♂, 21-VIII-4-IX-2020, leg. P. Falck (PF); 8 km N Pie de la Cuesta, 895 m, 4 ♂♂, 1 ♀, 17-30-IX-2018, leg. P. Falck, genitalia slide 2816PF, DNA samples Lepid Phyl 0040PF/CILEP40-19, 0137PF/CILEP136-19 (PF); Ayacata, 1400 m, 3 ♂♂, 17-30-IX-2018, leg. P. Falck, genitalia slides 2817PF, 2848PF, DNA samples Lepid Phyl 0041PF/CILEP41-19, 0138PF/CILEP137-19; same data but, 3 ♂♂, 1 ♀, 21-VIII-4-IX-2020, leg. P. Falck, DNA sample Lepid Phyl 0678PF/CILEP677-20 (PF); Carreteria, 455 m, 32 ♂♂, 20 ♀♀, 8-20-VIII-2020, leg. P. Falck, genitalia slide 3692PF, DNA samples Lepid Phyl 0676PF/CILEP676-20, 0681PF/CILEP680-20, 0682PF/CILEP681-20, 0683PF/CILEP682-20, 0686PF/CILEP685-20 (PF); Fontanales, 1100 m, 38 ♂♂, 8 ♀♀, 8-20-VIII-2020, leg. P. Falck, genitalia slide 3381PF, 3694PF, DNA samples Lepid Phyl 0677PF/CILEP676-20, 0679PF/CILEP678-20, 0680PF/CILEP679-20, 0687PF/CILEP686-20, 0688PF/CILEP687-20 (PF); Barranco Moya, 80 m, 2 ♂♂, 2 ♀♀, 8-20-VIII-2020, leg. P. Falck, DNA samples Lepid Phyl 0684PF/CILEP683-20, 0685PF/CILEP684-20 (PF); Barranco de Azuaje, 270 m, 4 ♂♂, 1 ♀, 8-20-VIII-2020, leg. P. Falck, genitalia slide 3693PF (PF); Fataga, 500 m, 1 ♂, 21-VIII-4-IX-2020, leg. P. Falck (PF); Barranco Guayadeque, 700 m, 2 ♂♂, 21-VIII-4-IX-2020 (PF, MNCN).

Description: Male. Wingspan 12.5-14 mm. Labial palp upturned, segment 2 dark grey-brown mottled with white scales, especially dorsally, segment 3 almost as long as segment 2, dark grey mottled with white scales. Antenna nearly as long as the length of the forewing, black with indistinct grey rings. Head and neck grey mottled white. Thorax and tegula dark greyish brown. Forewing whitish, basally dark greyish brown, towards apex mottled with ochreous, black and brown; at 1/3 an oblique, broad dark brown fascia, mottled with ochreous in the middle; at 2/3 an indistinct brownish black spot; termen mottled with black; fringe grey. Hindwing brown with grey fringe. Abdomen greyish brown.

Female: Wingspan 14-16.5 mm. Differs from male by the slightly shorter antenna and the broader forewing.

Variation: *C. variabilis* exhibits considerable variation. In both sexes the ground colour varies from almost pure off-white to dark grey and the wing pattern may be absent.

Male genitalia (Figures 56, 56a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal half, apex rounded; sacculus slightly longer than 1/2 the length of valva, apically straight pointed; appendix a little shorter than valva, slightly bent, apex pointed; juxta hourglass-shaped, anteriorly rectangular, posteriorly forked; saccus triangular; phallus slender, almost straight, slightly bent anteriorly; two cornuti groups each with 12-16 rather short spines.

Female genitalia (Figure 76): Papilla analis long, distally rounded, posterior apophysis slender, 2.5 times longer than papilla analis; anterior apophysis slightly shorter than posterior apophysis; tergum VIII sub-rectangular, sternum VIII with median fissure widening anteriorly; lamella antevaginalis sub-rectangular, posterior margin laterally rounded with a broad medial U-shaped invagination; antrum V-shaped; colliculum short, quite narrow and sclerotised; ductus bursae membranous, slightly broader than colliculum; corpus bursae membranous, oval, signum with about 15 small spines.

DNA barcodes (Figure 87): We obtained full length DNA barcode (658 bp) from eighteen specimens and DNA barcode fragments of 581 bp, 605 bp and 612 bp from three specimens. The barcodes fall within Barcode Index Numbers (BIN) BOLD: ADT9918 (nineteen specimens) and ADT9915 (two specimens). The maximum intraspecific p-distance is high 2.36%. The minimum p-distance to the nearest neighbour *C. canariensis* is 5.35%.

Diagnosis: *C. variabilis* resembles other members of the genus, especially *C. extricata*. It is distinguished by the robust appearance and the rounded apex of the forewing. In the male genitalia the short straight sacculus and two cornuti groups are characteristic. In the female genitalia the rounded posterior margin of the lamella antevaginalis, the short colliculum and the narrow ductus bursae are characteristic.

Biology: Early stages unknown. Most specimens were collected at light, but some were disturbed from varied vegetation during the daytime, from the beginning of August until the end of September, at altitudes from 80 to 1400 m.

Distribution: Widely distributed on the island of Gran Canaria, Spain, except coastal areas.

Etymology: The species is named after the variable adults.

Remarks: Interestingly it seems that the different populations are highly local. Specimens near the city of Moya all belong to the grey form with a distinct wing pattern, while further south near the city of Fontanales the specimens are with a white or light grey ground colour, and with indistinct or totally without a wing pattern, at the southernmost location, Pie de la Cuesta the specimens are dark grey with an indistinct wing pattern. The molecular analyses show high intraspecific divergence, but without any correlation between the different populations of *C. variabilis*.

Chersogenes sophroniellus (Rebel, 1894) (Figures 7-8, 57, 57a, 77), **comb. rev.**
Holcopogon sophroniellus Rebel, 1894, in Rebel & Rogenhofer. *Annln naturh. Mus. Wien, 9*, 89
Type locality: SPAIN, Tenerife.

Material examined: SPAIN, Gran Canaria, Teror, 500 m, 3 ♂♂, 28-III-1-IV-2012, leg. J. Junnilainen, genitalia slide 201517JL, 201519JL, 3393PF (JJ), same data but 14 ♂♂, 2 ♀♀, 1-13-IV-2022, leg. P. Falck, genitalia slide 3695PF, 3698PF, 3729PF, 3731PF, DNA samples Lepid Phyl 1062PF/CILEP1061-22, 1063PF/CILEP1062-22, 1064PF/CILEP1063-22 (PF); Valleseco, 1 ♂, 1-IV-2012, leg. J. Junnilainen (JJ).

Description: Male. Wingspan 10.5-13 mm. Labial palp upturned, segment 2 creamy white dorsally and medially, ventrally with a dark brown scale tuft, extending beyond the base of segment 3, segment 3 half the length of segment 2, creamy white, laterally mottled with black scales. Antenna black with indistinct grey rings. Head and neck yellowish brown; thorax and tegula yellowish brown, mottled with brown scales. Forewing yellowish brown, with a distinct broad dark brown costal line reaching apex; dorsal 1/3 light brown mottled with a few black scales; at 1/3 one or two diffuse brownish black spots, at 2/3 two distinct black discal spots; termen with distinct black spots; fringe grey. Hindwing grey with grey fringe. Abdomen yellowish brown. Female. Wingspan 12 mm. Differs from the male by the uniformly yellowish-brown colour of the head, neck, thorax, tegula and forewing.

Variation: The spots may be more or less distinct, sometimes forming two indistinct oblique fasciae.

Male genitalia (Figures 57, 57a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 5 times longer than broad, slightly upturned in distal half, apex rounded; sacculus about 2/3 length of valva, apically sickle-shaped; appendix a little shorter than valva, slightly bent, apex pointed; juxta hourglass-shaped, anteriorly rectangular, posteriorly forked; saccus triangular; phallus almost straight, slightly tapering posteriorly; one cornuti group with 13-15 spines of various length, the longest more than 1/3 half the length of phallus.

Female genitalia (Figure 77): Papilla analis long, distally pointed, posterior apophysis slender, twice as long as papilla analis; anterior apophysis slightly longer than half the length of posterior apophysis; tergum VIII sub-rectangular, sternum VIII with median fissure widening anteriorly; lamella antevaginalis sub-rectangular, broad, posterior margin laterally slightly concave with a broad medial V-shaped invagination; antrum cup shaped; colliculum quite narrow and sclerotized; ductus bursae membranous, about twice as broad as colliculum and slightly narrowing anteriorly; corpus bursae membranous oval, signum with about 15 small spines.

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from three specimens. The barcodes fall within Barcode Index Number (BIN) BOLD: ADF2619. The maximum intraspecific p-distance is 0.31%. The barcodes of *C. sophroniellus*, *C. pseudocanariensis* and *C. canariensis* cluster together in the neighbour-joining tree, and the minimum p-distance between them is 3.04% (*C. sophroniellus* vs. *C. pseudocanariensis*), 4.13% (*C. sophroniellus* vs. *C. canariensis*) and 4.89% (*C. pseudocanariensis* vs. *C. canariensis*). The nearest neighbour to them is *C. variabilis* with a 5.35% divergence.

Diagnosis: The yellowish-brown colour, the distinct dark brown costal line (in male) and the long segment 2 of the labial palp separates *C. sophroniellus* from similar species such as *C. canariensis* and *C. pseudocanariensis.* In the male genitalia the sickle-shaped apex of the sacculus and only one cornuti group with very long cornuti are characteristic. It differs from *C. canariensis* by the sickle-shaped apex of the sacculus, and by having only one group of very long cornuti. It differs from *C. pseudocanariensis* in the slightly broader valva and in having fewer cornuti. In the female genitalia the shape of the posterior margin lamella antevaginalis is characteristic. It differs from from *C. canariensis* in the concave postero-lateral margin of ostium and the less pronounced invagination. It closely resembles *C. pseudocanariensis* and there is no reliable difference in the female genitalia between the two species. Adults of *C. sophroniellus* are very characteristic and are easily separated from other members of the genus.

Biology: Early stages unknown. Most of the examined specimens were caught during evening sunshine, and a few were collected at light during late March and April at altitudes ranging from about 500-1000 m.

Distribution: Known only from the holotype from the island of Tenerife and a few specimens from the surroundings of Teror and one specimen from Valleseco in the northern part of Gran Canaria.

Remarks: *Epanastasis sophroniellus* was described by Rebel (1894) on the basis of a single male collected by John Henry Leech in April 1885 on the island of Tenerife, deposited in the Walsingham collection (NHMUK). In a later publication Rebel (1896, p. 128, pl. III) provides a more detailed description based on a series of specimens from nearby Teror at the northern part of Gran Canaria collected the 10th of May 1895 by the Danish lepidopterologist Wilhelm von Hedemann.

The spelling *"sophroniella"* is an unnecessary gender-agreement variant of the original *sophroniellus* in the literature.

The genitalia of the male holotype collected by Hedemann near Teror are figured by Gozmány (2008, p. 411, fig. 160 (a), p. 412, fig. 161 (a)). Klimesch (1985) misinterpreted this taxon as *C. canariensis*, *q. v.*

***Chersogenes pseudocanariensis* Falck & Karsholt, sp. nov.** (Figures 9-10, 58, 58a, 78)

Holotype ♀: Spain, Gran Canaria, Fataga, 1000 m, 22-III-1979, leg. P. Stadel Nielsen (ZMUC).

Paratypes: Spain, Gran Canaria, Barranco de Mogan, Paso de Ojeda, 600-850 m, 6 ♀♀, 14-I-2016, leg. J. Junnilainen; Barranco de Fataga, 450-750 m, 2 ♀♀, leg. J. Junnilainen; Ayacata, 1400 m, 3 ♀♀, 4-23-III-2019, leg. P. Falck, DNA sample Lepid Phyl 0153PF/CILEP152-19, same data but, 1 ♀, 9-22-VI-2021, leg. P. Falck (PF); Pie de la Cuesta, 500 m, 3 ♀♀, 4-23-III-2019, leg. P. Falck, genitalia slide 3654PF, DNA samples Lepid Phyl 0151PF/CILEP150-19, 0152PF/CILEP151-19, same data but, 1 ♂, 10 ♀♀, 1-13-IV-2022, leg. P. Falck (PF); Barranco de Guayadeque, 800 m, 8 ♂♂, 9 ♀♀, 1-13-IV-2022, leg. P. Falck, genitalia slides 3655PF, 3656PF, 3707PF, DNA samples Lepid Phyl 1059PF/CILEP1058-22, 1060PF/CILEP1059-22, 1061PF/CILEP1059-22 (PF, MNCN).

Description: Male. Wingspan 14-15 mm. Labial palp upturned, segment 2 grey mottled with light brown and white scales, especially dorsally, dorsally with a small grey scale tuft, segment 3 as long as segment 2, grey mottled with white scales. Antenna black with indistinct grey rings. Head, neck, thorax and tegula grey, mottled with light brown and white scales. Forewing grey, with a broad dark grey costal line reaching a pointed apex; middle 1/3 whitish with 4 longitudinal black streaks; dorsal 1/3 grey mottled with a few black scales; at 1/3 one blackish spot, at 2/3 two distinct black discal spots; termen mottled with black; fringe grey. Hindwing grey with grey fringe. Abdomen greyish. Female. Wingspan 14-16 mm. Differs from male in the colour of the forewing and the wing pattern. Forewing uniformly grey mottled with black; at 1/3 an irregular, slightly oblique, blackish fascia; at 2/3 two indistinct, blackish, rather large discal spots.

Variation. The male is quite constant, but the black streaks may be indistinct or nearly absent. In the female the fascia and spots may be more or less distinct, the fascia does not always reach the costa, and the discal spots may be confluent.

Male genitalia (Figures 58, 58a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal half, apex rounded; sacculus about 2/3 length of valva, apically sickle-shaped; appendix a little shorter than valva, slightly bent, apex pointed; juxta hourglass-shaped, anteriorly rectangular, posteriorly forked; saccus triangular; phallus almost straight, slightly tapering posteriorly; one cornuti group with 20-22 spines of various length, the longest more than one third the length of the phallus.

Female genitalia (Figure 78): Papilla analis long, distally pointed, posterior apophysis slender, twice as long as papilla analis; anterior apophysis slightly longer than half the length of the posterior apophysis; tergum VIII sub-rectangular, sternum VIII with median fissure widening anteriorly; lamella antevaginalis sub-rectangular, broad, posterior margin laterally slightly concave with a broad medial U-shaped invagination; antrum-cup shaped; colliculum quite narrow and sclerotised; ductus bursae membranous, about 2.5 times broader than colliculum and narrowing anteriorly; corpus bursae membranous, oval, signum with about 15 small spines.

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from six specimens. The barcodes fall within Barcode Index Number (BIN) BOLD: ADF2781. The maximum intraspecific p-distance is 1.38%. The results are presented in the DNA barcodes section of *C. sophroniellus*.

Diagnosis: *C. pseudocanariensis* is similar to *C. canariensis*, q.v.

Biology: Early stages unknown. Most of the specimens were attracted to light, but most of the males were found nectaring on flowers of *Todaroa montana* Webb ex Christ on a rainy and humid day. The adults of *C. pseudocanariensis* were collected from January to late June at altitudes from 450 m to 1400 m.

Distribution: Known only from mountain regions in the southern half of the island of Gran Canaria, Spain.

Etymology: The species name is derived from combining the Greek word øåõäï (pseudo = false) and *canariensis*, referring to its similarity to *C. canariensis*.

Chersogenes canariensis (Rebel, 1906). **comb. nov.** (Figures 11-16, 59, 59a, 79)
Symmoca canariensis Rebel, 1906. *Annln naturh. Mus. Wien, 21*, 39
Type locality: SPAIN, Tenerife, Güímar.
= *Symmoca aegrella* Walsingham, 1908. *Proc. zool. Soc. Lond., 1907,* 949, pl. 52, fig. 2
Type locality: SPAIN, Tenerife, La Laguna.

Material examined: Spain, Gran Canaria, Los Tilos de Moya, 600 m, 19-VII-1984, leg. P. Olsen, B. Skule & P. Stadel Nielsen, genitalia slide 5985 Gozmány (ZMUC); Bahia Feliz, 2 ♂♂, 6-7-V-2018, leg. K. Larsen (ZMUC); Juan Grande, 1 ♂, 8-V-2018, leg. K. Larsen (ZMUC); El Doctoral, 350 m, 2 ♂♂, 9-12-V-2018, leg. K. Larsen (ZMUC); Pie de la Cuesta, 500 m, 13 ♂♂, 20 ♀♀, 11-26-VI-2018, leg.

P. Falck, genitalia slides 2746PF, 2748PF, 2749PF, 2754PF, 2755PF, 2833PF, DNA sample Lepid Phyl 0028PF/CILEP28-19, same data but, 14 ♂♂, 12 ♀♀, 4-23-III-2019, leg. P. Falck, genitalia slide 3702PF, DNA samples Lepid Phyl 0146PF/CILEP0145-19, 0147PF/CILEP-19 (PF); Los Tilos de Moya, 55 m, 1 ♂, 1 ♀, 11-26-VI-2018, leg. P. Falck, genitalia slides 2747PF, 2756PF, DNA samples Lepid Phyl 0148PF/CILEP147-19, 0149PF/CILEP148-19, same data but, 2 ♂♂, 17-30-IX-2019, leg. P. Falck, genitalia slide 2820PF, DNA sample Lepid Phyl 0150PF/CILEP149-19, same data but, 1 ♂, 8-20-VIII-2020 leg. P. Falck, genitalia slide 3392PF (PF); Puerto Rico, 50 m, 2 ♂♂, 11-24-VI-2018, leg. P. Falck (PF); Barranquillo Andrés, 700 m, 1 ♂, 11-24-VI-2018, P. Falck (PF); Playa del Cura, 30 m, 2 ♂♂, 4-23-III-2019, leg. P. Falck (PF); El Sao, 110 m, 1 ♂, 4-23-III-2019, leg. P. Falck, DNA sample Lepid Phyl 0145PF/CILEP144-19, same data but, 1 ♀, 1-13-IV-2022, leg. P. Falck (PF); Barranco de Azuaje, 270 m, 3 ♂♂, 1 ♀, 8-20-VIII-2020, leg. P. Falck, genitalia slides 3497PF, 3498PF (PF); Carreteria, 455 m, 4 ♂♂, 8-20-VIII-2020, leg. P. Falck, genitalia slide 3393PF (PF); Ayacata, 1400 m, 1 ♂, 9-22-VI-2021, leg. P. Falck, DNA sample Lepid Phyl 0872PF/CILEP871-21 (PF); Barranco de Guayedeque, 800 m, 2 ♀♀, 9-22-VI-2021, leg. P. Falck, genitalia slide 3719PF (PF); El Hierro, Erese, 750 m, 18 ♂♂, 14 ♀♀, 22-VII-3-VIII-2022, leg. P. Falck, genitalia slide 3750PF, DNA samples Lepid Phyl 1065PF/CILEP1064-22, 1066PF/CILEP1065-22, 1067PF/CILEP1066-22 (PF); Jinama, 1250 m, 3 ♂♂, 8 ♀♀, 22-VII-3-VIII-2022, leg. P. Falck (PF); Cruz de Las Reyes, 1360 m, 4 ♂♂, 1 ♀, 22-VII-3-VIII-2022, leg. P. Falck (PF); Frontera, 280 m, 2 ♂♂, 22-VII-3-VIII-2022, leg. P. Falck (PF). Tenerife, Guimar, 2 ♂♂, 15-28-III-1965, leg. J. Klimesch (ZMUC); Aguamansa, 1300 m, 3 ♂♂, 29-VII-2-VIII-1979, leg. P. Stadel Nielsen, genitalia slide 3799aPF (ZMUC); 5 ♂♂, 1 ♀, Vilaflor, Las Lajas, 1800 m, 24-IV-1998, leg. K. Larsen, genitalia slide 5422 Karsholt (ZMUC); Arona, 670 m, 13 ♂♂, 3 ♀♀, 1-20-III-2017, leg. P. Falck, genitalia slides 2532PF, 2534PF, 2750PF, 2751PF, 2753PF, 3659PF, 3712PF, DNA samples Lepid Phyl 0030PF/CILEP30-19, 0143PF/CILEP142-19, 0144PF/CILEP143-19 (PF), same data but, 2 ♂♂, 21-V-3-VI-2019, leg. P. Falck (PF); Los Gigantes, 150 m, 2 ♂♂, 5 ♀♀, 1-20-III-2017, leg. P. Falck, genitalia slides 2529PF, 2531PF, 2534PF, 2752PF, 2534PF (PF); Playa Paraiso, 50 m, 2 ♂♂, 1-20-III-2017, leg. P. Falck, DNA sample Lepid Phyl 0029PF/CILEP29-19 (PF); Ifonche, 1040 m, 1 ♂, 21-V-3-VI-2019, leg. P. Falck (PF); Las Mercedes, 750 m, 5 ♂♂, 9 ♀♀, 21-V-3-VI-2019, leg. P. Falck, genitalia slide 3390PF, same data but 1 ♀, 13-26-VIII-2019, leg. P. Falck, same data but, 6 ♀♀, 1-13-VI-2022, leg. P. Falck, genitalia slide 3657PF (PF); 8 km N Vilaflor, 1700 m, 3 ♂♂, 1 ♀, 21-V-3-VI-2019, leg. P. Falck, genitalia slide 3700PF (PF); Aguamansa, 1050 m, 7 ♂♂, 13-26-VIII-2019, leg. P. Falck, genitalia slide 3391PF, DNA samples Lepid Phyl 0323PF/CILEP322-19, 0324PF/CILEP323-19, 0325PF/CILEP324-19, same data but, 1 ♂, 1-13-VI-2022, leg. P. Falck (PF): Güímar, 500 m, 1 ♂, 21-V-3-VI-2019, leg. P. Falck, same data but, 7 ♂♂, 1 ♀, 1-13-VI-2022, leg. P. Falck (PF); Las Manchas, 1050 m, 2 ♀♀, 21-V-3-VI-2019, leg. P. Falck, genitalia slide 3658PF; El Caletón, 150 m, 1 ♀, 1-13-VI-2022, leg. P. Falck (PF).

Description: Male. Wingspan 12-17 mm. Labial palp upturned, segment 2 grey mottled with light brown and white scales, especially dorsally, dorsally with a greyish brown scale tuft, segment 3 almost as long as segment 2, whitish mottled with dark grey scales, indistinctly ringed near apex. Antenna black with indistinct grey rings. Head and thorax whitish mottled grey; neck and tegula greyish brown. Forewing grey, with a broad dark grey costal line reaching apex; median 1/3 light grey mottled with ochreous scales; dorsal 1/3 grey, darker brownish grey towards termen; one or two black discal spots; termen mottled with black; fringe grey. Hindwing grey with grey fringe. Abdomen greyish.

Female: Wingspan 11-16 mm. Differs from male by the colour of the forewing and the wing pattern. Forewing uniformly grey mottled with black; at 1/3 an irregular, slightly oblique, dark grey fascia; at 2/3 two indistinct, dark grey, rather large discal spots.

Variation: *C. canariensis* exhibits considerable variation. The ground colour varies from whitish grey or dark grey to yellowish brown or ochreous in both sexes. In both sexes the wing pattern may be absent.

Male genitalia (Figures 59, 59a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal half, apex rounded; sacculus slightly longer than half the length of valva, apically rather broad with a small hook-shaped apex; appendix distinctly shorter than valva, slightly bent, apex pointed; juxta hourglass-shaped, anteriorly sub-rectangular, posteriorly forked; saccus triangular, apex rounded; phallus bent anteriorly, slightly tapering posteriorly, slightly shorter than valva; two cornuti groups, one with 5-8 spines of medium length, the second with 12-16 spines also of medium length.

Female genitalia (Figures 79): Papilla analis long, distally pointed, posterior apophysis slender, twice as long as papilla analis; anterior apophysis slightly longer than half the length of posterior apophysis; tergum VIII sub-rectangular, sternum VIII with median fissure widening anteriorly; lamella antevaginalis sub-rectangular, broad, posterior margin laterally straight with a broad medial V-shaped invagination; antrum cup shaped; colliculum quite narrow and sclerotised; ductus bursae membranous, about 3 times broader than colliculum and narrowing anteriorly; corpus bursae membranous oval, signum with about 15 small spines.

DNA barcodes (Figure 87): We obtained full length DNA barcode (658 bp) from eleven specimens and DNA barcode fragments of 519 bp, 605 bp, 629 bp, 630 bp, 634 bp, 647 bp and 648 bp from seven specimens. The barcodes fall within Barcode Index Numbers (BIN) BOLD: ADT8333 (thirteen specimens from northern Gran Canaria, El Hierro and Tenerife), ADI4064 (four specimens from southern Gran Canaria) and AEN3712 (one specimen from central Gran Canaria), the minimum p-distance between the BINs is 1.92% (ADI4064 vs. AEN3712), 2.08% (ADI4064 vs. ADT8333) and 2.22% (ADT8333 vs. AEN3712). The maximum intraspecific p-distance is very high 3.10%. The results are presented in the DNA barcodes section of *C. sophroniellus*.

Diagnosis: *C. canariensis* resembles *C. sophroniellus* (q.v.) and especially *C. pseudocanariensis*, and it is not possible to distinguish specimens from the southern part of Gran Canaria without dissection of the genitalia. In the male genitalia the short hook-shaped apex of the sacculus and two cornuti groups are characteristic. In the female genitalia the laterally straight posterior margin of lamella antevaginalis and the bulbous ductus bursae are characteristic.

Biology: Early stages unknown. Most specimens were collected at light, but some were disturbed from varied vegetation during daytime, from March to September, at altitudes from sea level to 1800 m.

Distribution: Only known from the Canary Islands: Gran Canaria, El Hierro, La Palma (Baez, 2010, p. 303) and Tenerife, Spain.

Remarks: In his paper “Fünfter Beitrag zur Lepidopterenfauna der Kanaren” Rebel (1906) described *Symmoca canariensis* from one male specimen collected at Güímar, Tenerife by W. White. It was examined by Walsingham (1908, pp. 949-950) and compared with the type specimen of *C. sophroniellus*. He concluded that adults of these two highly variable species only were separable by the difference in labial palps. In later literature e. g. Klimesch (1985, p. 136) and Gozmány (2008, p. 190) *C. canariensis* was misinterpreted as *C. sophroniellus*.

Symmoca aegrella was described from two specimens collected in June 1907 at La Laguna, Tenerife, it was compared with *canariensis* by Walsingham (1908, pp. 949-950). Later *C. aegrella* was synonymised with that species by Gozmány (1963, p. 453). The male genitalia of the lectotype are figured by Gozmány (2008, p. 411, figure (b)).

It appears that the males of *C. canariensis* occur in two geographical forms in Gran Canaria, in the northern part they are similar to specimens from El Hierro and Tenerife, in the southern part they are similar to males of *C. pseudocanariensis.* The molecular analyses show high intraspecific divergence in COI, and there seems to be some correlation between the different populations from Gran Canaria in the DNA and in the adult appearance. Although the divergence between two of the populations is above the 2% threshold suggested as a putative guideline for species delimitation by Hebert et al. (2003), we hesitate to describe them as new species, because we were unable to find any constant difference in the genitalia.

Chersogenes subextricata **Falck & Karsholt, sp. n.** (Figures 17-18, 60, 60a)

Holotype ♂: SPAIN, Tenerife, Puerto de la Cruz, 200 m, 18-XI-8-XII-2018, leg. P. Falck, genitalia slide 2864PF, DNA sample Lepid Phyl 0155PF/CILEP154-19 (MNCN).

Paratypes: Spain, Near Chirche, 100 m, 1 ♂, 8-22-XI-2016, leg. P. Falck, genitalia slide 2535PF, DNA sample Lepid Phyl 0044PF/CILEP44-19; 3 km NW Los Roques, 160 m, 1 ♂, 18-XI-8-XII-2018, leg. P. Falck, genitalia slide 2865PF, DNA sample Lepid Phyl 0154PF/CILEP153-19 (PF).

Description: Male. Wingspan 14-15.5 mm. Labial palp upturned, segment 2 white mottled with black and brown scales, especially ventrally and laterally, ventrally a small brownish scale tuft, segment 3 almost as long as segment 2, whitish mottled with dark grey scales. Antenna almost as long as forewing, black. Head and neck grey mottled with white; thorax and tegula greyish brown with a few white scales. Forewing greyish white, mottled with ochreous, brown and black scales, fringe grey. Hindwing grey with grey fringe. Abdomen greyish.

Female: Unknown.

Variation: One of the specimens has the forewing grey with a broad dark grey costal line reaching the apex; median 1/3 light grey mottled with ochreous scales; dorsal 1/3 grey, darker brownish grey towards termen; one black discal spot. *C. subextricata* is probably a variable species.

Male genitalia (Figures 60, 60a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal half, apex rounded; sacculus about 2/3 length of valva, apically sickle-shaped; appendix shorter than valva, slightly bent, apex pointed; juxta semi-oval, posteriorly forked; saccus triangular; phallus almost straight, slightly tapering posteriorly; one cornuti group with 20-25 relatively short spines.

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from three specimens. The barcodes fall within Barcode Index Number (BIN) BOLD: ADU9684. The maximum intraspecific p-distance is 1.44%. The barcodes of *C. subextricata*, *C. extricata* and *C. gomerae* cluster together in the neighbour-joining tree and the minimum p-distances between them are 4.51% (*C. subextricata* vs. *C. extricata*), 4.81% (*C. subextricata* vs. *C. gomerae*) and 5.86% (*C. extricata* vs. *C. gomerae*). The nearest neighbour to them is *C. variabilis*, with a 5.50% divergence.

Diagnosis: In the male genitalia the sickle-shaped sacculus, the short appendix and only one group of cornuti are characteristic. For separation from similar species see under *C. extricata*.

Biology: Early stages unknown. The specimens were attracted to light from the beginning of November until the beginning of December, at altitudes between 100 m and 200 m.

Distribution: Only known from the island of Tenerife, Spain.

Etymology: The species is named *C. subextricata* because of its similarity to *C. extricata*.

Chersogenes extricata (Gozmány, 1964), **sp. rev., comb. nov.** (Figures 19-22, 61, 61a, 80)
Epanastasis extricata Gozmány, 1964. *Acta zool. hung., 10,* 120-121
Type locality: SPAIN, Gran Canaria, Las Palmas.

Material examined: Spain, Gran Canaria, 4 km N Mogan, Lugar del Pie de la Questa, 570 m, 2 ♂♂, 4-XI-2014, leg. B. Skule (ZMUC); 3.5 km NNE Mogan, Barranco Mogan, 430 m, 2 ♂♂, 5-XI-2014, leg. B. Skule (ZMUC); Pie de la Cuesta, 500 m, 1 ♂, 17-30-IX-2018, leg. P. Falck, DNA sample Lepid Phyl 0141PF/CILEP140-19; same data but, 10 ♂♂, 24-X-13-XI-2020, leg. P. Falck, DNA sample Lepid Phyl 0811PF/CILEP810-21 (PF); Ayacata, 1400 m, 1 ♂, 17-30-IX-2018, leg. P. Falck, genitalia slide 2819PF, DNA sample Lepid Phyl 0043PF/CILEP43-19, same data but, 4 ♂♂, 1 ♀, 24-X-13-XI-2020, leg. P. Falck, genitalia slide 3730PF, DNA sample Lepid Phyl 0812PF/CILEP811-21 (PF); Barranco Guayadeque, 800 m, 23 ♂♂, 24-X-13-XI-2020, leg. P. Falck, genitalia slides 3697PF, 3706PF, DNA sample Lepid Phyl 0813PF/CILEP812-21 (PF).

Description: Male. Wingspan 14-16.5 mm. Labial palp upturned, segment 2 white, laterally and ventrally mottled with dark brown and black scales, segment 3 almost as long as segment 2, whitish mottled with brown and black. Antenna almost as long as forewing, black with indistinct grey rings. Head and neck greyish white mottled with brown; thorax and tegula ochreous mottled with brown especially towards neck. Forewing grey mottled with brown and black; from the base to near apex a whitish mottled with ochreous median streak, at 1/3 and before 2/3 bordered by two black dots; along termen and apex 6-8 black dots; fringe grey. Hindwing grey with grey fringe. Abdomen greyish brown.

Female: Wingspan 13 mm. Differs from the male in being brachypterous, the forewing being shorter and broader, the hindwing slenderer with a pointed apex. Forewing dark brownish.

Variation: *C. extricata* exhibits considerable variation. The ground colour varies from whitish grey or dark grey to yellowish brown or ochreous, the median streak is often indistinct or missing, the distal black spots are sometimes confluent, or the black spots may be totally absent.

Male genitalia (Figures 61, 61a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal half, apex rounded; sacculus about 2/3 length of valva, apically sickle-shaped; appendix distinctly shorter than valva, slightly bent, apex pointed; juxta sub-rectangular, posteriorly forked; saccus triangular; phallus almost straight, slightly tapering posteriorly; two cornuti groups, anterior group with 14-15 short spines, posterior group with 8-9 short spines.

Female genitalia (Figure 80): Papilla analis long, distally pointed, posterior apophysis slender, twice as long as papilla analis; anterior apophysis slightly longer than half the length of posterior apophysis; tergum VIII sub-rectangular, sternum VIII with median fissure widening anteriorly; lamella antevaginalis sub-rectangular, broad, posterior margin laterally rounded with a broad medial U-shaped invagination; antrum V-shaped; colliculum narrow and sclerotised; ductus bursae membranous, slightly broader than colliculum and narrowing anteriorly; corpus bursae membranous, round, signum with about 25 small spines.

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from four specimens and DNA barcode fragments of 633 bp from one specimen. The barcodes fall within Barcode Index Number (BIN) BOLD: ADF2779. The maximum intraspecific p-distance is 1.61%. The results are presented in the DNA barcodes section of *C. subextricata*.

Diagnosis: The three species *C. extricata*, *C. subextricata* and *C. gomerae* are closely related, and it is not possible to separate them without dissection of the genitalia or barcoding. The group is distinguished from the similar looking species *C. canariensis* and *C. pseudocanariensis* by the lack of a scale tuft ventrally on segment 2 of the labial palp. In the male genitalia of *C.extricata* the sickle-shaped sacculus, the short appendix and the two group of cornuti are characteristic. It is distinguished from *C. subextricata* in having two groups of cornuti, and from *C. gomerae* in the more curved apex of the sacculus and a larger number of cornuti in both groups of cornuti.

Biology: Early stages unknown. The specimens were attracted to light during October and November, at altitudes from 430 m to 1400 m. The only known female was found running on the ground near the light.

Distribution: Known only from the mountain area in the central part of the island of Gran Canaria, Spain.

Remarks: The genitalia of the holotype are figured by Gozmány (2008, p. 412, fig. 161).

Chersogenes gomerae Falck & Karsholt, sp. nov. (Figures 23-26, 62, 62a,)

Holotype ♂: SPAIN, La Gomera, Arure, 820 m, 24-X-12-XI-2021, leg. P. Falck, genitalia slide 3705PF (ZMUC).

Paratypes: SPAIN, La Gomera, Arure, 820 m, 22 ♂♂, 24-X-12-XI-2021, leg. P. Falck, genitalia slide 3696PF, DNA samples Lepid Phyl 0985PF/CILEP984-22, 0986PF/CILEP985-22 (PF); Epina, 820 m, 10 ♂♂, 24-X-12-XI-2021, leg. P. Falck, genitalia slide 3653PF, DNA sample Lepid Phyl 0984PF/CILEP983-22; El Cedro, 570 m, 1 ♂, 24-X-12-XI-2021, leg. P. Falck (PF; MNCN).

Description: Male. Wingspan 14-17 mm. Labial palp upturned, segment 2 white, laterally and ventrally mottled with dark brown and black scales, segment 3 almost as long as segment 2, whitish mottled with brown and black. Antenna almost as long as forewing, black with indistinct grey rings. Head and neck greyish white mottled with brown; thorax and tegula ochreous mottled with brown especially towards neck. Forewing grey mottled with brown and black; from the base to near apex a whitish mottled with ochreous median streak, at 1/3 and before 2/3 bordered by two black dots; along termen and apex 6-8 black dots; fringe grey. Hindwing grey with grey fringe. Abdomen greyish brown.

Variation: *C. gomerae* exhibits considerable variation. The ground colour varies from whitish grey or dark grey to yellowish brown or ochreous, the median streak is often indistinct or missing, the distal black spots are sometimes confluent, or the black spots may be totally absent.

Female: Unknown.

Male genitalia (Figures 62, 62a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal half, apex rounded; sacculus shorter than 2/3 length of valva, apically sickle-shaped; appendix distinctly shorter than valva, slightly bent, apex pointed; juxta sub-rectangular, posteriorly forked; saccus triangular; phallus almost straight, slightly tapering posteriorly; two cornuti groups, anterior group with 21-23 short spines, posterior group with 10-11 short spines.

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from three specimens. The barcodes fall within Barcode Index Number (BIN) BOLD: AEP5785. The maximum intraspecific p-distance is 0.16%. The results are presented in the DNA barcodes section of *C. subextricata*.

Diagnosis: In the male genitalia the sickle-shaped sacculus, the short appendix and two groups of cornuti are characteristic. For separation from similar species see under *C. extricata*.

Biology: Early stages unknown. All specimens of the type series were attracted to light from late October until the beginning of November at altitudes from 570 m to 820 m.

Distribution: Only known from a few scattered localities in the mountain region of the island of La Gomera, Spain.

Etymology: The species is named after the Canary Island, La Gomera.

***Chersogenes nigra* Falck & Karsholt, sp. nov.** (Figures 27-28, 63, 63a, 81)

Holotype ♂: SPAIN, Gran Canaria, Pie de la Cuesta, 500 m, 21-VIII-4-IX-2020, leg. P. Falck, genitalia slide 3727PF, DNA sample Lepid Phyl 0743PF/CILEP742-20 (PF).

Paratype: SPAIN, Pie de la Cuesta, 500 m, 1 ♀, 21-VIII-4-IX-2020, leg. P. Falck, genitalia slide 3732PF, DNA sample Lepid Phyl 0700PF/CILEP699-20 (PF).

Description: Male. Wingspan 8.5 mm. Labial palp upturned, segment 2 blackish, posteriorly white and mottled white ventrally, segment 3 almost as long as segment 2, blackish. Antenna as long as the length of forewing, black with indistinct grey rings. Head and neck dark brown mottled light grey; thorax and tegula blackish brown. Forewing dark brown mottled with black scales; at 1/5 and 1/2 two broad, diffuse, lighter brown fasciae; fringe grey. Hindwing dark brown with grey fringe. Abdomen dark greyish brown.

Female: Wingspan 8.5 mm. Differs from male by the broader forewing and the more clearly marked fasciae.

Male genitalia (Figures 63, 63a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, clearly upturned and broadening in distal third, apex rounded; sacculus about 1/2 length of valva, apically straight and pointed; appendix clearly shorter than valva, almost straight, apex pointed; juxta anteriorly rectangular, posteriorly forked; saccus triangular; phallus narrow, bent before 1/2, slightly tapering posteriorly; without cornuti.

Female genitalia (Figure 81): Papilla analis short, distally rounded, posterior apophysis slender, about three times longer than papilla analis; anterior apophysis longer than half the length of posterior apophysis; tergum VIII narrow, sub-rectangular, sternum VIII sub-rectangular, corrugate anteriorly; lamella antevaginalis sub-rectangular, narrow, posterior margin slightly concave, laterally rounded; antrum narrowing anteriorly; colliculum weakly sclerotized, narrow and slightly tapering anteriorly; ductus bursae short, membranous; corpus bursae membranous, oval, without signum.

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from two specimens. The barcodes fall within Barcode Index Number (BIN) BOLD: AEG0351. The intraspecific p-distance is 0.00%. The minimum p-distance to nearest neighbour *C. canariensis* is 6.25%.

Diagnosis: *C. nigra* does not resemble other members of the genus, but the female is superficially similar to some species of *Scythris* Hübner, 1825, especially in the *S. petrella* species-group (Bengtsson, 1997, p. 138). The small size and dark colour are characteristic. In the male genitalia the short straight sacculus, the upturned apex of the valva and the lack of cornuti are characteristic. In the female genitalia the short papilla analis, the narrow segment VIII, the narrow concave lamella antevaginalis and the lack of signum are characteristic.

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

Distribution: Only known from the type locality, Pie de la Cuesta, Gran Canaria, Spain.

Etymology: The species is named after its dark colour.

Chersogenes eupracta (Gozmány, 1988), **comb. nov.** (Figures 29-32, 64, 64a, 82)
Epanastasis eupracta Gozmány, 1988. *Boll. Mus. reg. Sci. nat. Torino, 6*, 185-186
Type locality: SPAIN, Gran Canaria, Los Tilos de Moya.

Type material examined: Holotype ♂, “Canary Isl., Gr. Canaria, Los Tilos, Moya, 19-VII-1984, 600 m, leg. Olsen, Skule, Stadel” “HOLOTYPUS, *Epanastasis eupracta* Goz., gen. prep. No. 5982, det L. Gozmány” “ZMUC 00401387” (ZMUC). Paratype ♂, “Canary Isl., Gr. Canaria, Bco. Virgen, Moya, 20-VII-1984, 400 m, leg. Olsen, Skule, Stadel” “PARATYPUS, *Epanastasis eupracta* Goz., gen. prep. No. 5984, det L. Gozmány” (ZMUC).

Material examined: SPAIN, Gran Canaria; Inagua, Tasarte, 600 m, 1 ♂, 28-VII-1995, leg. K. Larsen, genitalia slide 5424 Karsholt (ZMUC); Los Tilos de Moya, 500 m, 2 ♂♂, 11-24-VI-2018, leg. P. Falck, same data but, 16 ♂♂, 15 ♀♀, 17-30-IX-2018, leg. P. Falck (PF); Pie de la Cuesta, 500 m, 5 ♂♂, 11-24-VI-2018, leg. P. Falck, genitalia slides 2824PF, 2827PF, DNA sample Lepid Phyl 0038PF/CILEP38-19, same data but, 7 ♂♂, 3 ♀♀, 17-30-IX-2018, leg. P. Falck (PF); El Sao, 110 m, 2 ♂♂, 11-24-VI-2018, leg. P. Falck, DNA sample Lepid Phyl 0039PF/CILEP39-19(PF); Ayacata, 1400 m, 11 ♂♂, 3 ♀♀, 17-30-IX-2018, leg. P. Falck, genitalia slide 2828PF, DNA sample Lepid Phyl 0037PF/CILEP37-19, same data but, 2 ♂♂, 21-VIII-4-IX-2020, leg. P. Falck, genitalia slide 3728PF, DNA samples Lepid Phyl 0689PF/CILEP688-20, 0690PF/CILEP689-20 (PF); Carreteria, 455 m, 5 ♂♂, 8 ♀♀, 8-20-VIII-2020, leg. P. Falck, genitalia slide 3708PF (PF); Fontanales 1100 m, 6 ♂♂, 2 ♀♀, 8-20-VIII-2020, leg. P. Falck (PF); Barranco de Moya, 80 m, 1 ♀, 8-20-VIII-2020, leg. P. Falck (PF); Barranco de Azuaje, 270 m, 1 ♀, 8-20-VIII-2020, leg. P. Falck (PF); Tenerife; Las Manchas, 1050 m, 2 ♂♂, 3-16-VIII-2021, leg. P. Falck, genitalia slides 3522PF, 3714PF, DNA samples Lepid Phyl 0870PF/CILEP869-21, 0871PF/CILEP870-21 (PF).

Description: Male. Wingspan 10-14 mm. Labial palp upturned, segment 2 brown, dorsally yellowish brown, segment 3 almost as long as segment 2, yellowish, indistinctly brown ringed near apex. Antenna black with indistinct grey rings. Head and neck yellowish brown; thorax and tegula yellowish brown, the latter dark brown towards base. Forewing yellowish brown, sometimes mottled with dark brown scales; at 1/3 an indistinct, oblique, ochreous fascia, bordered particularly medially by black scales, at 2/3 an indistinct, rounded, ochreous marking; termen with black spots; fringe grey. Hindwing dark grey with grey fringe. Abdomen yellowish brown.

Female: Wingspan 12-15 mm. Differs from the male by a more prominent wing pattern.

Variation: *C. eupracta* is a highly variable species. The colour of the forewing varies from yellowish to brownish and grey, and the mottling may be absent or very prominent. The wing pattern is sometimes almost absent, giving a uniform appearance of the wing, and in other specimens the wing pattern is very pronounced and forming two distinct, dark brown fasciae, especially in the females.

Male genitalia (Figures 64, 64a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 8 times longer than broad, slightly upturned in distal half, apex rounded; sacculus about 2/3 length of valva, apical 1/3 slender, evenly rounded upwards at a 90 degree angle, apically pointed; appendix as long as valva, slightly bent, apex pointed; transtilla with long, narrow projection, nearly as long as half the length of the posterior margin of valva; juxta hourglass-shaped, anteriorly semi-oval, posteriorly forked; saccus triangular, tapered anteriorly; phallus broad, longer than half the length of valva, almost straight, slightly tapering posteriorly; two cornuti groups, one with 14-16 spines of various length of which about 10 are very short, and the second one with 16-18 rather long spines.

Female genitalia (Figure 82): Papilla analis slender, distally pointed, posterior apophysis slender, 2.5 times longer than papilla analis; anterior apophysis slightly longer than half the length of posterior apophysis; tergum VIII sub-rectangular, sternum VIII with median fissure widening anteriorly; lamella antevaginalis rectangular, broad, posterior margin laterally slightly concave with a broad median V-shaped invagination; antrum sclerotised narrowing anteriorly; colliculum sclerotised and widening posteriorly, ductus bursae membranous and twisted anteriorly; ductus seminalis membranous, large and bulbous corpus bursae membranous oval, signum edged with about 20 small spines, centrally about 20 minute spines.

DNA barcodes (Figure 87): We obtained full length DNA barcode (658 bp) from seven specimens. The barcodes fall within Barcode Index Number (BIN) BOLD: ADT8332. The maximum intraspecific p-distance is 0.64%. The barcodes of *C. eupracta*, *C. hermiguae* and *C. mercedella* cluster together in the neighbour-joining tree and the minimum p-distances between them are 6.60% (*C. eupracta* vs. *C. hermiguae*), 7.30% (*C. eupracta* vs. *C. mercedella*) and 8.52% (*C. hermiguae* vs. *C. mercedella*). The nearest neighbour to them is *C. variabilis*, with a 6.27% divergence.

Diagnosis: The yellowish-brown colour of the forewing and the very contrasting dark grey hindwing separates *C. eupracta* from most species in the genus. It closely resembles *C. mercedella* and can be distinguished by the two ochreous spots before and beyond the middle. In the male genitalia the slender and bent apex of the sacculus, and the long, narrow transtilla projection are characteristic. It differs from *C. mercedella* by the evenly bent apex of the sacculus and the longer transtilla projection. In the female genitalia the twisted membraneous part of ductus bursae and the large ductus seminalis are characteristic.

Biology: Early stages unknown. The specimens were collected from the beginning of June until the end of October mainly at light, but *C. eupracta* was also observed flying actively in the afternoon sunshine in great numbers, both in a mixed forest and in open mountain areas at altitudes from 110 m to 1400 m.

Distribution: Widely distributed on the island of Gran Canaria and from one locality in the western part of the island of Tenerife, Spain.

***Chersogenes hermiguae* Falck & Karsholt, sp. nov.** (Figures 33, 65, 65a)

Holotype ♂: SPAIN, La Gomera, Hermigua, 250 m, 9-12-VIII-2021, leg. P. Falck, genitalia slide 3675PF, DNA sample Lepid Phyl 0869PF/CILEP868-21 (MNCN).

Paratype: SPAIN, La Gomera, Hermigua, 250 m, 1 ♂, 9-12-VIII-2021, leg. P. Falck, genitalia slide 3718PF, DNA sample Lepid Phyl 0868PF/CILEP867-21 (PF).

Description: Male. Wingspan 9 mm. Labial palp upturned, segment 2 grey mottled with white scales, segment 3 grey, half the length of segment 2. Antenna black with indistinct grey rings. Vertex whitish; head with laterally, grey and white scale tufts; neck grey mottled with white scales, thorax and tegula greyish mottled with brown scales. Forewing grey, apically mottled with black scales; basally with blackish spot at costa; at 1/3 an indistinct, oblique, black fascia, in the middle part mottled with ochreous scales; at 2/3 an indistinct, oblique black fascia; in the discal area an ochre-coloured spot. fringe grey. Hindwing grey with grey fringe. Abdomen greyish brown.

Female: Unknown.

Male genitalia (Figures 65, 65a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 7 times longer than broad, slightly upturned in distal half, apex rounded; sacculus about 2/3 length of valva, apical 1/3 slender, evenly rounded upwards at a 90 degree angle, apically pointed; appendix clearly longer than valva, slightly bent, apex pointed; transtilla with long, narrow projection, about 1/3 the length of the posterior margin of valva; juxta hourglass-shaped, anteriorly triangular, posterior part very small triangular; saccus triangular, tapered anteriorly; phallus broad, about half the length of valva, bent, slightly tapering posteriorly; two cornuti groups, one with 15-16 rather long spines, and a second one with 25-28 spines of various length.

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from two specimens. The barcodes fall within Barcode Index Number (BIN) BOLD: AEM6648. The intraspecific p-distance is 0.00%. The results are presented in the DNA barcodes section of *C. eupracta*.

Diagnosis: The small size and grey colour with two dark oblique fasciae of the forewing separates *C. hermiguae* from other species in the genus. In the male genitalia the long appendix, the long narrow projection of the transtilla and the 90º degree angle of the sacculus are very characteristic.

Biology: Early stages unknown. The specimens were attracted to light.

Distribution: Known only from the type locality in the northern part of the island of La Gomera, Spain.

Etymology: The species is named after its type locality, Hermigua.

Chersogenes mercedella **Falck & Karsholt, sp. nov.** (Figures 34, 66, 66a,)

Holotype ♂: Spain, Tenerife, Las Mercedes, 750 m, 13-26-VIII-2019, leg. P. Falck, genitalia slide 3665PF (ZMUC).

Paratypes: Spain, Tenerife Las Mercedes, 750 m, 13 ♂♂, 13-26-VIII-2019, leg. P. Falck, genitalia slide 3674PF, 3709PF, DNA samples Lepid Phyl 0320PF/CILEP319-19, 0321PF/CILEP320-19, 0322PF/CILEP321-19 (PF, MNCN).

Description: Male. Wingspan 7-10.5 mm. Labial palp upturned, segment 2 dark brown, ventrally yellowish, segment 3 longer than the half the length of segment 2, yellowish, mottled with dark brown scales. Antenna black with indistinct grey rings. Head, neck, tegula and thorax yellowish brown. Forewing yellowish brown, mottled with light brown and dark brown scales; mottled with black scales at dorsum in distal half, in discal area and apically; fringe grey. Hindwing dark grey with grey fringe. Abdomen yellowish brown.

Female: Unknown.

Variation: The mottling with black scales of the forewing is sometimes almost absent, otherwise forming two indistinct, oblique, black fasciae.

Male genitalia (Figures 66, 66a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal half, apex rounded; sacculus about 2/3 length of valva, abruptly turning upwards at a 90 degree angle, apically pointed; appendix slightly shorter than valva, slightly bent, apex pointed; transtilla with long, narrow projection, about 1/3 the length of the posterior margin of valva; juxta hourglass-shaped; saccus triangular, tapered anteriorly; phallus broad, longer than half the length of valva, bent; two cornuti groups, one with 4-6 rather strong spines, and a second one with 25-30, the basal 4-6 spines very short.

DNA barcodes (Figure 87): We obtained a full-length DNA barcode (658 bp) from one specimen and DNA barcode fragments of 635 and 627pb from two specimens. The barcodes fall within Barcode Index Number (BIN) BOLD: AEC2599. The maximum intraspecific p-distance is 0.96%. The results are presented in the DNA barcodes section of *C. eupracta*.

Diagnosis: The yellowish-brown colour of the forewing and the very contrasting dark grey hindwing separates *C. mercedella* from most of the species in the genus. It closely resembles *C. eupracta*, q. v.

Biology: Early stages unknown. The specimens were attracted to light.

Distribution: Known only from the type locality in the eastern part of the island of Tenerife, Spain.

Etymology: The species is named after its type locality, Las Mercedes.

Chersogenes duabusalis Falck & Karsholt, sp. nov. (Figures 35-36, 67, 67a, 83)

Holotype ♂: SPAIN, Lanzarote, Las Casitas de Femes, 1 ♂, 4-II-1994, leg. J. P. Baungaard (ZMUC).

Paratypes: SPAIN, Fuerteventura, Betancuria, 400 m, 49 ♂♂, 11 ♀♀, 27-II-19-III-2018, leg. P. Falck, genitalia slides 2835PF, 2854PF, 3715PF, 3720PF, DNA samples Lepid Phyl 0052PF/CILEP52-19, 0053PF/CILEP53-19; Corralejo, 10 m, 1 ♂, 7-27-XI-2017, leg. P. Falck, DNA samples Lepid Phyl 0054PF/CILEP54-19 (PF, MNCN).

Description: Male. Wingspan 7-8 mm. Brachypterous. Labial palp upturned, segment 2 dark brown, dorsally whitish, segment 3 half the length of segment 2, dark brown mottled with white medially. Antenna as long as forewing, dark brown with indistinct grey rings. Head, neck, thorax and tegula dark brown. Forewing very slender, pointed, costa slightly concave in apical half; ground colour dark brown mottled with ochreous and a few black scales; fringe grey. Hindwing rudimentary. Abdomen dark beige.

Female: Wingspan 7-8 mm. Differs from the male by the shorter antenna, the broader forewing and the distinctly concave apical half of costa.

Variation: Ground colour varies from beige, grey and to dark brown, often present is an indistinct, median, beige streak from base to about 2/3.

Male genitalia (Figures 67, 67a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, upturned in distal third, apex rounded; sacculus about 2/3 length of valva, apically evenly bent upwards; appendix distinctly shorter than valva, slightly bent, apex pointed; transtilla projection short; juxta sub-rectangular, slightly narrowing in the middle; saccus triangular; phallus bent; two cornuti groups almost confluent, anterior group with 4-6 robust spines, posterior group with 4-5 spines.

Female genitalia (Figure 83): Papilla analis long, distally pointed, posterior apophysis slender, twice as long as papilla analis; anterior apophysis half the length of posterior apophysis; tergum VIII sub-rectangular, narrow, sternum VIII with median fissure widening anteriorly; lamella antevaginalis sub-rectangular, posterior margin crown-shaped with median 1/3 slightly concave and laterally with deeper concavity; colliculum sclerotised and short; ductus bursae membranous, bulbous, twice as broad as colliculum, tapering anteriorly; corpus bursae membranous elongate, semi-oval; signum a sub-rectangular plate with irregular edges, covered by several micro-spines.

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from three specimens. The barcodes fall within Barcode Index Number (BIN) BOLD: ADV1498. The maximum intraspecific p-distance is 0.64%. The results are presented in the DNA barcodes section of *C. klimeschi.*

Diagnosis: The rudimentary hindwing separates *C. duabusalis* from most species in the genus. It resembles *C. aguiari* and is distinguished by the broader wings and larger size. In the male genitalia the small transtilla projection, the very short appendix and the bent phallus with few robust cornuti are characteristic. They differ from *C. aguiari* by the longer appendix, the shorter gnathos, the posteriorly broader phallus and by having two cornuti groups. In the female genitalia the crown-shaped lamella antevaginalis and the irregular signum plate are characteristic.

Biology: Early stages unknown. Most of the specimens were netted in open grass areas during daytime in full sunshine, and a few were attracted to light, all from February, March and November at altitudes ranging from sea level to 400 m.

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

Etymology: The species is named after the Latin words *duabus alis* (= two wings) referring to the adult appearance, as appearing to have only two wings.

Chersogenes aguiari Falck & Karsholt, sp. nov. (Figures 37, 68, 68a,)

Holotype ♂: PORTUGAL, Selvagens Islands, Selvagem Grande, 30-IX-2007, leg. Dieter Pützner, descent to Captain Kid's cave, in the shade, soil sifted near *Schizogyne sericea* (L.f.) DC. (Asteraceae), genitalia slide 5237♂ Karsholt (MMF).

Paratypes: 2 ♂♂, same data as holotype, genitalia slide 3801APF (AFA, ZMUC).

Description: Male. Wingspan 5 mm. Labial palp light grey-brown, slightly upcurved, segment 2 broadest in apical part; segment 3 almost three times shorter than segment 2, with pointed apex. Antenna slightly longer than forewing, ringed dark brown and whitish. Head and thorax [partly denuded] whitish grey-brown. Forewing very slender, pointed, whitish grey with some grey-brown tipped scales. Hindwing rudimentary. Abdomen rather stout, yellowish white.

Female: Unknown.

Male genitalia (Figures 68, 68a): Uncus long, slender rectangular, apex spatulate; gnathos slightly shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal third, apex rounded; sacculus 2/3 length of valva, apically evenly bent upwards; appendix very short, straight, apex pointed; transtilla projection short; juxta anteriorly sub-rectangular, posteriorly with a sclerotized ring; saccus sub-triangular; phallus anteriorly bent, posteriorly straight; one cornuti group with 5-6 spines.

DNA barcodes: Barcoding failed twice.

Diagnosis: *C. aguiari* resembles *C. duabusalis* (q. v.). In the male genitalia the short appendix and the bent, rather slender phallus with one cornuti group are characteristic.

Biology: Early stages unknown. The three type specimens were sifted from soil near *Schizogyne sericea* (L.f.) DC. (Asteraceae) growing in shade.

Distribution: Only known from the type locality Selvagem Grande in the Selvagens Islands, Portugal.

Etymology: The species is dedicated to António M. Franquinho Aguiar, who placed the known specimens of this new species at our disposal and contributed so much to the knowledge of the entomofauna of the Madeira Islands.

Remarks: The Selvagens Islands, situated between the Canary Islands and Madeira, have a very low diversity of lepidopteran fauna. Aguiar & Karsholt (2006, p. 13) listed only 24 lepidopteran species from these islands. None of them are endemic to the islands but are either widespread or also occur on the Canary Islands. The geological history of the Selvagens Islands is most closely related with that of the Canary Islands (Geldmacher et al., 2001). *C. aguiari* is thus the first endemic Lepidoptera species for the Selvagens Islands, which has 59 endemic arthropod species (UNESCO, 2017).

The islands are of volcanic origin and were never connected to the continent. They are very old, about 29 million years, and very eroded and have probably not been submerged during the last 4-5 million years (Geldmacher et al. 2001), which is crucial for the terrestrial fauna. The largest of the islands, and type locality of *C. aguiari*, Selvagem Grande, has an area of only 245 ha and raises to a rather flat plateau with altitudes up to 163 m. It is dominated by low vegetation and strong winds, giving only limited shelter for winged insects like Lepidoptera.

Chersogenes klimeschi (Gozmány, 1975), **comb. nov.** (Figures 38-41, 69, 69a)
Ambloma klimeschi Gozmány, 1975. *Acta zool. hung., 21,* 267-268, fig. 4
Type locality: SPAIN, La Gomera, La Caleras.
= *Epanastasis excellens* Gozmány, 1977. *Acta zool. hung., 23,* 96-97, fig. 10, **syn. nov.**
Type locality: SPAIN, Gran Canaria, Las Palmas.

Material examined: SPAIN, La Gomera, Playa de Santiago, sea level, 3 ♂♂, 27-VII-1984, leg. P. Olsen, B. Skule & P. Stadel Nielsen, genitalia slides Gozmány 5986, 6039, 6040 (ZMUC); Valle Gran Rey, 150 m, 9 ♂♂, 24-X-12-XI-2021, leg. P. Falck, DNA sample Lepid Phyl 0981PF/CILEP980-22 (PF); Arure, 820 m, 4 ♂♂, 24-X-12-XI-2021, leg. P. Falck, genitalia slides 3660PF, 3663PF, DNA samples Lepid Phyl 0982PF/CILEP981-22, 0983PF/CILEP982-22 (PF); Hermigua, 250 m, 1 ♂, 24-X-12-XI-2021, leg. P. Falck, genitalia slide 3716PF (PF); Gran Canaria, 2 km S Mogan, El Barranquillo, Andres, 2 ♂♂, 24-VII-1995, leg. K. Larsen (ZMUC); 1.3 km N Mogan, 430 m, 4 ♂♂, 3-8-XI-2014, leg. B. Skule (ZMUC); Bahia Feliz, 2 ♂♂, 6-7-V-2018, leg. K. Larsen (ZMUC); El Doctoral, 350 m, 6 ♂♂, 9-12-V-2018, leg. K. Larsen (ZMUC); Puerto Rico, 50 m, 15 ♂♂, 11-24-VI-2018, leg. P. Falck (PF); Pie de la Cuesta, 500 m, 19 ♂♂, 11-24-VI-2018, leg. P. Falck, same data but, 4 ♂♂, 17-30-IX-2018, leg. P. Falck, DNA sample Lepid Phyl 0049PF/CILEP49-19 (PF); 8 km NW Pie de la Cuesta, 895 m, 6 ♂♂, 17-30-IX-2018, leg. P. Falck, genitalia slide 3040PF, DNA sample Lepid Phyl 0048PF/CILEP48-19 (PF); Barranquillo Andrés 700 m, 5 ♂♂, 17-30-IX-2018, leg. P. Falck, DNA sample Lepid Phyl 0161PF/CILEP160-19 (PF); El Sao, 110 m, 2 ♂♂, 17-30-IX-2018, leg. P. Falck, genitalia slide 3662PF, same data but, 1 ♂, 21-VIII-4-IX-2020, leg. P. Falck, same data but, 1 ♂, 1-13-IV-2022, leg. P. Falck (PF); Playa del Cura, 30 m, 2 ♂♂, 4-23-III-2019, leg. P. Falck, genitalia slide 3717PF, DNA sample Lepid Phyl 0159PF/CILEP150-19 (PF); Puntilla de la Caleta, 10 m, 1 ♂, 4-23-III-2019, leg. P. Falck, genitalia slide 3033PF, DNA sample Lepid Phyl 0164PF/CILEP163-19 (PF); San Filipe, 25 m, 7 ♂♂, 24-X-13-XI-2020, leg. P. Falck, DNA sample Lepid Phyl 0980PF/CILEP979-22 (PF): Barranco de Guayadeque, 800 m, 1 ♂, 1-13-IV-2022, leg. P. Falck, genitalia slide 3690PF (PF); El Hierro, Tacorón, 170 m, 7 ♂♂, 22-VII-3-VIII-2022, leg. P. Falck, genitalia slide 3780PF, DNA samples Lepid Phyl 1068PF/CILEP1067-22, 1069PF/CILEP1068-22 (PF); Tenerife, Arona, 300 m, 1 ♂, 22-XII-1981, leg. W. O. De Prins (ZMUC); Arona, 670 m, 2 ♂♂, 1-20-III-2017, leg. P. Falck, DNA sample Lepid Phyl 0158PF/CILEP157-19, same data but, 1 ♂, 21-V-3-VI-2019, leg. P. Falck (PF); El Medano, 25 m, 1 ♂, 1-20-III-2017, leg. P. Falck, DNA sample Lepid Phyl 0160PF/CILEP159-19 (PF); Armenime, 50 m, 1 ♂, 3-9-III-2013, leg. P. Falck, genitalia slide 2520PF (PF).

Description: Male. Wingspan 8-12 mm. Labial palp upturned, segment 2 white with small dark grey scale tuft ventrally, segment 3 white mottled dark grey especially ventrally, slightly shorter than segment 2. Antenna as long as forewing, dark grey. Head greyish. Neck whitish. Thorax grey mottled with white. Tegula dark grey basally, greyish white distally. Forewing slender and pointed; ground colour grey heavily mottled with white and with scattered black scales; at 1/3 two small, sometimes confluent, indistinct ochreous spots, at 2/3 one small indistinct ochreous spot; fringe grey. Hindwing grey with grey fringe. Abdomen dark beige.

Female: Unknown.

Variation: It appears that there is some general geographic variation in the ground colour. It varies from whitish (Gran Canaria), greyish with beige (La Gomera and Tenerife) and to dark grey (El Hierro), the spots are sometimes very diffuse and often totally absent.

Male genitalia (Figures 69, 69a): Uncus long, slender rectangular, apex spatulate; gnathos longer than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal third, apex rounded; sacculusabout 2/3 length of valva, apically evenly bent upwards; appendix short, distinctly shorter than valva, slightly bent, apex pointed, transtilla projection short; juxta anteriorly sub-rectangular, posteriorly with a sclerotised ring; saccus triangular; phallus anteriorly slightly bent; three cornuti groups, one group with 3-5 spines, one group with 2-4 spines and one group with 6-7 spines, the spines are relatively short.

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from twelve specimens and DNA barcode fragments of 591 bp and 623 bp from two specimens. The barcodes fall within Barcode Index Numbers (BIN) BOLD: AEH2995 (one specimen from Gran Canaria), AEH2996 (one specimen from Gran Canaria), AEH2997 (three specimens from Gran Canaria), ADF2780 (one specimen from Gran Canaria), ADU2892 (two specimens from Tenerife), ADY9824 (one specimen from Tenerife and three specimens from La Gomera) and AEW3196 (two specimens from El Hierro). The maximum intraspecific p-distance is very high 5.20%. The barcodes of *C. klimeschi*, *C. duabusalis, C. coxi* and *C. lanzarotae* cluster together in the neighbour-joining tree and the minimum p-distances between them are 5.29% (*C. klimeschi* vs. *C. duabusalis*), 5.81% (*C. klimeschi* vs. *C. coxi*), 5.35% (*C. klimeschi* vs. *C. lanzarotae*), 6.17% (*C. duabusalis* vs. *C. lanzarotae*), 5.81% (*C. duabusalis* vs. *C. coxi*) and 3.93% (*C. coxi* vs. *C. lanzarotae*). The nearest neighbour to them is *C. variabilis*, with a 6.57% divergence.

Diagnosis: *C. klimeschi* resembles other members of the genus, especially pale specimens of *C. coxi*. It is distinguished by the smaller scale tuft ventrally on segment 2 of the labial palp. In the male genitalia the long gnathos, the short transtilla projection and three cornuti groups are characteristic.

Biology: Early stages unknown. The specimens were netted from low vegetation during the daytime in full sunshine or attracted to light from almost all months of the year at altitudes ranging from sea level to 895 m.

Distribution: Only known from the Canary Islands: Gran Canaria, La Gomera, El Hierro and Tenerife, Spain.

Remarks: Despite the high intraspecific divergence in COI and variation in adult appearance we were not able to find any morphological differences in the genitalia between the separate populations. We consider *C. excellens* as a synonym based on similar morphology both in the adult appearance and the genitalia. Gozmány (2008, p. 413) figures the male genitalia without the transtilla projection, whereas Klimesch (1985, p. 146) illustrated them (from the same genitalia slide) with the transtilla projection on the right side. If the transtilla projections are small they are easily hidden by the costal margin of the valva. During dissection of the genitalia it is important to place both the valva and the phallus in the correct position to recognise the diagnostic details such as the small transtilla projection, juxta and the number of cornuti groups. The best way to recognize the number of cornuti groups is to leave the phallus in situ.

Chersogenes brachyptera (Walsingham**,** 1908), **comb. nov.** (Figures 42, 70, 70a)
Ambloma brachyptera Walsingham, 1908. *Proc. zool. Soc. Lond., 1907*, 946
Type locality: SPAIN, Tenerife, Güímar.

Material examined: SPAIN, Tenerife, El Medano, 1 ♂, 13-IV-1972, same data but, 2 ♂♂, II-1975, leg. J. Klimesch (ZMUC, PF), genitalia slide 3799PF; Los Abrigos, 50 m, 1 ♀, 19-I-1981, leg. P. Stadel Nielsen (ZMUC).

Description: Male. Brachypterous. Wingspan 8-9 mm. Labial palp upturned, segment 2 white with small dark grey scale tuft ventrally, segment 3 slightly shorter than segment 2, whitish dark grey especially ventrally. Antenna as long as forewing, dark grey. Head greyish. Neck whitish. Thorax grey mottled with white. Tegula dark grey basally, greyish white distally. Forewing very slender and pointed; ground colour grey, heavily mottled with white and with scattered black scales; at 1/3 a diffuse ochreous spot; fringe grey. Hindwing very slender, short and pointed, grey with grey fringe. Abdomen greyish.

Female: Unknown. Probably brachypterous.

Male genitalia (Figures 70, 70a): Uncus long, slender rectangular, apex spatulate; gnathos long, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal third, apex rounded; sacculus about 2/3 length of valva, apically evenly bent upwards; appendix short, distinctly shorter than valva, slightly bent, apex pointed, transtilla projection short; juxta anteriorly sub-rectangular, posteriorly with a sclerotised ring; saccus triangular; phallus anteriorly slightly bent, slender; one cornuti group with 7-9 spines.

DNA barcodes: Due to the lack of fresh material we were not able to barcode any specimens.

Diagnosis: *C. brachyptera* resembles *C. coxi* and especially *C. klimeschi* in the colour and the wing pattern. It is distinguished by being brachypterous. In the male genitalia the long gnathos, the short transtilla projection, the relatively long and slender phallus with one cornuti group are characteristic. It differs from *C. klimeschi* in the shorter gnathos, the longer and slenderer phallus and in having only one cornuti group with longer spines.

Biology: Early stages unknown. Most of the specimens were netted from *Andropogon* sp. (Poaceae) (Klimesch, 1985, p. 139) and one specimen, the holotype, was found under leaves of *Lotus sessilifolius* DC. (Fabaceae) (Walsingham, 1908, p. 947).

Distribution: Known only from the southern coastal areas of the island of Tenerife, Spain.

Chersogenes coxi **Falck & Karsholt, sp. nov.** (Figures 43-45, 71, 71a, 84)

Holotype ♂: Spain, Fuerteventura, Corralejo, 1 ♂, 3-8-III-1985, leg. A. Cox, genitalia slide 5140 Hendriksen, (ZMUC).

Paratypes: Spain, Fuerteventura, Corralejo, 1 ♀, 3-8-III-1985, leg. A. Cox, genitalia slide 3800APF (ZMUC); Corralejo, 10 m, 4 ♂♂, 7-27-XI-2017, leg. P. Falck, genitalia slide 2667PF, DNA sample Lepid Phyl 0045PF/CILEP45-19, same data but, 8 ♂♂, 27-II-19-III-2018, leg. P. Falck, genitalia slides 3664PF, 3670PF, 3673PF, DNA samples Lepid Phyl 0046PF/CILEP46-19, 0047PF/CILEP47-19, 0162PF/CILEP161-19, 0163PF/CILEP162-19 (PF); Betancuria, 400 m, 3 ♂♂, 27-II-19-III-2018, leg. P. Falck, genitalia slides 2852PF, 2853PF, DNA samples Lepid Phyl 0035PF/CILEP35-19, 0036PF/CILEP36-19, same data but, 2 ♂♂, 6-26-I-2020, leg P. Falck, genitalia slide 3672PF (PF); Las Parcelas, 70 m, 1 ♂, 7-27-XI-2017, leg. P. Falck, genitalia slide 2841PF, DNA sample Lepid Phyl 0033PF/CILEP33-19 (PF, MNCN).

Description: Male. Wingspan 9.5-11 mm. Labial palp upturned, segment 2 white, ventrally and laterally dark grey and with dark grey scale tuft ventrally, segment 3 shorter than segment 2, whitish mottled with dark grey ventrally and laterally. Antenna almost as long as forewing, grey with indistinct whitish rings. Head and neck whitish. Thorax and tegula whitish with a few scattered black scales. Forewing slender and pointed; ground colour whitish, grey at costa and dorsum, in the middle part at 1/3 and 2/3 and in the apical area mottled with relatively few black scales; at 1/3 and 2/3 diffuse ochreous spots; fringe grey. Hindwing grey with grey fringe. Abdomen light grey.

Female: Wingspan 10 mm. Differs from the male by being brachypterous, the forewing being shorter and broader, the distinctly concave apical half of costa and the hindwing slenderer with pointed apex. Forewing ochreous; at 1/3 a broad, diffuse brownish fascia, apical half mottled with a few light to dark brown scales.

Variation: *C. coxi* exhibits considerable variation. The ground colour varies from white or grey to yellowish brown or ochreous. The scattered black scales may be almost absent.

Male genitalia (Figures 71, 71a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal third, apex rounded; sacculus about 2/3 length of valva, apically evenly bent upwards; appendix short, distinctly shorter than valva, slightly bent, apex pointed; transtilla projection short; juxta anteriorly sub-rectangular, posteriorly with a sclerotised ring; saccus triangular; phallus anteriorly slightly bent, relatively short and broad, posteriorly abruptly tapering with drop-like apex; one cornuti group with 2-5 short spines.

Female genitalia (Figure 84): Papilla analis long, distally pointed, posterior apophysis slender, slightly more than twice the length of papilla analis; anterior apophysis half the length of posterior apophysis; tergum VIII sub-rectangular, sternum VIII with median fissure widening anteriorly; lamella antevaginalis sub-rectangular, narrow, posterior margin crown-shaped with median 1/3 slightly concave and laterally with slightly deeper concavity; antrum funnel-shaped; ductus bursae membranous, slightly bulbous; corpus bursae membranous elongate, semi-oval; without signum.

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from six specimens and DNA barcode fragments of 632 bp and 619 bp from two specimens. The barcodes fall within Barcode Index Numbers (BIN) BOLD: ADU1582 and ADT9919. The maximum intraspecific p-distance is very high, 3.86%. The results are presented in the DNA barcodes section of *C. klimeschi*.

Diagnosis: *C. coxi* resembles other members of the genus, especially *C. klimeschi* q.v. and *C. lanzarotae*. It is distinguished from the latter by the usual greater number of black scales. In the male genitalia the short transtilla projection, the short and broad phallus with the drop-like apex and one cornuti group are characteristic.

Biology: Early stages unknown. Most of the specimens were attracted to light and a few were disturbed from varied vegetation during the daytime during the months of October, November and February at altitudes ranging from sea level to 400 m.

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

Etymology: The species is dedicated to the late Dutch lepidopterist Anton Cox, who collected the first known specimens used for our study.

Remarks: Specimens from dune areas have a white or light grey ground colour while specimens from the rocky and mountain areas have a yellowish to ochreous ground colour. The molecular analyses show high intraspecific divergence and splitting into two well separated clusters, but without any clear correlation to the two populations of *C. coxi*, since the “dune population” is represented in both clusters. We did not find any differences in the genitalia between the populations.

***Chersogenes lanzarotae* Falck & Karsholt, sp. nov.** (Figures 46-47, 72, 72a)

Holotype ♂: SPAIN, Lanzarote, Mala, 18 m, 21-X-10-XI-2019, leg. P. Falck, DNA sample Lepid Phyl 0328PF/CILEP327-19 (ZMUC).

Paratypes: SPAIN, Lanzarote, Mala, 18 m, 3 ♂♂, 21-X-10-XI-2019, leg. P. Falck, genitalia slide 3668PF, DNA samples Lepid Phyl 0327PF/CILEP326-19, 0329PF/CILEP328-19; Orzola, Mojón Blanco, 20 m, 1 ♂, 21-X-10-XI-2019, leg. P. Falck, genitalia slide 3669PF, DNA samples Lepid Phyl 0330PF/CILEP329-19; Tabayesco, 280 m, 3 ♂♂, 1-13-II-2022, leg. P. Falck, genitalia slides 3666PF, 3671PF; Arrieta 100 m, 1 ♂, 1-13-II-2022, leg. P. Falck, genitalia slide 3667PF (PF; MNCN).

Description: Male. Wingspan 9-11 mm. Labial palp upturned, segment 2 white ventrally and laterally dark grey, ventrally with dark grey scale tuft, segment 3 shorter than segment 2, whitish mottled with dark grey ventrally and laterally. Antenna almost as long as forewing, grey with indistinct whitish rings. Head and neck brownish grey. Thorax brownish, ochreous towards abdomen. Tegula brownish, distally beige. Forewing slender and pointed; ground colour brownish grey, at the base and in middle half to near apex ochreous; a few scattered black scales in apical half; at 2/3 sometimes a small black dot near dorsum; fringe grey. Hindwing grey with grey fringe. Abdomen light brownish.

Female: Unknown.

Variation: The ground colour varies from grey to brown, the ochreous part is sometimes reduced to a narrow diffuse streak and the black scales are sometimes absent.

Male genitalia (Figures 72, 72a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal third, apex rounded; sacculus 2/3 length of valva, apically evenly bent upwards; appendix short, distinctly shorter than valva, slightly bent, apex pointed; transtilla projection short; juxta anteriorly sub-rectangular, posteriorly with a sclerotised ring; saccus rounded; phallus anteriorly slightly bent, posteriorly straight, slightly tapering posteriorly, posterior edge near apex with a small projection; Two cornuti groups, anterior group with 2-4 strongly curved spines, posterior group with one small straight spine.

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from three specimens and DNA barcode fragments of 652 bp from one specimen. The barcodes fall within Barcode Index Numbers (BIN) BOLD: AEC6345, AEC2598 and AEC5794. The maximum intraspecific p-distance is 2.24%. The results are presented in the DNA barcodes section of *C. klimeschi*.

Diagnosis: *C. lanzarotae* is characterized by the slender and pointed forewing, the scale tuft ventrally on segment 2 of the labial palps and the very few scattered black scales. It resembles *C. coxi* q. v. In the male genitalia the strongly curved and one small straight cornuti are very characteristic.

Biology: Early stages unknown. The specimens were all attracted to light in the months of October, November and February at altitudes ranging from sea level to 280 m.

Distribution: Known only from the island of Lanzarote, Spain.

Etymology: The species is named after the island of Lanzarote.

Remarks: *C. lanzarotae* is, like several other members of the genus, highly variable and with high intraspecific divergence in the DNA barcodes.

Chersogenes victimella Walsingham, 1908 (Figures 48, 73, 73a)
Chersogenes victimella Walsingham, 1908. *Proc. zool. Soc. Lond., 1907*, 947
Type locality: SPAIN, Tenerife, Santa Cruz.

Material examined: Spain, Tenerife, Güímar, 500 m, 4 ♂♂, 1-13-IV-2022, leg. P. Falck, genitalia slide 3745PF, DNA samples Lepid Phyl 1055PF/CILEP1054-22, 1056PF/CILEP1055-22 (PF).

Description: Male. Wingspan 12 mm. Labial palp straight and long, segment 2 with dark grey scale tuft ventrally, the whole segment covered by rough, long dark grey scales, white dorsally, segment 3 dark brown. Antenna almost as long as forewing, dark grey with indistinct whitish rings. Head, neck, thorax and tegula greyish brown mottled with white. Forewing slender and pointed, costa slightly concave in apical half; ground colour dark grey, from the base to about 2/3 a narrow yellowish white streak; at 1/3 a spot of black raised scales on each side of the streak, at 2/3 a smaller spot of black raised scales on each side of the streak; fringe grey. Hindwing dark brown with dark grey fringe. Abdomen brownish.

Female: Unknown.

Male genitalia (Figures 73, 73a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal third, apex rounded; sacculus about 2/3 length of valva, apically sickle-shaped; appendix short, distinctly shorter than valva, slightly bent, apex pointed; transtilla projection short, rather stout; juxta anteriorly sub-rectangular, posteriorly large sub-rectangular; saccus small, triangular; phallus straight, slightly tapering posteriorly; two cornuti groups each with about 10 spines.

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from two specimens. The barcodes fall within Barcode Index Number (BIN) BOLD: AEV1724. The intraspecific p-distance is 0.00%. The minimum p-distance to nearest neighbour (*C. fuerteventurae*) is 8.1%.

Diagnosis: *C. victimella* is very characteristic because of the long and roughly scaled labial palp and the black dots with raised scales. It resembles no other species in the genus. In the male genitalia the relatively stout transtilla projection, the sickle-shaped apex of the sacculus and the straight phallus with two cornuti groups are characteristic.

Biology: Early stages unknown. The examined specimens were disturbed from a stone-wall during the daytime.

Distribution: Only known from two locations in the south-eastern part of Tenerife, Spain.

***Chersogenes fuerteventurae* Falck & Karsholt, sp. nov.** (Figures 49-50, 74, 74a, 85)

Holotype ♂: Spain, Fuerteventura, Betancuria, 27-II-19-III-2018, leg. P. Falck, genitalia slide 3713PF (ZMUC).

Paratypes: Spain, Fuerteventura, Betancuria, 36 ♂♂, 5 ♀♀, 27-II-19-III-2018, leg. P. Falck, genitalia slides, 2831PF, 2834PF, 2836PF, 2832PF, 2837PF, 3710PF, 3721PF, DNA samples Lepid Phyl 0025PF/CILEP25-19, 0026PF/CILEP26-19, 0027PF/CILEP27-19 (PF, MNCN).

Description: Male. Wingspan 7-8 mm. Labial palp upturned, segment 2 light brown, ventrally with a small brown scale tuft, segment 3 dark brown and slightly shorter than segment 2. Antenna almost as long as forewing, brown. Head, neck, thorax and tegula greyish brown. Forewing dark beige mottled with dark brown especially along termen and apex, costa blackish; at 1/3 and 2/3 two small indistinct dark brown spots, costal spots located more basally; fringe grey. Hindwing grey with grey fringe. Abdomen dark beige.

Female: Wingspan 10 mm. The forewing more heavily mottled with brown.

Variation: Only minor variation in the distinctiveness of the spots.

Male genitalia (Figures 74, 74a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, upturned in distal third, apex rounded; sacculus about 2/3 length of valva, apically evenly bent upwards; appendix distinctly shorter than valva, slightly bent, apex pointed; juxta sub-rectangular, slightly narrower in the middle, in anterior half two small lateral lamella; saccus triangular; phallus slightly bent, broad; two cornuti groups almost confluent, anterior group with 14-16 spines of various length, posterior group with 3-4 short spines.

Female genitalia (Figure 85): Papilla analis relatively short, distally rounded, posterior apophysis slender, twice as long as papilla analis; anterior apophysis slightly longer than half the length of posterior apophysis; tergum VIII sub-rectangular, narrow, sternum VIII with median fissure widening anteriorly; lamella antevaginalis sub-rectangular posterior margin with small, slightly V-shaped median invagination; antrum short, V-shaped; colliculum slightly sclerotised and bulbous; ductus bursae membranous, half the width of colliculum; corpus bursae membranous elongate, semi-oval; without signum.

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from three specimens. The barcodes fall within Barcode Index Number (BIN) BOLD: ADT9917. The intraspecific p-distance is 0.00%. The minimum p-distance to nearest neighbour (*C. victimella*) is 8.01%.

Diagnosis: *C. fuerteventurae* is characterized by the size and the dark beige colouration and the distinct wing pattern. In the male genitalia the shape of the juxta and the broad phallus with two almost confluent cornuti groups are characteristic. In the female genitalia the shape of the antrum and colliculum and the lack of a signum are characteristic.

Biology: Early stages unknown. The males were netted or disturbed from varied vegetation during daytime in full sunshine, the females were found nectaring on flowers of *Asteriscus sericeus* DC. (Asteraceae) from late February and March.

Distribution: Known only from the island of Fuerteventura, Spain.

Etymology: The species is named after the island of Fuerteventura where the type series was collected.

Chersogenes indistincta **Falck & Karsholt, sp. nov.** (Figures 51-52, 75, 75a, 86)

Holotype ♂: Spain, Lanzarote, 2 km SW Urb. Famara, Las Laderas, 75 m, 2-8-XI-2018, leg. B. Skule & C. Hviid (ZMUC)

Paratypes: Spain, Fuerteventura, Jandia, Bco. Esquinzo, 1 ♀, 25-IX-19-10-2002, leg. Pass (ZMUC); Betancuria, 400 m, 11 ♂♂, 12 ♀♀, 7-27-XI-2017, leg. P. Falck, genitalia slides 2662PF, 2666PF, 3701PF, DNA samples Lepid Phyl 0031PF/CILEP31-19, 0032PF/CILEP32-19, same data but, 1 ♂, 27-II-19-III-2018, leg. P. Falck, genitalia slide 3699PF (PF); Caldereta, 120 m, 10 ♂♂, 2 ♀♀, 7-27-XI-2017, leg. P. Falck, genitalia slide 2668PF (PF); Corralejo, 10 m, 5 ♂♂, 2 ♀♀, 7-27-XI-2017, leg. P. Falck, genitalia slide 2669PF (PF); Lajares, 75 m, 4 ♂♂, 7-27-XI-2017, leg. P. Falck, genitalia slide 3726, DNA sample Lepid Phyl 0034PF/CILEP34-19PF; same data but, 1 ♂, 6-26-I-2020, leg. P. Falck (PF); Las Parcelas, 70 m, 6 ♂♂, 7-27-XI-2017, leg. P. Falck (PF); Lanzarote, 2 km SW Urb. Famara, Las Laderas, 75 m, 8 ♂♂, 1 ♀, 2-8-XI-2018, leg. B. Skule & C-. Hviid (ZMUC); Pozo Negro, 1 ♂, 27-II-2019, leg. K. Larsen (ZMUC); Orzola, Mojón Blanco, 20 m, 21 ♂♂, 3 ♀♀, 21-X-10-XI-2019, leg. P. Falck, genitalia slide 3725PF (PF); Caleta de Famara, 20 m, 6 ♂ ♀, 21-X-10-XI-2019, leg. P. Falck (PF); El Golfo, 95 m, 2 ♂♂, 21-X-10-XI-2019, leg. P. Falck (PF); Mala, 18 m, 1 ♂, 21-X-10-XI-2019, leg. P. Falck (PF); El Bosquecillo, 610 m, 1 ♂, 21-X-10-XI-2019, leg. P. Falck (PF); Arrieta, 100 m, 1 ♂, 1-13-II-2022, leg. P. Falck (PF, MNCN).

Description: Male. Wingspan 12-16.5 mm. Labial palp upturned, segment 2 white, mottled with dark beige, ventrally a large dark beige scale tuft, segment 3 as long as segment 2, whitish mottled with beige and grey. Antenna as long as forewing, light brownish with indistinct grey rings. Head and neck beige mottled with dark grey. Thorax and tegula dark beige. Forewing beige mottled with dark grey and black, especially along costa and apex, cell more whitish; at 1/3 and 2/3 two small indistinct ochreous spots, bordered by scattered black scales. Hindwing grey with grey fringe. Abdomen beige.

Female. Similar to male, but with shorter antenna.

Variation: The ground colour varies from beige to grey heavily mottled with black, wing pattern more or less distinct or totally absent.

Male genitalia (Figures 75, 75a): Uncus long, slender rectangular, apex spatulate; gnathos shorter than uncus, straight, apically hook-shaped, apex pointed; tegumen sub-triangular, anterior margin flatly U-shaped; valva simple, approximately 6 times longer than broad, slightly upturned in distal half, apex rounded; sacculus about 2/3 length of valva, apically evenly bent upwards; appendix distinctly shorter than valva, slightly bent, apex pointed; juxta sub-rectangular, posteriorly with two relatively large, lateral projections; saccus long, sub-triangular; phallus slightly bent, tapering posteriorly; two cornuti groups, the anterior group with 3-4 robust spines, the posterior group with 10-13 short spines.

Female genitalia (Figure 86): Papilla analis relatively short, distally rounded, posterior apophysis slender, twice as long as papilla analis; anterior apophysis slightly longer than half the length of posterior apophysis; tergum VIII sub-rectangular, sternum VIII with median fissure widening anteriorly; lamella antevaginalis sub-rectangular, narrow, posterior margin almost straight; antrum short, V-shaped; colliculum short and sclerotised; ductus bursae membranous, bulbous, twice as broad as colliculum, tapering anteriorly; corpus bursae membranous oval, signum heavily sclerotized, edged with 3-4 robust spines and 4-6 smaller spines

DNA barcodes (Figure 87): We obtained full length DNA barcodes (658 bp) from three specimens. The barcodes fall within Barcode Index Number (BIN) BOLD: ADT9916. The maximum intraspecific p-distance is 0.16%. The minimum p-distance to nearest neighbour (*C. klimeschi*) is 8.56%.

Diagnosis: *C. indistincta* resembles no other known species of the genus. It is characterized by the size, the beige colouration with indistinct wingpattern and the large scale-tuft on the labial palp. In the male genitalia the long saccus, the shape of juxta and the few cornuti in the anterior group are characteristic. In the female genitalia the narrow lamella antevaginalis and the heavily sclerotised signum with robust spines are characteristic.

Biology: Early stages unknown. The specimens were attracted to light in the months February, March, October and November at altitudes ranging from sea level to 610 m. One specimen was reared by chance from *Lotus lancerottensis* Webb & Berthel. (Fabaceae).

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

Etymology: The species is named after the normally quite indistinct appearance of the adult.

HOLCOPOGONINAE

Turatia Amsel, 1942

Turatia Amsel, 1942. *Veröff. dt. Kolon. u. Übersee-Mus. Bremen, 3*, 234

Type species: *Holcopogon morettii* Turati, 1926. *Atti ital. Soc. Sci. nat., 65*, 70, fig. 38.

= *Ilionarsis* Gozmány, 1959. *Annls hist.-nat. Mus. natn. hung., 51,* 369

Type species: *Ilionarsis foeldvarii* Gozmány, 1959. *Annls hist.-nat. Mus. natn. hung., 51*, 369, figs 5A, 5B.

The genus *Turatia* includes 16 species distributed in dry areas of the Afrotropical region and in the Palaearctic region through North Africa to Turkey and Iran. The early stages and feeding substrate are unknown. Most species fly during the winter (Gozmány, 2000, p. 61).

Turatia iranica Gozmány, 2000 (Figure 53)

Turatia iranica Gozmány, 2000, *Microlep. Palaea.* (Vol. 10), 68-69

Type locality: IRAN, Balutschistan, Bender Tchahbabar.

Material examined: SPAIN, Fuerteventura, 1 ♂, 7-27-XI-2017, leg. P. Falck, genitalia slide 2663PF, DNA sample Lepid Phyl 0062PF/CILEP62-19 (PF). **New to the Canary Islands, Spain**.

DNA barcodes (Figure 87): We obtained a full-length DNA barcode (658 bp) from the specimen. The barcode falls within Barcode Index Number (BIN) BOLD: ADT3067. The minimum p-distance to nearest neighbour (*T. iranica* from the United Arab Emirates with Barcode Index number BOLD: ACK8187) is 3.85%.

Biology: Early stages unknown. The specimen was attracted to light.

Distribution: South Iran; Oman (Derra 2008, p. 584); Spain, Fuerteventura.

Remarks: The occurrence of *T. iranica* in the Canary Islands far away from its hitherto known distribution around the Persian Gulf is surprising. The identity of the disjunct populations was confirmed by their similar genitalia. However, further studies may reveal cryptic diversity, because specimens from Canary Islands and the Arab United Emirates differ by 3.85% in the DNA barcodes. The species probably also occurs through northern parts of the Sahara. The male and female genitalia are figured by Gozmány (2000, pp. 133, 151).

Hesperesta Gozmány, 1978
Hesperesta Gozmány, 1978. *Faun. Abh. Mus. Tierk. Dresden, 7*, 61
Type species: *Epidola hartigi* Turati, 1934. *Atti. Soc. ital. Sci. nat., 73*, 199.

Hesperesta is a small genus with six species, which are distributed from South Spain (Vives Moreno, 1987, pp. 59-62; Derra, 2008, p. 582), North and South Africa and in Arabia. Their biology is unknown.

Hesperesta hartigi (Turati, 1934) (Figure 54)
Hesperesta hartigi (Turati, 1934). *Atti. Soc. ital. Sci. nat., 73*, 199-200
Type locality: LIBYEN, Bengasi.

Material examined: Spain, Fuerteventura, 1 ♂, 7-27-XI-2017, leg. P. Falck, genitalia slide 3688PF, DNA sample Lepid Phyl 1057PF/CILEP1056-22 (PF). **New to the Canary Islands, Spain**.

DNA barcodes: Failed.

Biology: Early stages unknown. The specimen was attracted to light.

Distribution: North Africa from Libya to Morocco; Spain, Fuerteventura.

Remarks: The adult, the male and female genitalia are figured by Gozmány (2000, p. 123, 148).

Oecia Walsingham, 1897
Oecia Walsingham, 1897. *Proc. Zool. Soc. Lond., 1897*, 111
Type species: *Oecia maculata* Walsingham, 1897. *Proc. Zool. Soc. Lond., 1897*, 111.
= *Macroceras* Staudinger, 1876, in Kalchberg. *Stett. ent. Ztg., 37,* 150, nomen preoccupied by *Macrocera* Semper, 1870 (Mollusca).

The single *Oecia* species is distributed in tropical and subtropical areas around the world. Its biology is discussed below.

Oecia oecophila (Staudinger, 1876) (Figure 55)
Macroceras oecophila (Staudinger, 1876). *Stettin. ent. Ztg., 37*, 150
Type locality: ITALY, Sicily, Palermo.
= *Oecia maculata* Walsingham, 1897. *Proc. Zool. Soc. Lond., 1897*, 111
Type locality: USA, Virgin Islands, St. Thomas.
= *Apatema husadeli* Rebel, 1910. *Annln naturh. Mus. Wien, 24,* 353, pl. 12, fig. 7
Type locality: SPAIN, Gran Canaria, Las Palmas.

Material examined: Spain, Fuerteventura, Corralejo, 10 m, 1 ♂, 7-27-XI-2017, leg. P. Falck (PF); Gran Canaria, Gran Canaria, 3.5 km NNE Mogan, Barranco Mogan, 430 m, 1 ♂, 5-XI-2014, leg. B. Skule (ZMUC); Carreteria, 455 m, 10 ♂♂, 8-20-VIII-2020, leg. P. Falck, genitalia slide 3689PF, DNA sample Lepid Phyl 1058PF/CILEP1057-22 (PF); Los Tilos de Moya, 500 m, 1 ♀, 9-22-VI-2021, leg. P. Falck (PF); El Hierro, Sabinosa, 100 m, 1 ♀, 22-VII-3-VIII-2022, leg. P. Falck, genitalia slide 3783PF (PF); Lanzarote, Orzola, Mojón Blanco, 1 ♀, 21-X-10-XI-2019, leg. P. Falck (PF); La Palma, Barranco de las Nieves, 250 m, 13-16-VIII-2018, leg. K. Larsen (ZMUC); Tenerife, Puerto de la Cruz, 200 m, 1 ♀, 13-26-VIII-2019, leg. P. Falck. Portugal, Madeira, Ponta do Sol, sea level, 1 ♂, 2-VII-1993, leg. O. Karsholt (ZMUC).

DNA barcodes (Figure 87): We obtained a full-length DNA barcode (658 bp) from one specimen. The barcode falls within Barcode Index Number (BIN) BOLD: ADY2185. The minimum p-distance to nearest neighbour (*Mompha unifasciella* (Chambers, 1876), Momphidae) is 7.56%.

Biology: The early stages have been described in detail by NASU et al. (2016). The larvae are reported to feed mainly on dead plant material, e. g. leaf litter, and fruits, but is also reported from dried faeces of rats, concealed in a tube-like nest made of the fragments of the faeces. Pupation took place in an oval cocoon of the fragments of faeces, and the pupa did not protrude from the cocoon at emergence (Nasu et al. 2016, p. 210). Larvae are also supposed to feed on human faeces (Gozmány, 1975, p. 264; 2000, p. 87).

Distribution: Widely distributed in tropical and subtropical parts the world. However, records from some areas are based on misidentified specimens of similar looking species of Tineidae or Oecophoridae (Gozmány, 2000, p. 88).

Remarks: This genus and species were placed by Hodges (1998, p. 141) in a monotypic subfamily Oeciinae of his newly erected family Schistonoeidae. However, this action has not received general acceptance, and Gozmány (2000, p. 85) transferred it to the Holcopogonidae. The latter is currently considered as a subfamily, Holcopogoninae of the Autostichidae (Heikkilä et al. 2014, p. 585, L. Kaila in litt.).

Oecia oecophila was first recorded from Madeira by Carvalho (1995, p. 579) without locality and date. We have only seen the specimens listed above from that island.

Remarks: The male and female genitalia are figured by Gozmány (2000, pp. 144, 157). *O. oecophila* was first recorded from the Canary Islands by Rebel (1910, p. 353-354) as *O. husadeli*, which was synonymized with *O. oecophila* by Gozmány (1975, p. 265). It is not mentioned from the Canary Islands by Vives Moreno (2014).

Discussion

The molecular analyses support the taxonomic arrangement. All identified species are clearly genetically distinct from other species with uncorrected p-distance values between species ranging from 3.93% (between *C. coxi* and *C. lanzarotae*) to 12.08% (between *C. coxi* and *C. fuerteventurae*). The taxonomy of the Canarian symmocinae species is not entirely unproblematic, as several species exhibit high variability in the adult appearance and very high intraspecific values in COI, both between populations from separate islands of the Canary Islands (e. g. *C. canariensis* and *C. klimeschi*) but also between populations from the same island (e. g. *C. klimeschi*, *C. variabilis* and *C. lanzarotae*). A high intraspecific variation in COI between species from separate islands of the Canary Islands is commonly observed (Falck et al. 2021, p. 298; Falck et al. 2022, p. 108). It can be interpreted as a snapshot of the evolutionary process; however further studies may reveal cryptic species.

The Autostichidae occurring in the Canary Islands are largely restricted to two genera, *Apatema* Walsingham, 1900 with 18 species (see Falck et al. 2021) and *Chersogenes* with 19 species. In addition to these, only three species of Holcopogonidae are recorded from the islands. Moreover, we describe one species of *Chersogenes* from the Selvagens Islands, which belong to Portugal.

Based on our study of the morphology and DNA barcodes we conclude that all Symmocinae species found in the Canary Islands belong to a single genus, *Chersogenes*. Outside of the Canary and Selvagens Islands this genus is only known from North Africa, where seven species have been recorded under the genus synonym of *Epanastasis.* Our data do not allow us to conclude if *Chersogenes* species from North Africa or from the Canary Islands phylogenetically are most basal. It is, however, evident that the fauna of *Chersogenes* from the Canary and Selvagens Islands are much more diverse, compared with the species occurring in North Africa. They have probably been present for a very long time, having had time to evolve external differences in, e. g. labial palps, form and venation of the wings and brachyptery. This is also reflected in the DNA barcode, with large percentage distances between many of the species.

Hypotheses relating to brachyptery and its function in species of Lepidoptera are not uniform and each case should be looked at on its own merits (Sattler, 1991, p. 244). With the biology and larval host-plants being largely unknown it is not clear which factors benefit development of wing reduction in *Chersogenes*. Sattler, 1991, p. 248 comments that a number of Lepidoptera species with brachypterous females or with wing reduction in both sexes inhabit grassland, which constitutes a permanent, continuous habitat.

In Lepidoptera wing reduction is rare, being known from less than 1% of the described species (Sattler & Wojtusiak, 2000, p. 435). It is usually confined to the female. In most cases species with brachyptery in both sexes are endemic to small oceanic islands or coastal localities. The crucial evolutionary factor that favours flightlessness in males is seen in the exposure of restricted habitats to continuous strong winds (Sattler, 1991, p. 251). Brachyptery in both sexes is exceedingly rare. According to Karsholt & Sattler (1998, p. 36) it is only known from 25 species, with a few additional species described subsequently (e. g. Sattler & Wojtusiak, 2000; Bidzilya, 2014; Bidzilya & Karsholt, 2018). Therefore, the description of *C. duabusalis* and *C. aguiari* represents a distinct addition to the number of known Lepidoptera with brachypterous males. All such species have brachypterous females.

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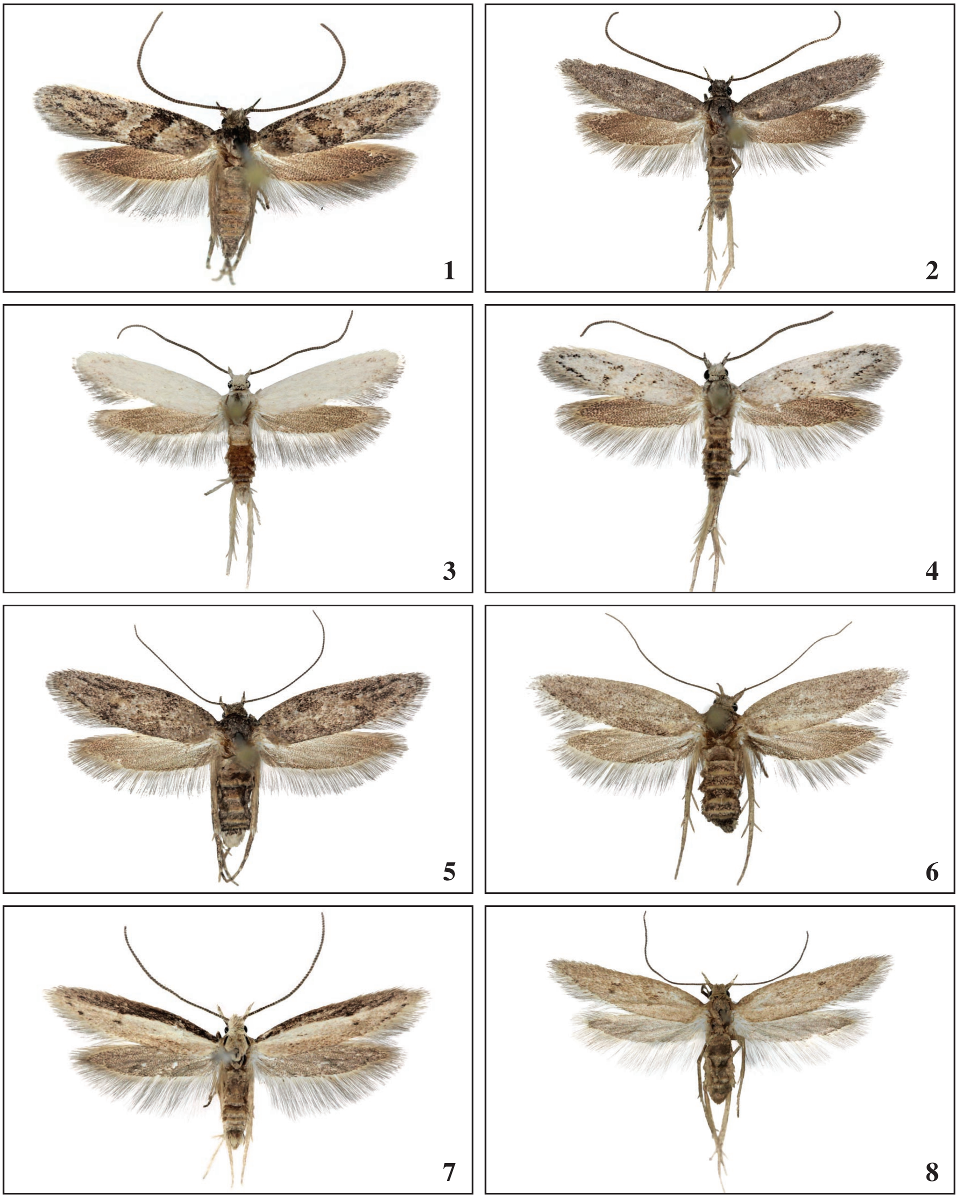

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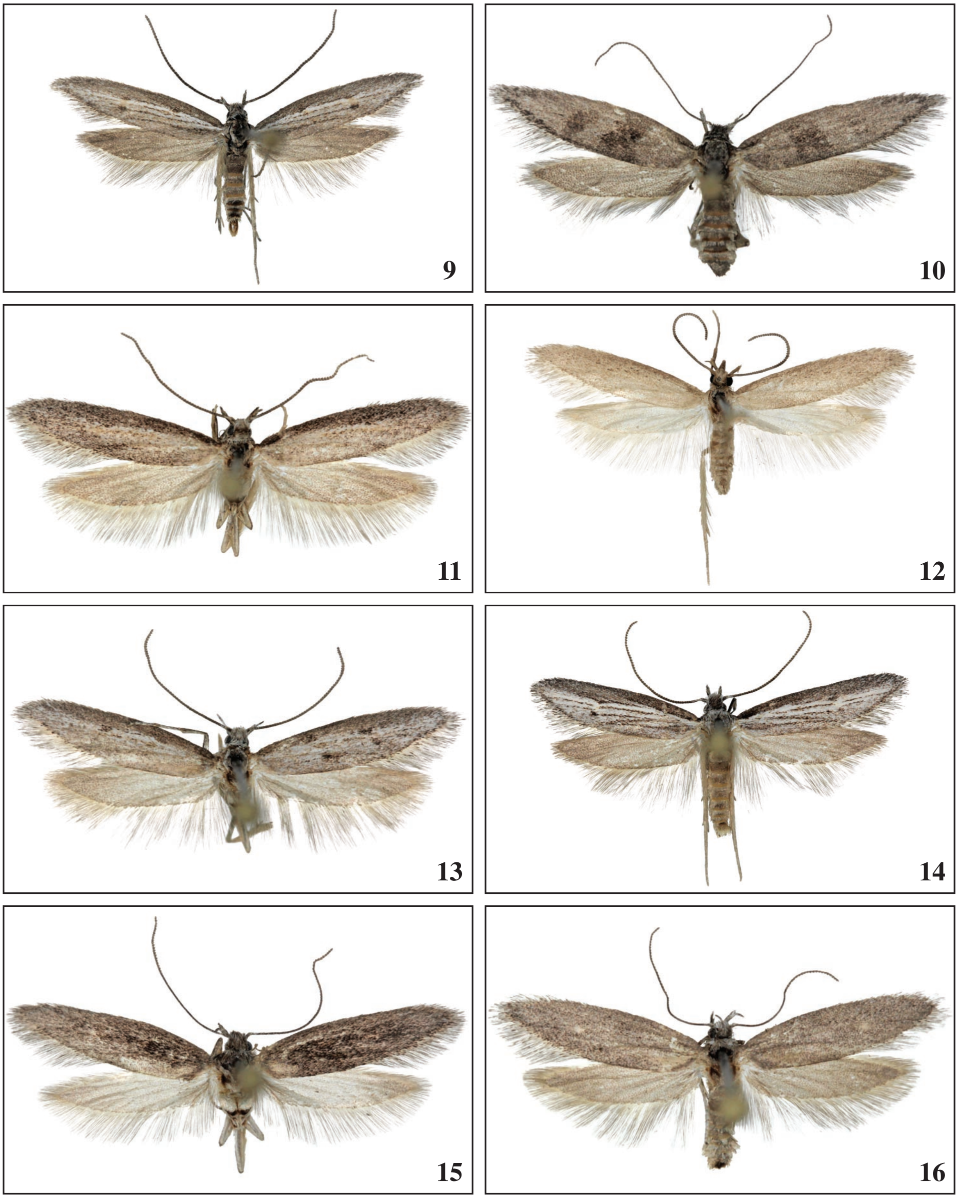

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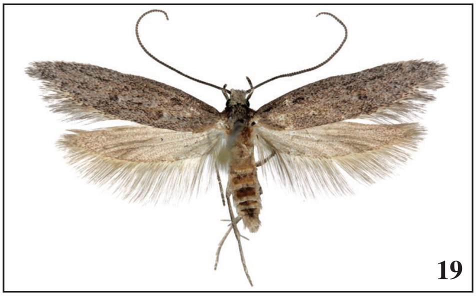
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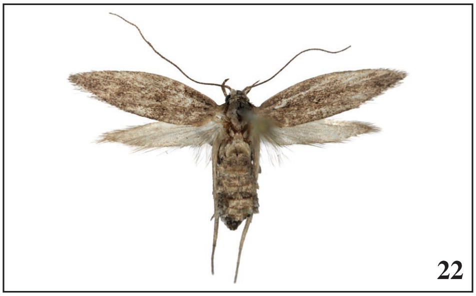
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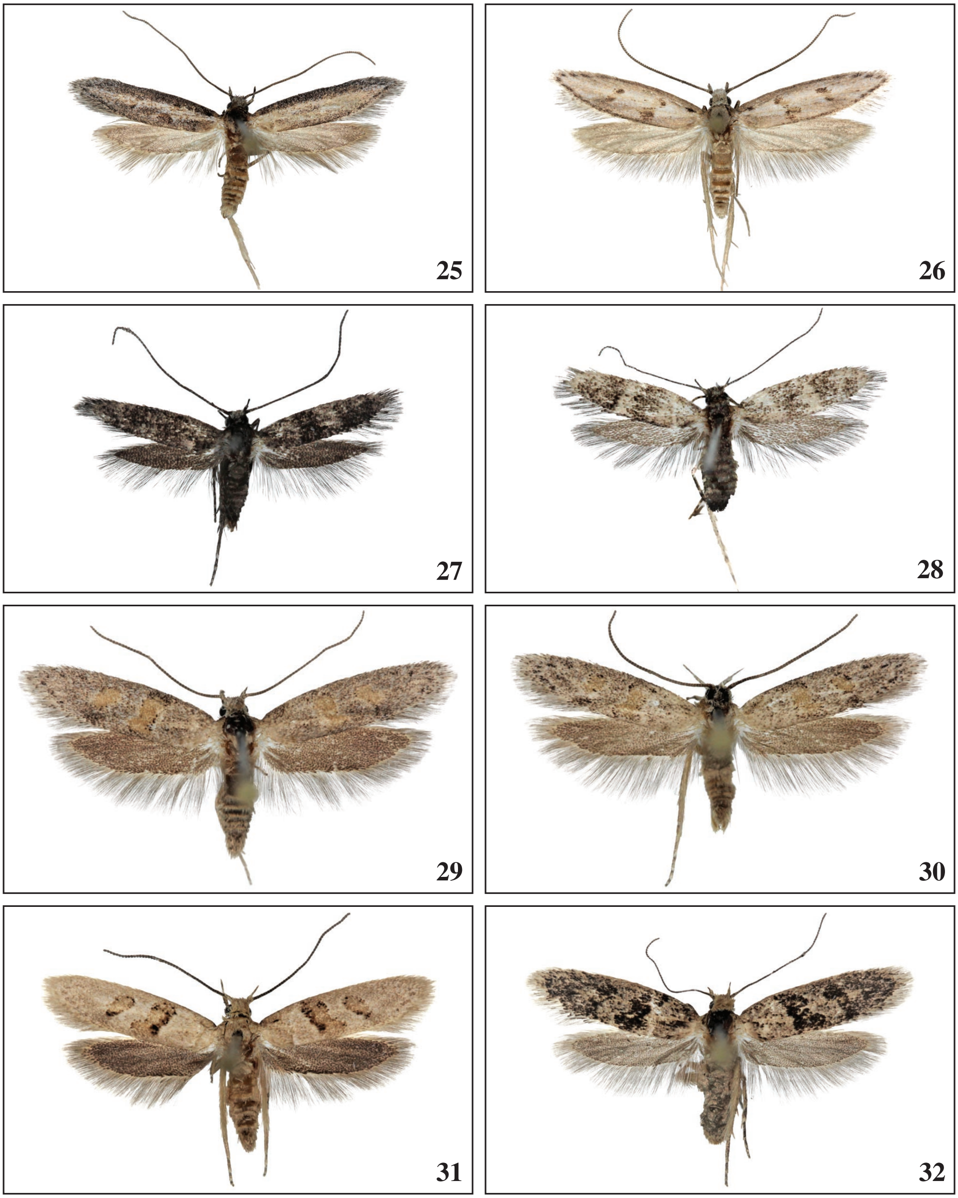

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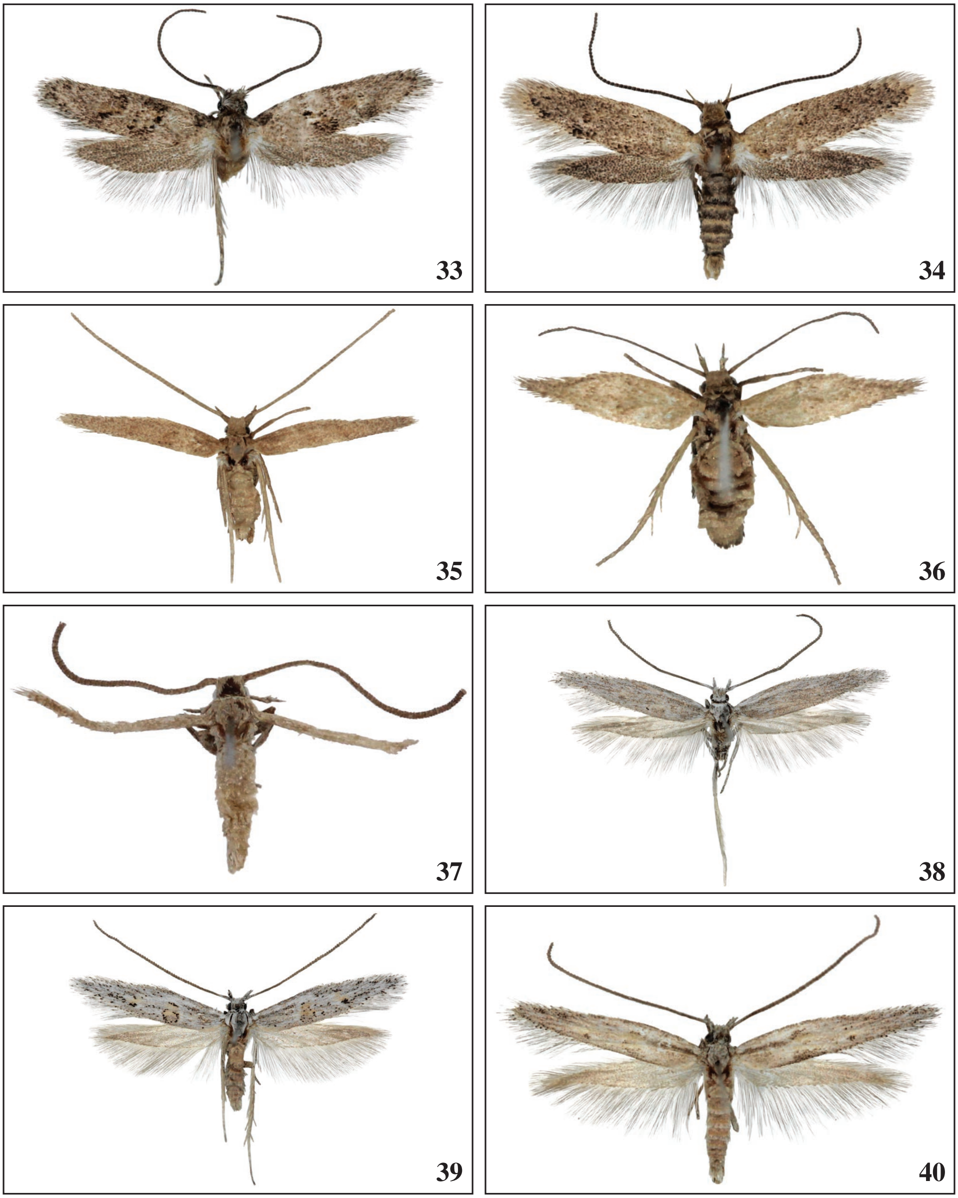

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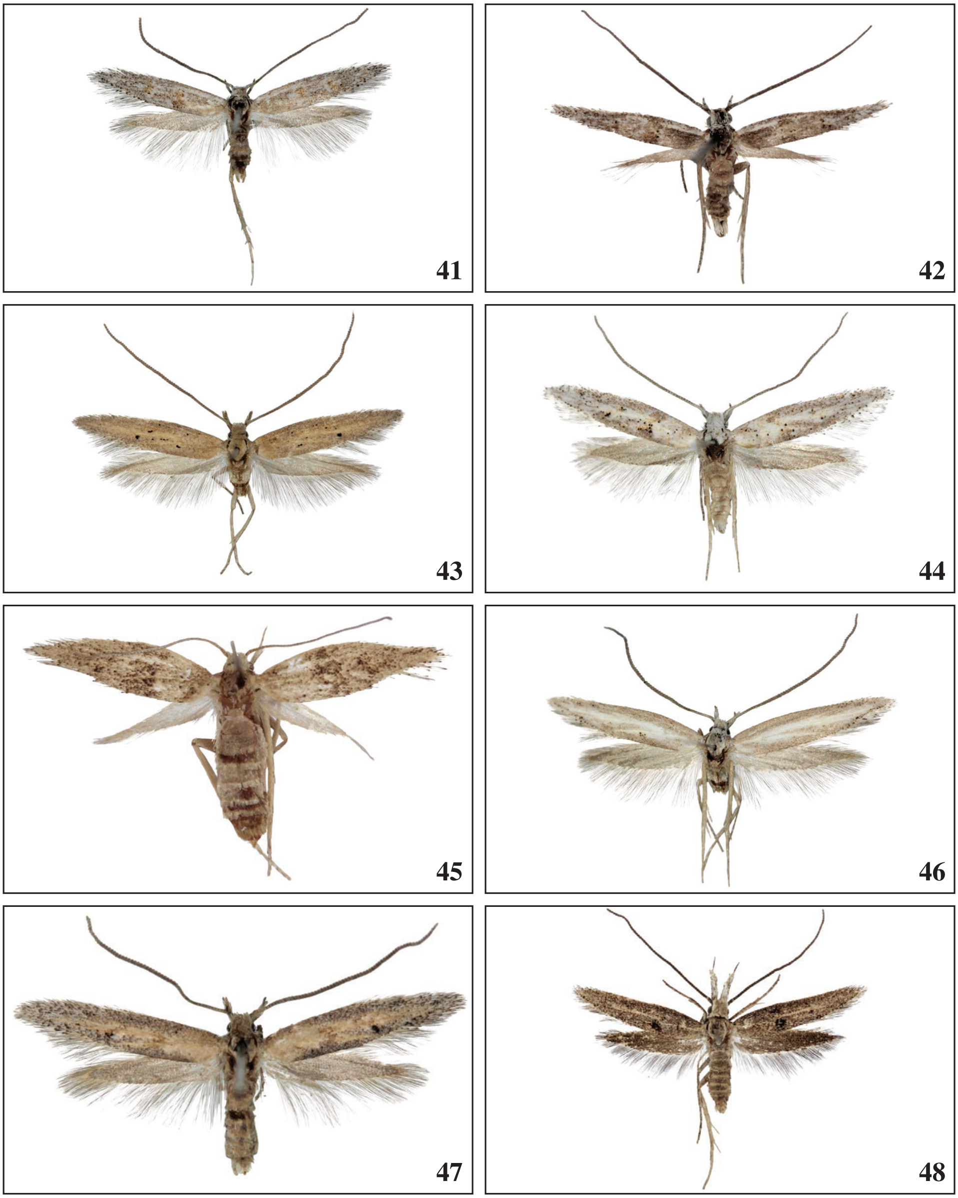

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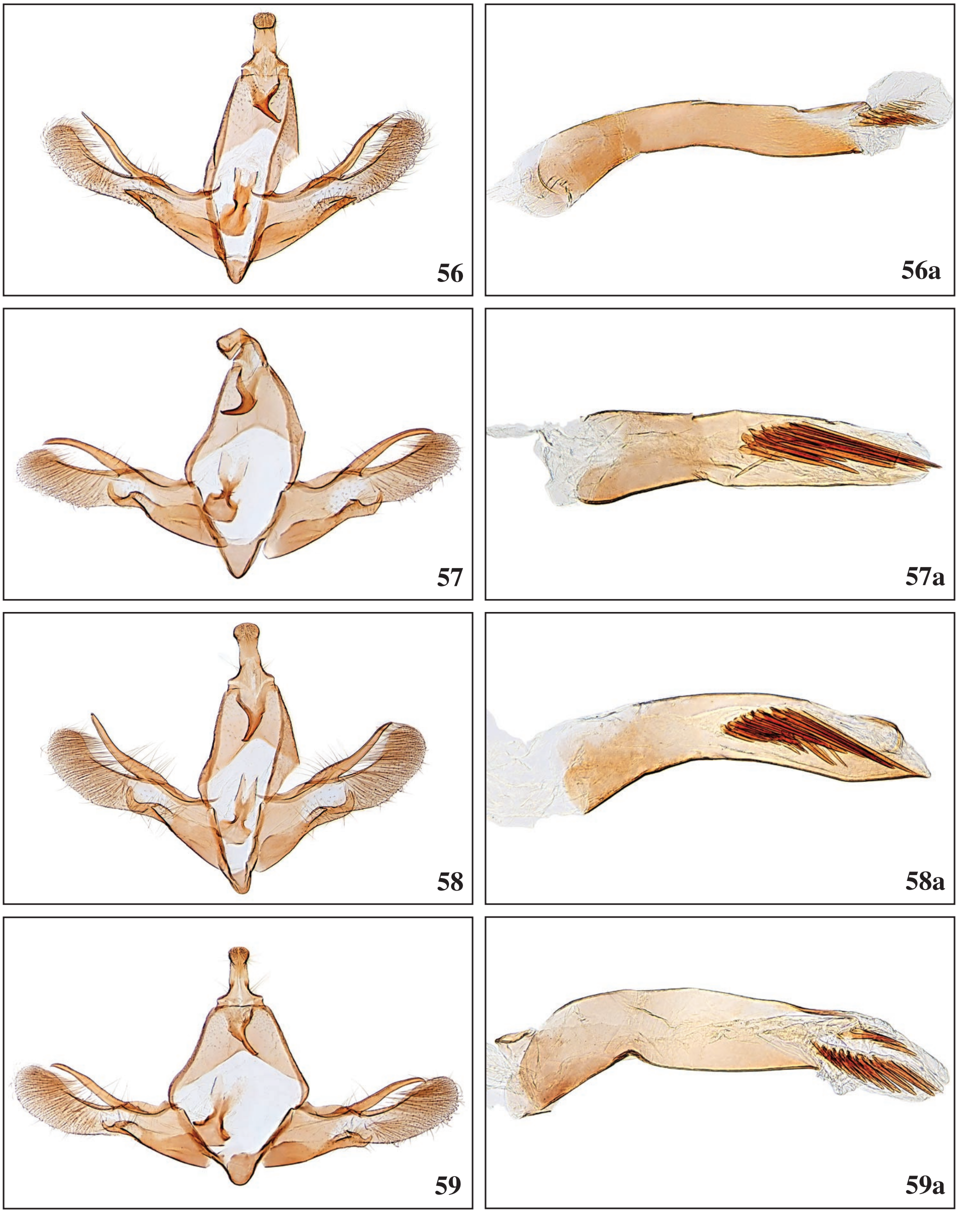
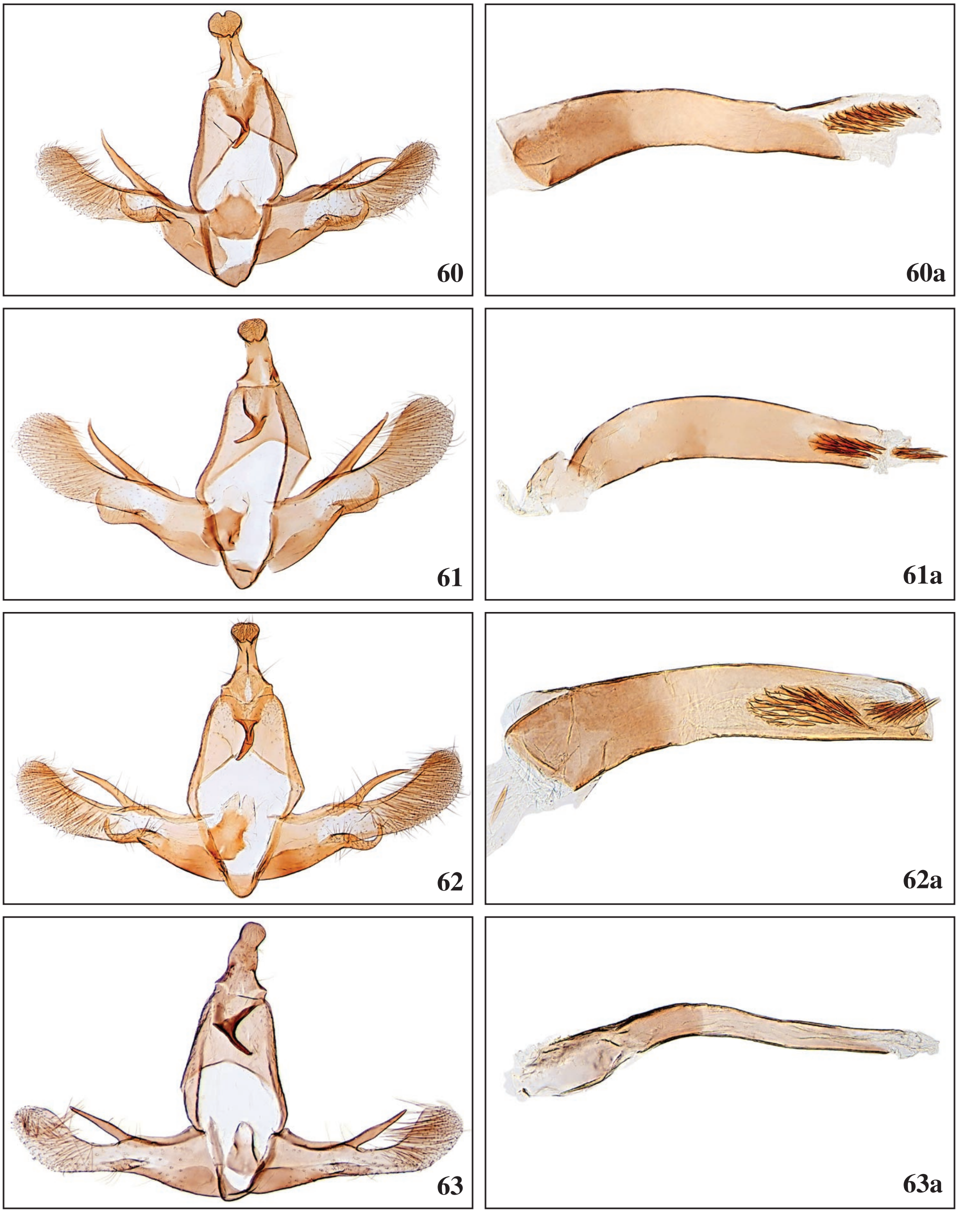
Figures 49-55. 49. *Chersogenes fuerteventurae* Falck & Karsholt, sp. nov., ♂, Fuerteventura, 8.5 mm. **50.** *Chersogenes fuerteventurae* Falck & Karsholt, sp. nov., ♀, Fuerteventura, 10.5 mm. **51.** *Chersogenes indistincta* Falck & Karsholt, sp. nov., ♂, Fuerteventura, 12.5 mm. **52.** *Chersogenes indistincta* Falck & Karsholt, sp. nov., ♀, Fuerteventura, 15.5 mm. **53.** *Turatia iranica* Gozmány, 2000, ♂, Fuerteventura, 16.5 mm. **54.** *Hesperesta hartigi* (Turati, 1934), ♂, Fuerteventura, 14 mm. **55.** *Oecia oecophila* (Staudinger, 1876), ♂, Gran Canaria, 11 mm.



Figures 56-59a. 56. *Chersogenes variabilis* Falck & Karsholt, sp. nov., ♂, Gran Canaria, GP3693PF. **56a.** *Chersogenes variabilis* Falck & Karsholt, sp. nov., phallus, GP3693PF. **57.** *Chersogenes sophroniellus* (Rebel, 1894), ♂, Gran Canaria, GP3698PF. **57a.** Phallus, GP3698PF. **58.** *Chersogenes pseudocanariensis* Falck & Karsholt, sp. nov., ♂, Gran Canaria, GP3707PF. **58a.** Phallus, GP3707PF. **59.** *Chersogenes canariensis* (Rebel, 1906), ♂, Tenerife, GP3700PF. **59a.** Phallus, GP3700PF.



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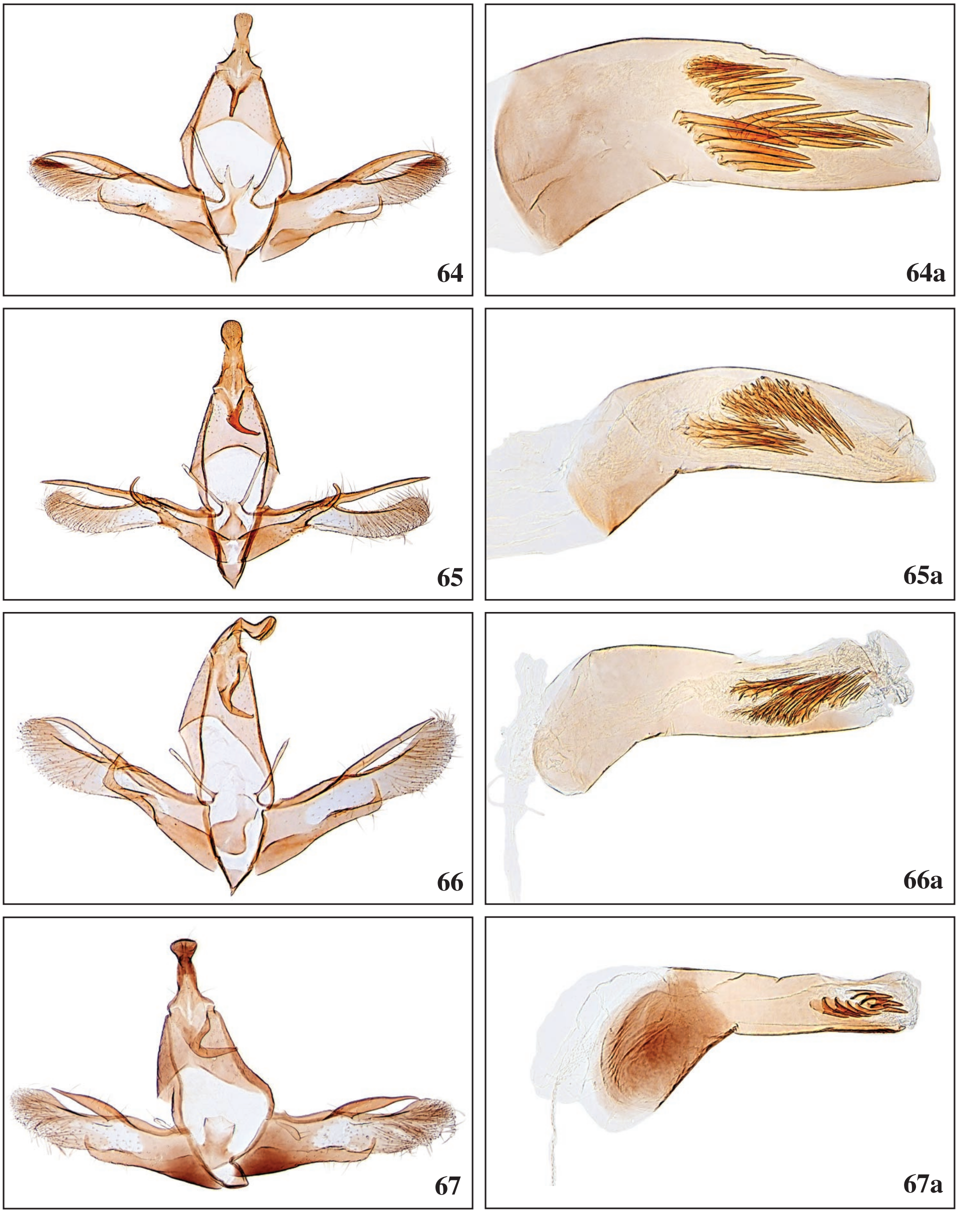

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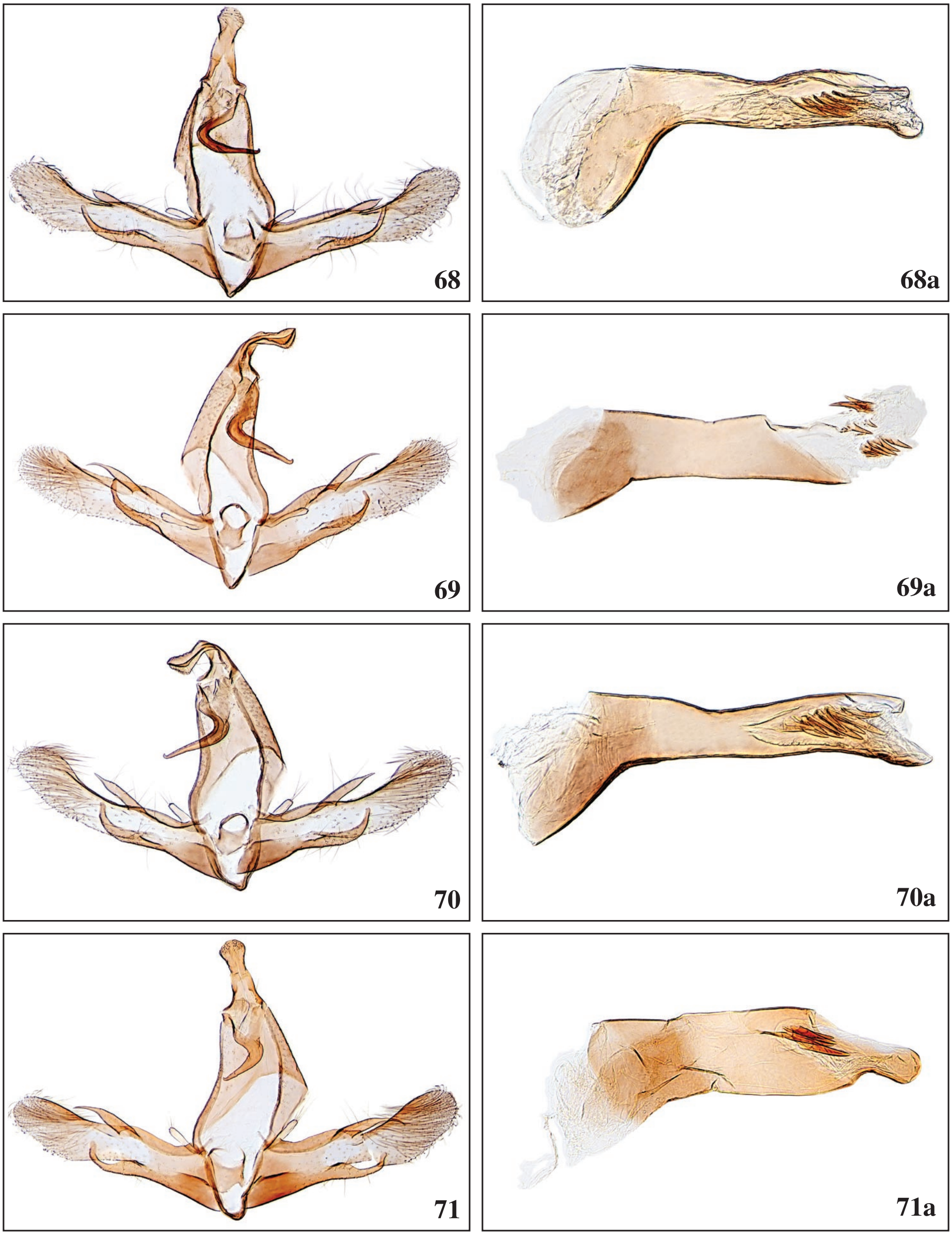

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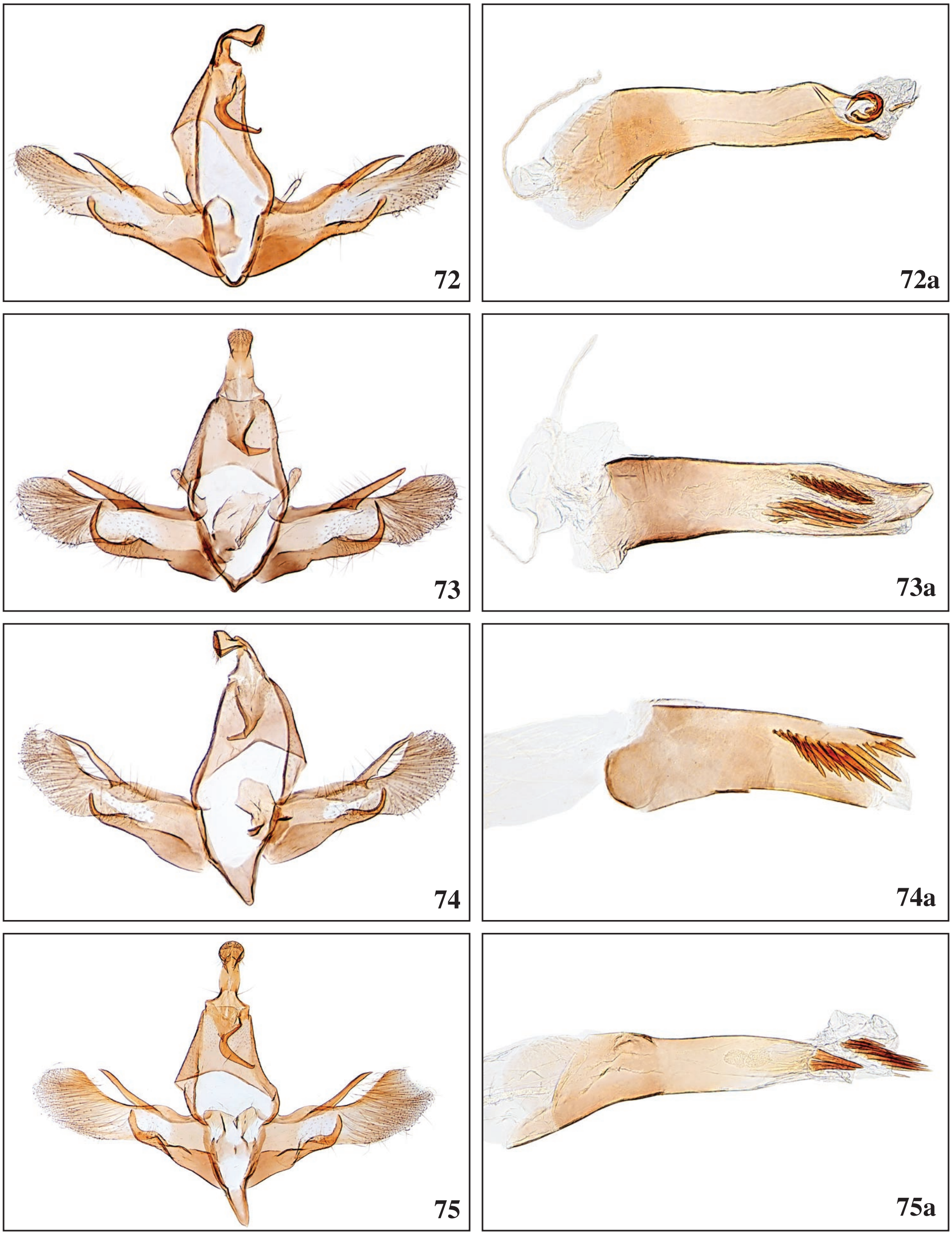

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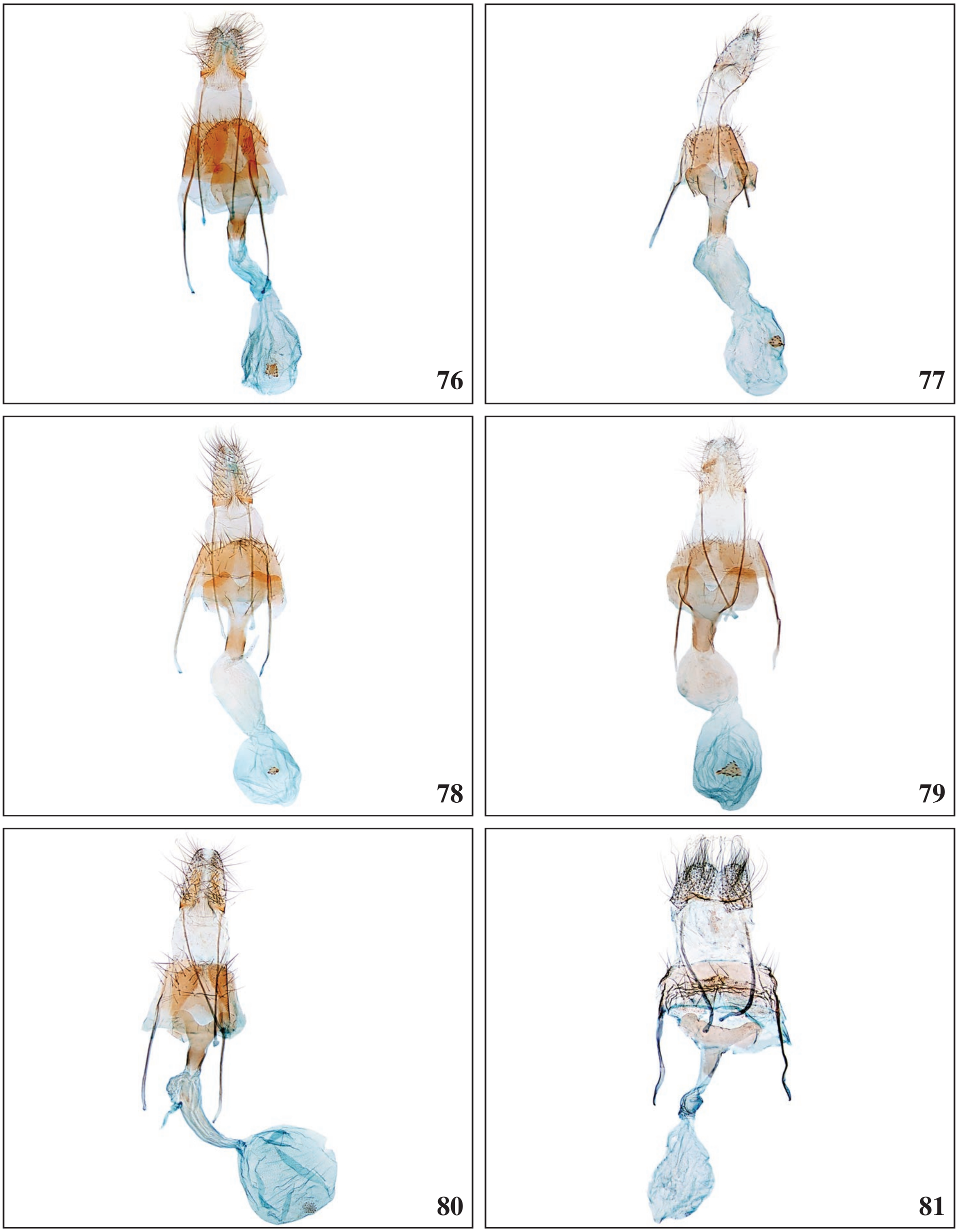

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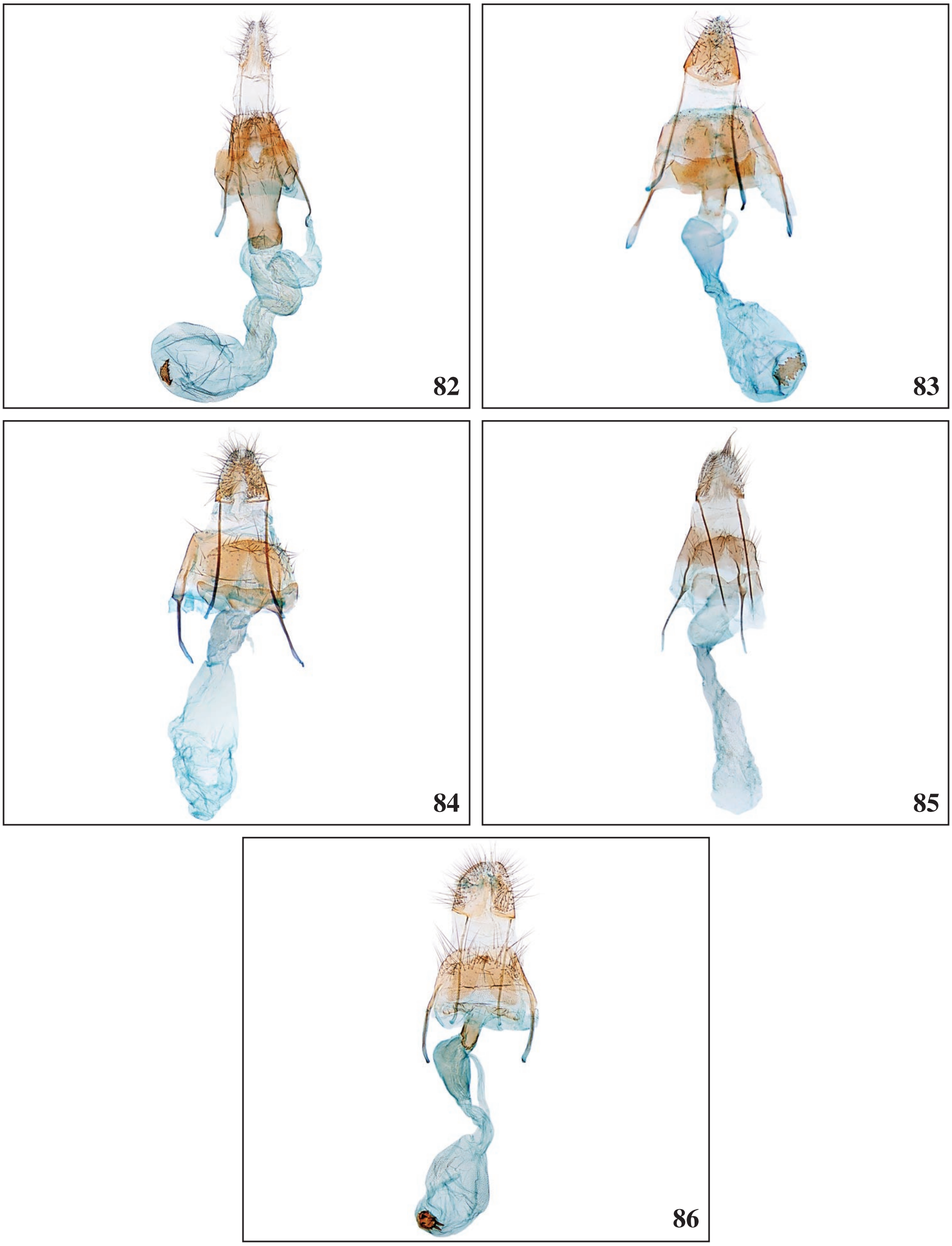

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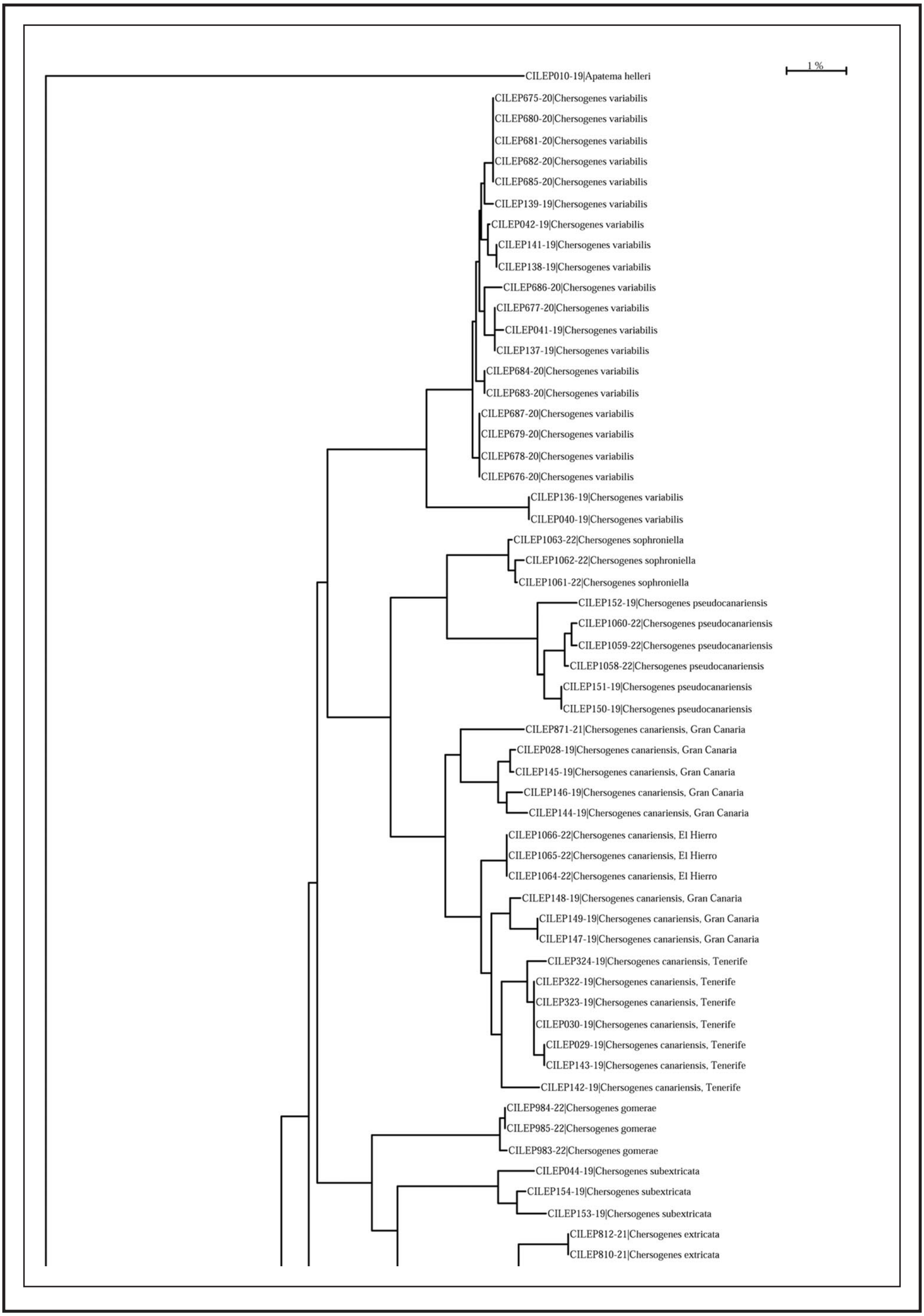
1 %
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CILEP675-20|Chersogenes variabilis
CILEP680-20|Chersogenes variabilis
CILEP681-20|Chersogenes variabilis
CILEP682-20|Chersogenes variabilis
CILEP685-20|Chersogenes variabilis
CILEP139-19|Chersogenes variabilis
CILEP042-19|Chersogenes variabilis
CILEP141-19|Chersogenes variabilis
CILEP138-19|Chersogenes variabilis
CILEP686-20|Chersogenes variabilis
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CILEP1062-22|Chersogenes sophroniella
CILEP1061-22|Chersogenes sophroniella
CILEP152-19|Chersogenes pseudocanariensis
CILEP1060-22|Chersogenes pseudocanariensis
CILEP1059-22|Chersogenes pseudocanariensis
CILEP1058-22|Chersogenes pseudocanariensis
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CILEP871-21|Chersogenes canariensis, Gran Canaria
CILEP028-19|Chersogenes canariensis, Gran Canaria
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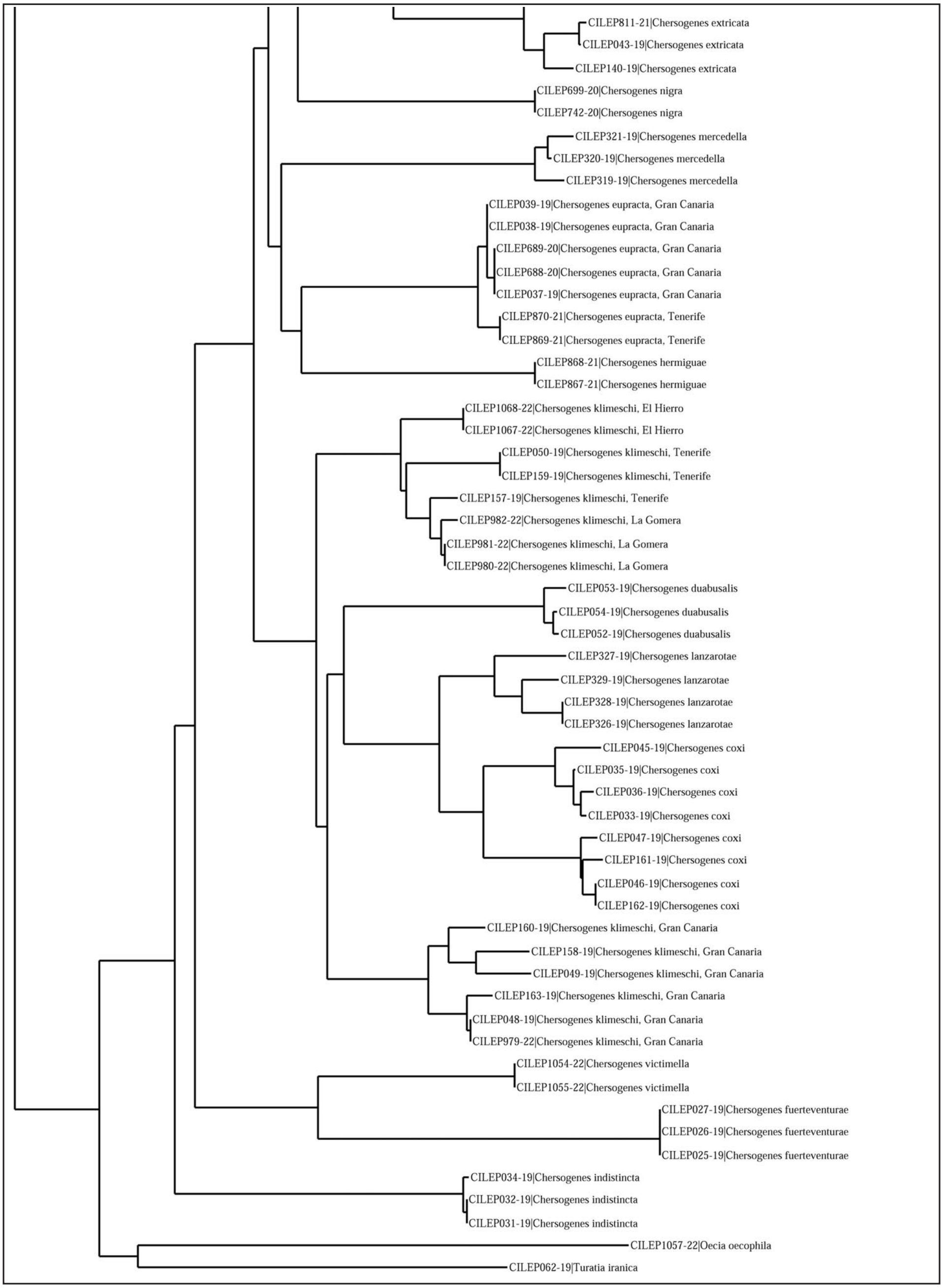

Figure 87. Neighbor-joining tree of DNA barcodes of eighteen species of *Chersogenes*, two species of Holcopogoninae and *Apatema helleri* (Rebel, 1910).

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A new subspecies of *Thaumantis hainana* (Crowley, 1900) from Guizhou province, southwest region of China (Lepidoptera: Nymphalidae)

Xue-jian Wang & Song-yun Lang

Abstract

In this paper, the *Thaumantis diores* Doubleday, 1845-complex, including *T. diores* Doubleday, 1845 and *T. hainana* (Crowley, 1900), is studied, and a new subspecies, *T. hainana libodiores* Lang & Wang, ssp. nov., is described from Guizhou province, S.W. China.

Keywords: Lepidoptera, Nymphalidae, *Thaumantis*, new subspecies, China.

Una nueva subespecie de *Thaumantis hainana* **(Crowley, 1900) de la provincia Guizhou,**
región suroeste de China
(Lepidoptera: Nymphalidae)

Resumen

En este trabajo se estudia el complejo *Thaumantis diores* Doubleday, 1845, que incluye *T. diores* Doubleday, 1845 y *T. hainana* (Crowley, 1900) y se describe una nueva subespecie, *T. hainana libodiores* Lang & Wang, ssp. nov., de la provincia de Guizhou, suroeste de China.

Palabras clave: Lepidoptera, Nymphalidae, *Thaumantis*, nueva subespecie, China.

Introduction

The genus *Thaumantis* Hübner, [1826] (Morphinae: Amathusiini) is a small Oriental genus and inhabits the tropical rainforests. *Nandogea hainana* Crowley, 1900 was described from Hainan Island, southwest of China as a distinct species (Crowley, 1900). Stichel (1906, in Wytsman) sunk it to an insular subspecies of *Thaumantis diores* Doubleday, 1845, viz. *T. diores hainana* (Crowley), and for a long time, it was considered as an endemic subspecies of Hainan (Fruhstorfer, 1911 in Seitz; Stichel, 1933 in Strand; D'Abrera, 1985; Gu & Chen, 1997). Osada et al. (1999) treated specimen from North of Laos as *T. diores hainana* (Crowley), but according to Inayoshi & Saito (2021), it is still *T. diores diores* Dbld. Basing upon differences of male genitalia, Lang (2010) recovered the species status of *Thaumantis hainana* (Crowley), and meanwhile, he found that this species also distributes in Asian mainland (Mt. Dayaoshan, Guangxi province, China). Inayoshi & Saito (2021) recognized two subspecies of *Thaumantis diores diores* Dbld. (= *ramdeo* Moore, [1858]) (Range: north of India, Bhutan, north of Myanmar, north and centre of Thailand, Laos, Vietnam, southwest of China including S.E. Tibet and S. Yunnan) and *Thaumantis diores splendens* Tytler, 1939 (Range: south Myanmar, west and Peninsula Thailand). According to Inayoshi (pers. comm.), some populations of subspecies *diores* Dbld. from Vietnam also have *hainana*-like structure of male genitalia, and obviously, they are more closely related to continental *Thaumantis hainana* (Crowley) from Guangxi. Here, we propose *Thaumantis diores* Dbld. species complex which includes both *T. diores* Dbld. and *T. hainana* (Crowley). In Indo-Chinese region and south of China, the *T. diores* Dbld.-complex is possibly undergoing a process of speciation, therefore, its different species, whose male genitalia already are distinct, have their superficial appearances very similar from each other. This phenomenon can be also found in other Amathusiini species complex, such as the *Faunis aerope* (Leech, 1890)-complex and the *Aemona amathusia* (Hewitson, 1867)-complex from the same region (Indochina and South of China) (Monastyrskii, 2005; Nakamura et al. 2010; Lang, 2012; Monastyrskii & Lang, 2016; Nakamura, 2021; Huang, 2021). In this study, a special local population is found from Maolan, Libo, south of Guizhou, near the border with Guangxi. This locality is on the northern boundary of the range of the *Thaumantis diores* Dbld.-complex. It is quite different from the known mainland *T. hainana hainana* (Crowley) from Mt. Dayaoshan, Guangxi, and should be a new subspecies of *T. hainana* (Crowley). It seems that marginal effect is workable in the speciation process of this species complex.

Materials

Specimens examined in this research are deposited in the following collections: Institute of Zoology, Chinese Academy of Sciences, Beijing, China (IZCAS); Chongqing Museum of Natural History, Beibei, China (CMNH); Guizhou Education University, Guiyang, China (GZEU); Dr. S. Y. Lang's private collection, Chengdu, China (LSY). Photographs of the type of *Nandogea hainana* Crowley kept in Natural History Museum, London, UK (NHM) were provided by Reynolds and Ackery.

The collecting data of related specimens in this research are: *Thaumantis hainana hainana* (Crowley): CHINA, Hainan, Lingshui, 2 ♂♂, 8-X-1934, leg. P. Bai (IZCAS); Hainan, Lingshui, Mt. Diaoluoshan, 260 m, 1 ♂, 5-V-2007, leg. S. Y. Lang (IZCAS); Hainan, Mt. Jianfengling, 3 ♂♂ 2 ♀♀, 2-VII-1981, 3-III-1-VIII-1983, leg. M. B. Gu (IZCAS); Hainan, Mt. Wuzhishan, Shuiman, 730-900 m, 1 ♂, 9-V-2007, leg. S. Y. Lang (IZCAS); Hainan, Mt. Wuzhishan, 5 ♂♂, 14-16-IV-2017, leg. S. Y. Lang (LSY); Guangxi, Jinxiu, 900 m, 1 ♂, 20-V-1999, leg. Y. Z. Zhang (IZCAS). *T. diores diores* Dbld.: CHINA: Yunnan, Xiaomengyang, 850 m, 1 ♂, 5-V-1957, leg. D. Panfilov (IZCAS); Yunnan, Mengla, Menghun, 580 m, 1 ♂, 12-IX-1993 (IZCAS); Yunnan, Mengla, Menghun, 710-1400 m, 2 ♀♀, 6-VI-1958, leg. C. P. Hong (IZCAS); Yunnan, Mengla, 620-650 m, 1 ♀, 16-XI-1958 (IZCAS); Yunnan, Mengla, 3 ♂♂, 2-5-V-2017, leg. S. Y. Lang & J. Hou (LSY); Yunnan, Ximeng, 1 ♂, 5-V-2019, leg. S. Y. Lang (LSY); Tibet, Bome, Yigong, 2300 m, 1 ♀, 27-VIII-1983, leg. Y. H. Han (IZCAS); Tibet, Medog, Beibeng, 800-900 m, 1 ♂, 2 ♀♀, 5-29-VIII-1974, leg. F. S. Huang (IZCAS); Tibet, Medog, Beibeng, 850 m, 1 ♂, 1 ♀, 23-29-V-1983, leg. Y. H. Han & Z. Lin (IZCAS); Tibet, Medog, Yarang, 800 m, 2 ♂♂, 4-VIII-1974, leg. F. S. Huang (IZCAS); Tibet, Medog, Yarang, 790 m, 3 ♂♂, 13-VIII-2006, leg. S. Y. Lang & F. Q. Chen (IZCAS).

Terminology

Terminology of male genitalia follows that of Klots (in Tuxen, 1970), excepting two specialized characters of the *Thaumantis diores* Dbld.-complex. Tegumen caudal end has a short and acute projection for which the term "uncus anticus" is used (Kirchberg, 1942); a short projection is present and attaches to the base of the dorsal ridge of the uncus, and Kirchberg (1942) used the term "crista" for this projection.

Taxonomy

Thaumantis hainana libodiores Lang & Wang, ssp. nov. (Figures 1-3, 11-13)

Material: Holotype ♂, CHINA: Guizhou, Libo, Maolan Natural Reserve, Banzhai, 800 m, 26-VIII-2013, leg. S. Y. Lang (CMNH). Paratypes: 11 ♂♂, ditto, 22-27-VIII-2013, leg. S. Y. Lang & X. J. Wang (GZEU, LSY).

Diagnosis: The new subspecies can be distinguished from the nominate subspecies by the combination of the following characters: 1. It is obviously larger than insular individuals of the nominate subspecies; 2. Iridescent blue patch on forewing upperside is narrowing towards the costa, whereas its anterior margin is wide in the nominate subspecies; 3. The dorsal surface of tegumen has 2 or 3 deep grooves, whereas it is smooth in the nominate subspecies; 4. Uncus anticus is coniform-shaped as in the nominate subspecies, but is more robust; 5. Crista is built as a finger like projection as in the nominate subspecies, but is obviously smaller.

The new subspecies is also superficially similar to *Thaumantis diores diores* Dbld., and it can be distinguished from the latter by the combination of the following characters: 1. Iridescent blue patches on upperside of both wings are often more restricted than those in *T. diores diores* Dbld.; 2. Iridescent blue patch on forewing upperside is narrowing towards the costa, whereas its anterior margin is wide in *T. diores diores* Dbld.; 3. Uncus anticus is coniform-shaped, whereas it is usually slightly flat in *T. diores diores* Dbld.; 4. Crista is built as a finger like projection, whereas it is very slender and flat in *T. diores diores* Dbld.

Notes: This subspecies also has features similar to *Thaumantis diores* Dbld., for example, its tegumen with grooves dorsally. Basing upon more characters shared with *T. hainana* (Crowley), we treat it as a subspecies of the latter: 1. Iridescent blue patches are often more reduced; 2. Uncus anticus is coniform-shaped; 3. Crista is built as a finger like projection.

Etymology: The specific name *libodiores* is composed by Libo, the type locality, and *diores*, the oldest name of this species complex.

Distribution: China (S. Guizhou).

Discussions

The fauna of Guangxi Province (China) is heterogeneous and diverse, and different mountain ridges are often isolated from each other here. Maolan Natural Reserve in Libo, Guizhou, type locality of *Thaumantis hainana libodiores* Lang & Wang, ssp. nov., is on the Guizhou-Guangxi border, and it is located at the southeastern fringe of the Yunnan-Guizhou plateau. Maolan is about 260 km to the northwest of Mt. Dayaoshan, which is an isolate ridge in east of Guangxi and a known habitat of *T. hainana hainana* (Crowley) in mainland. For Amathusiini, often local and slow flyers, such a distance and a degree of isolation can cause their speciation.

Only a male *Thaumantis hainana hainana* (Crowley) from Mt. Dayaoshan, Guangxi is examined in this study. Its male genitalia can hardly separate it from its conspecific relatives from Hainan Island, but it is obviously larger than those Hainanese individuals. Both its internal and external features are close to specimens of *T. diores diores* Dbld. from Vietnam (Inayoshi, pers. comm.). Therefore, populations of the *T. diores* Dbld.-complex from Guangxi and Vietnam might be a distinct subspecies of *T. hainana* (Crowley). Moreover, considering male genitalia differences, *T. hainana libodiores* Lang & Wang, ssp. nov. is also likely to be a distinct species. However, on the other hand, there is also another possibility that the *T. diores* Dbld.-complex is only a single species itself, *T. diores* Dbld., and all its taxa are conspecific and biogeographical subspecies, which are undergoing their vicariance (for example, differentiation of male genitalia structure). Of course, the above-mentioned hypotheses need more studies in the future.

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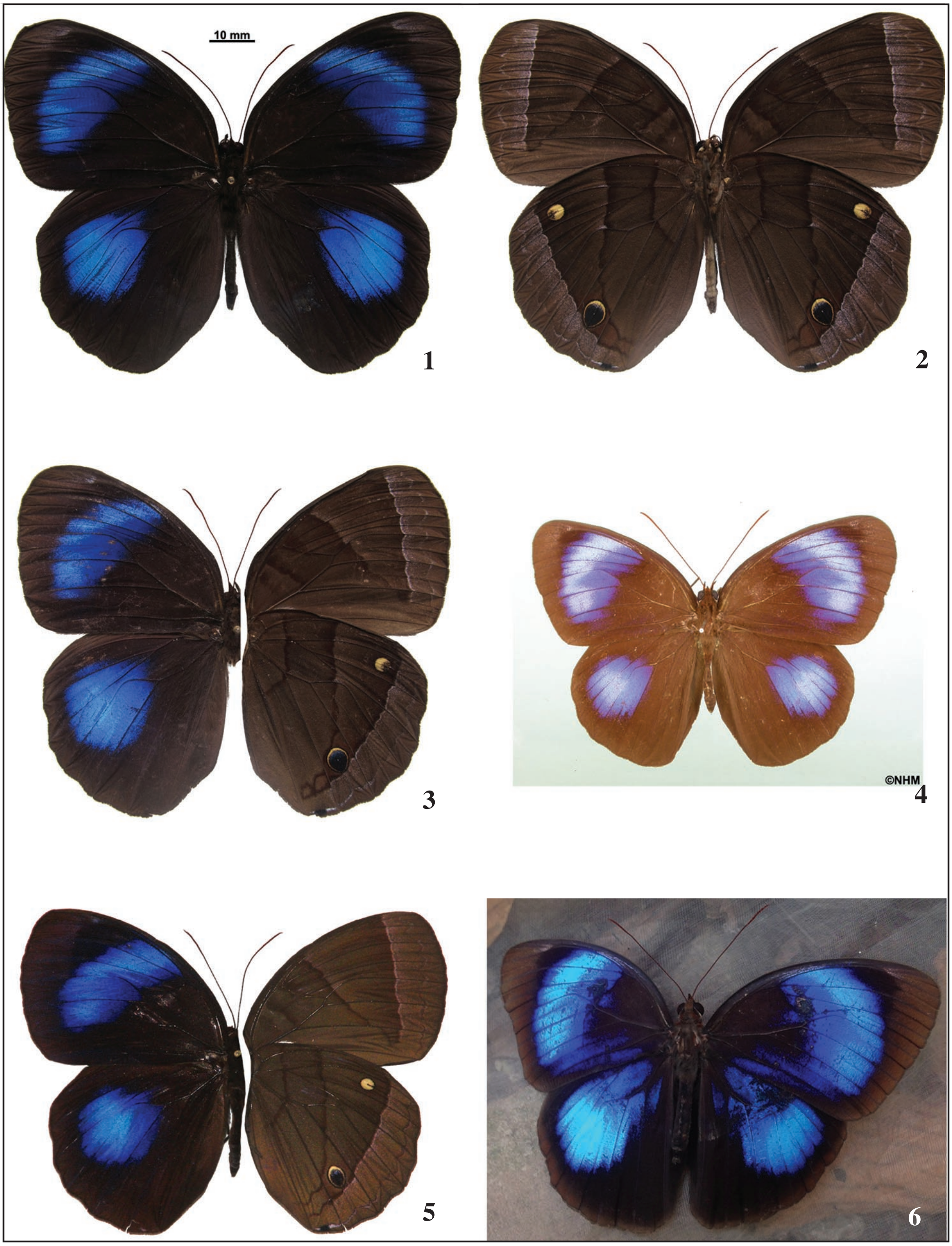
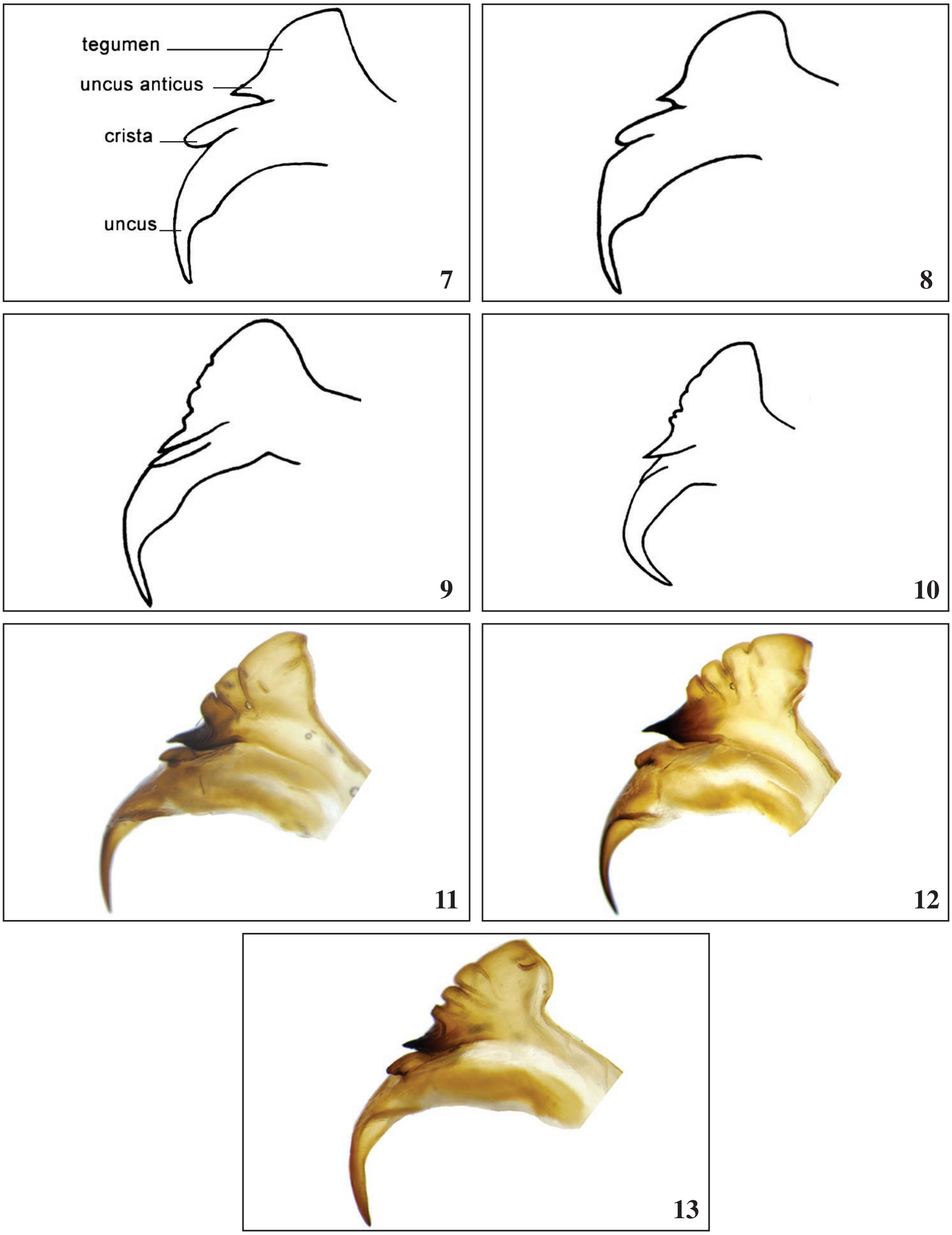


Figures 1-6. 1-2. *Thaumantis hainana libodiores* Lang & Wang, ssp. nov., holotype, ♂, Guizhou, Libo, CMNH. **3.** ditto, paratype, ♂, Guizhou, Libo, LSY. **4.** *Thaumantis hainana hainana* (Crowley), type of *Nandogea hainana* Crowley, ♂, Hainan, NHM. **5.** *Thaumantis diores diores* Doubleday, ♂, Tibet, Medog, IZCAS. **6.** ditto, ♂, Yunnan, Mengla, LSY.



Figures 7-13. Male genitalia (lateral view of tegumen + uncus). **7.** *Thaumantis hainana hainana* (Crowley), Hainan, Lingshui, after Lang (2010). **8.** ditto, Guangxi, Jinxiu, after Lang (2010). **9.** *Thaumantis diores diores* Doubleday, Yunnan, Xiaomengyang, after Lang (2010). **10.** ditto, Tibet, Medog, after Lang (2010). **11.** *Thaumantis hainana libodiores* Lang & Wang, sp. nov., paratype, Guizhou, Libo, LSY. **12.** ditto. **13.** ditto.

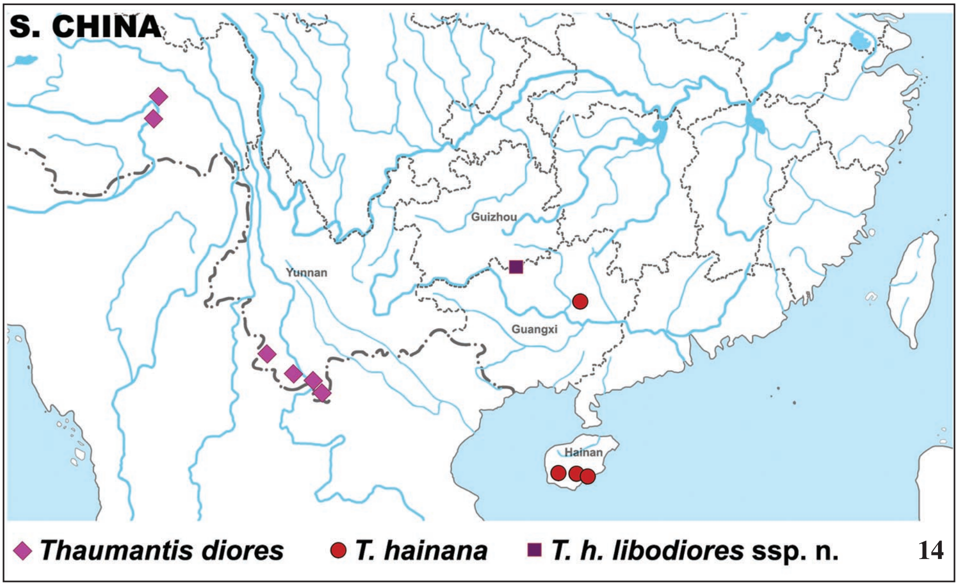


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Figure 14. Distribution map of *Thaumantis hainana* (Crowley) and *T. diores* Doubleday in China.

NOTICIAS GENERALES / *GENERAL NEWS*

SHILAP REVISTA DE LEPIDOPTEROLOGÍA EN LOS ÍNDICES DE IMPACTO INTERNACIONALES / SHILAP REVISTA DE LEPIDOPTEROLOGIA *IN THE INTERNATIONAL IMPACT INDEXES 2021*.– Según SCOPUS en su Índice SJR 2021 de *SCImago Journal Rank*, aparecemos con un **Indicador SJR: 0,262** FI, **Índice H: 13**, **Categoría: Ciencia Animal y Zoología: 334/416 (Q3), Ecología, Evolución, Comportamiento y Sistemática: 549/647 (Q3), Ciencia de los Insectos: 130/153 (Q3)**. Según CLARIVATE ANALYTICS en su Índice JCR 2021 de *Journal Citation Reports*, aparecemos con un **Índice de Impacto: 0,313, Categoría: 97/100 (Q4, Entomología)**, el **Influencia del artículo: 0,053**, el **Índice de inmediatez: 0,111**, el **Eigenfactor: 0,00016** y la **Categoría Eigenfactor: Ecología y Evolución.** / *According to SCOPUS in their Index SJR 2021 of* SCImago Journal Rank, *we appear with a **SJR Indicator: 0,262** FI, **H Index: 13**, **Rank: Animal Science and Zoology 334/416 (Q3), Ecology, Evolution, Behavior and Systematic: 549/647 (Q3), Insect Science: 130/153 (Q3)**. According to CLARIVATE ANALYTICS in their Index JCR 2021 of* Journal Citation Reports, *we appear with an **Impact Index: 0,313**, **Rank: 97/100 (Q4, Entomology)**,the **Article influence: 0,053**, the **Inmediacy Index: 0,111**, the **Eigenfactor: 0,00016**, and the **Eigenfactor Category: Ecology and Evolution**.*- **DETALLES / *DETAILS*:** SHILAP; Apartado de correos, 331; E-28010 Madrid; ESPAÑA / *SPAIN* (E-mail: avives1954@outlook.es).

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New species of *Meharia* Chrétien, 1915 from Morocco (Lepidoptera: Cossidae)

Thomas Sobczyk & Roman V. Yakovlev

Abstract

The article describes *Meharia ouanou* Sobczyk & Yakovlev, sp. nov., distributed in Morocco. The article has two illustrations.

Keywords: Lepidoptera, Cossidae, *Meharia*, biodiversity, species richness, taxonomy, new species, Morocco.

Nueva especie de *Meharia* Chrétien, 1915 de Marruecos (Lepidoptera: Cossidae)

Resumen

El artículo describe *Meharia ouanou* Sobczyk & Yakovlev, sp. nov., distribuida en Marruecos. El artículo tiene dos ilustraciones.

Palabras clave: Lepidoptera, Cossidae, *Meharia*, biodiversidad, riqueza de especies, taxonomía, nueva especie, Marruecos.

Introduction

The genus *Meharia* Chrétien, 1915 (Lepidoptera, Cossidae) includes 18 species, distributed in the arid regions of Western Palaearctic (up to Southern Volga region in the East), the Arabian peninsula and Africa (to Zambia and Zimbabwe in the South) (Wiltshire, 1990; Hacker, 1999, 2016; Yakovlev, 2011, 2014, 2018; Yakovlev et al. 2013, 2015; Yakovlev & Dubatolov, 2013; Yakovlev & Witt, 2015, 2016; Seizmar, 2018; Alipanah et al. 2021; De Prins & De Prins, 2022). In the collection of Microlepidoptera from Marocco, the first author of this article found a female specimen of a species new to science. Its description is given below.

Material and methods

The female genitalia were mounted in euparal on slides following Lafontaine & Mikkola (1987). The slides and adult specimen were photographed using a Canon EOS 600D with Canon macro photo lens MP-E 65, 1:2.8, 1-5x. The images were processed using PhotoScape software.

Taxonomical part

Meharia ouanou Sobczyk & Yakovlev, sp. nov. (Figures 1-2)

Type Holotype (Figure 1): Female, MOROCCO, “Morocco, Tata, 700 m, 18-X-2016, leg. R. Bläsius”. Deposited in the Zoologische Staatssammlung München, Germany (ZSM).

Description Female: Medium-sized moth with evenly densely scaled wings. Wingspan 17.0 mm, body length 7.0 mm, fore wing length 8.0 mm, maximum 2.5 mm wide, antennae length 4.5 mm.

Antenna with 39 segments, scapus and pedicellus with pale brownish scales. The other segments except for the distal segment with double pecten, densely covered with dark brownish scales. Length of pecten process 4 times longer than antenna stem diameter. Head and vertex covered with long, pale brown scales, frons with short, broad, whitish scales. Labial palps reduced, two-segmented, distal segment very short, both segments checked covered laterally with brown and pale scales, medially with whitish scales. Legs covered with brown scales, tibia and tarsal segments distally with a narrow ring of paler scales. Anterior tibia with a short, narrow epiphysis. Middle legs with one pair, hind legs with two pairs of spurs. Abdomen covered with brownish scales, distally somewhat darker. Forewing narrow, parallel-sided. Apex gradually rounded. Wing pale brown with slightly developed pale pattern consisting of light spots with irregular border. The wings are somewhat darker in the distal half. Fringe long, pale brown. Hind wing dark, brownish grey, patternless, fringes paler. Frenulum consisting of a cluster of 6 bristles, two of them on a separate basal bump.

Genitalia (Figure 2): (23-2021, Sobczyk) Papillae anales pyramidal-conical, covered by long setae, posterior apophyses long, pointed to apex; pore of ostium bursae broad, cup-like; ductus broad with thick sides; bursa sac-like, without signum.

Male: Unknown.

Habitat: The type locality is a semi-desert close to a settlement, which is characterized urban. The area is covered with some acacia and date palm trees (Figure 3).

Remark: The type locality is originally reproduced in the description. On inquire, the type location is a little south and is a district of Tata. The place name is shown differently on maps and online as Tigzmert (also Tighmert, Tigezmirt or Tiguezmert): 29º42’48.7”N 7º57’60.0”W.

Etymology: The name “ouanou” means a well in the Berber language Taschelhit. Near the type locality there the hotel “Oasis Dar Ouanou” which also refers to it.

Diagnosis

The new species is one of the smallest in the genus (according to the existing specimen - the smallest one). In the poorly modified pattern and very small size, it resembles *Meharia breithaupti* Yakovlev, 2014 (type locality: UAE, Ras Al Khaimah, Esfai garbage dump), from which it differs in a series of characters:

- length of the fore wing - 8 mm (that of the female *M. breithaupti* - 10 mm)
- absence of white spots on the fore wing (in *M. breithaupti,* there are white spots of an irregular shape on the fore wing, on the costal margin between the border of the basal and medium third and apically, in medio-basal area and along the anal margin)
- fringe on wings grey (in *M. breithaupti,* the fringe on the fore wing is grey at veins and white between veins, on the hind wing there are grey fringe scales interspersed with light scales in the fringe closer to the anal angle)
- posterior apophyses long, thin (in *M. breithaupti* - the posterior apophyses are twice shorter and thicker, lanceolate).

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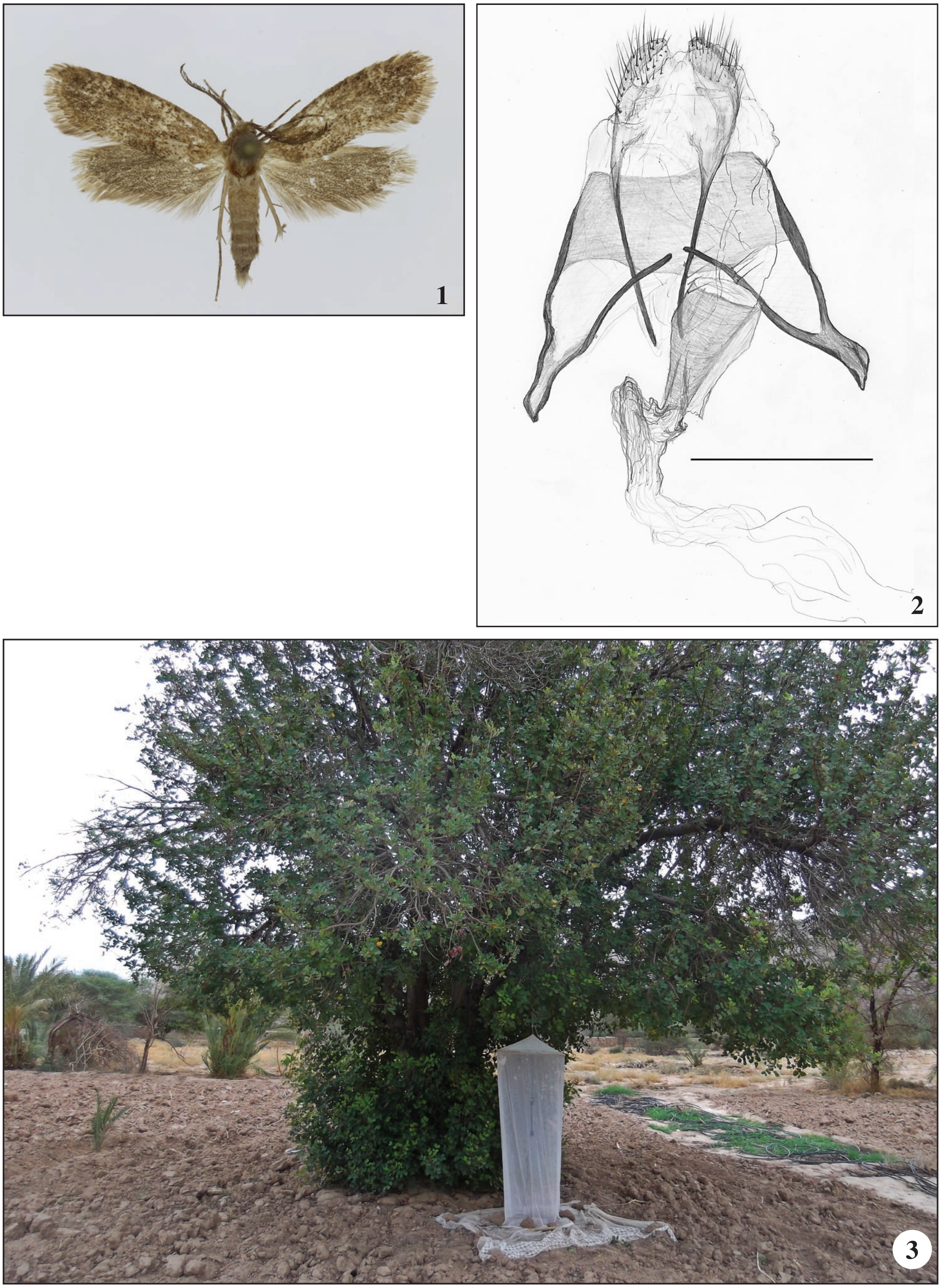

Figures 1-2. 1. *Meharia ouanou* Sobczyk & Yakovlev, sp. nov., holotype female. **2**. *Meharia ouanau* Sobczyk & Yakovlev, sp. nov., female genitalia**. 3.** Type locality, Morocco, Tata, 28-VII-2011 (photo R. Bläsius).

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Zygaenidae on stamps (Insecta: Lepidoptera)

Vazrick Nazari & Konstantin A. Efetov

Abstract

An overview of the representatives of the family Zygaenidae on stamps is provided. Determinations and erroneous identifications are discussed.

Keywords: Insecta, Lepidoptera, Zygaenidae, Zygaeninae, Chalcosiinae, Procridinae, stamps, determinations, misidentifications.

Zygaenidae en los sellos (Insecta: Lepidoptera)

Resumen

Se ofrece una visión general de los representantes de la familia Zygaenidae en los sellos. Se discuten las determinaciones y las identificaciones erróneas.

Palabras clave: Insecta, Lepidoptera, Zygaenidae, Zygaeninae, Chalcosiinae, Procridinae, sellos, determinaciones, identificaciones erróneas.

Introduction

It may be surprising to learn that moths such as Zygaenidae (although most of them are small) have been a source of inspiration to artists, such as the seventeenth century Dutch painter Otto Van Schriek who depicted *Zygaena* in his painting (Efetov & Tarmann, 2008). Zygaenidae are rare in works of art, and similarly they are uncommon on postage stamps. A recent survey of over 14,000 legally issued Lepidoptera stamps worldwide (Nazari, 2021) found only 68 (0.5%) stamps issued by 49 countries that portrayed species of the family Zygaenidae.

Results and discussion

The family Zygaenidae with more than 1.200 species is divided into five subfamilies, viz. Inouelinae Efetov & Tarmann, 2017, Zygaeninae Latreille, 1809 (with the tribes Pryeriini and Zygaenini), Callizygaeninae Alberti, 1954, Chalcosiinae Walker, 1865 (with the tribes Chalcosiini, Cyclosiini, Agalopini, Aglaopini, and Heteropanini), and Procridinae Boisduval, 1828 (with the tribes Artonini and Procridini) (Can Cengiz et al. 2018; Efetov, 1996, 1997, 1998, 1999, 2001, 2005; Efetov et al. 2014, 2015, 2016; Efetov & Hayashi, 2008; Efetov & Tarmann, 2013, 2014, 2016, 2017; Hofmann & Tremewan, 1996, 2017; Yen, 2003; Yen et al. 2005).

The above-mentioned 68 stamps (Table 1) represent about 29 recognizable species of the family Zygaenidae and some other that are identifiable only at genus or family level. Zygaenidae on stamps belong only to three subfamilies, viz. Zygaeninae (42 stamps with Zygaenini), Chalcosiinae (23 stamps: 19 with Chalcosiini and 5 with Agalopini) and Procridinae (3 stamps: 2 with Procridini and 1 with Artonini).

Zygaeninae are represented by *Epizygaenella caschmirensis* (Kollar, 1844), *Zygaena tamara* Christoph, 1889, *Zygaena laeta* (Hübner, 1790), *Zygaena brizae vesubiana* Le Charles, 1933, *Zygaena rubicundus* (Hübner, 1817), *Zygaena purpuralis* (Brünnich, 1763), *Zygaena hilaris* Ochsenheimer, 1808, *Zygaena carniolica* (Scopoli, 1763), *Zygaena occitanica* (Villers, 1789), *Zygaena rhadamanthus* (Esper, 1789), *Zygaena osterodensis* Reiss, 1921, *Zygaena transalpina* (Esper, 1780), *Zygaena filipendulae* (Linnaeus, 1758), *Zygaena trifolii* (Esper, 1783) (Zygaenini).

Chalcosiinae are represented by *Amesia sanguiflua* (Drury, 1773), *Erasmia pulchella* Hope, 1840, *Eterusia repleta* Walker, 1864, *Eterusia aedea edocla* Doubleday, 1847, *Gynautocera papilionaria* Guérin-Méneville, 1831, *Psaphis euschemoides* (Moore, 1866) (Chalcosiini), *Elcysma westwoodii* (Snellen van Vollenhoven, 1863), *Campylotes desgodinsi* (Oberthür, 1884), *Campylotes histrionicus* Westwood, 1839 (Agalopini).

Procridinae are represented by *Levuana iridescens* Bethune-Baker, 1906 (Artonini), *Adscita* sp., *Jordanita* sp. (Procridini).

Some countries have depicted Zygaenidae more than once, including São Tomé and Príncipe (5 times), Nepal (4 times), CAR, Gambia, and Maldives (3 times), and Belarus, Equatorial Guinea, Guinea-Bissau, Mozambique, Palau and Sierra Leone (twice). With 12 representations, *Zygaena filipendulae* is the most common species on stamps, followed by *Erasmia pulchella* (7), *Zygaena carniolica* (5), *Zygaena occitanica* (4), and *Amesia sanguiflua* (4). These species have all appeared in the stamps of more than one country. However, most species have appeared on stamps only once so far: *Epizygaenella* species (= *E. caschmirensis*, KAE ID) (Afghanistan 1971, figure 1), *Zygaena* [*brizae*] *vesubiana* (Monaco 1984, figure 2), *Z. laeta* (Tanzania 1996, figure 3), *Z. rhadamanthus* (Spain 2010, figure 4), *Z. rubicundus* (Italy 1996, figure 5), *Elcysma westwoodii* (Japan 1986, figure 6), *Eterusia aedea edocla* (Nepal 2014, figure 7), and the supposedly-extinct (Nazari et al. 2019) *Levuana iridescens* on the margin of a 2014 souvenir sheet from CAR (figure 8). In fact, 11 out of the 68 Zygaenidae are depicted not on the stamps themselves, but on the margins of souvenir sheets.

Some other notable species include *Zygaena occitanica* (figure 9), *Z. tamara* (figure 10), *Z. purpuralis* (figure 11), *Campylotes desgodinsi* (figure 12), *Amesia sanguiflua* (named as *"Erasmia sanguiflua*") (figure 13), *Eterusia repleta* (figure 14) and *Gynautocera papilionaria* (figure 15).

The first philatelic Zygaenidae is a *Z. carniolica* that appeared on a full-color stamp issued by Switzerland in 1956 (figure 16). Even though the name of the moth is not given, the excellent depiction allows for a proper identification. The latest Zygaenidae to appear on a stamp so far is a *Zygaena filipendulae* on a 2022 Moldova stamp (not shown).

Many Zygaenidae stamps do not offer any identifying information for the depicted moths, be it their scientific or common names. Some provide only a common name, for example "Zigena de las escabiosas" for a *Zygaena osterodensis* on a 1975 Equatorial Guinea stamp (not shown), The "Widderchen" for a *Zygaena carniolica* on a 1984 Berlin stamp (not shown), or the 2014 Marshall Islands stamp depicting a stylized *Zygaena* with the caption "Leaf Skeletonizer" (figure 17). But even when scientific names are provided, misidentifications or misspellings are not uncommon. The worst example is an *Erasmia pulchella* (VN ID) on a 1976 Equatorial Guinea stamp (figure 18) that is labelled *"Chrysiridia madagascariensis"* (!). Such misidentifications, however, are more often at genus or species levels. On two of the 2002 stamps issued by Gambia (not shown) where the moths are identified as *Zygaena carniolica*, one is a stylized *Zygaena hilaris* (KAE ID), and the other a stylized *Zygaena filipendulae* (Cosgrove ID). Similarly, the "BURNET MOTH [sic] *Adscita statices*" on a 2002 stamp from Turks and Caicos Islands (figure 19) is in fact a *Jordanita* species (KAE ID). An example of misspelling is the *Psaphis euschemoides* on a 1997 Eritrea stamp, misspelled *"eusehemoides*" [sic] (figure 20).

The early stages of *Zygaena* are very rarely shown on stamps. Portugal in 2018 issued stamps of *Zygaena trifolii,* which also included its caterpillar (figure 21). Belarus (2016) depicted the caterpillar of *Zygaena filipendulae* on the frame of a souvenir block with five stamps showing the adults (figure 22).

Sometimes Zygaenidae appear as a secondary subject or as decorative elements on stamps. Among the series "Forest fruits" issued by Romania in 1964, the stamp depicting the Woodland strawberry (*Fragaria vesca* L.) includes a gray scale *Zygaena* moth hovering around the plant (figure 23). A 2002 Sierra Leone stamp (not shown) depicting a Rough-Fruited Cinquefoil *Potentilia* [sic] *recta* L. similarly has a moth resting on it.

Natural enemies of Zygaenidae have also made their way onto stamps. A *Zygaena* moth on a 2007 São Tomé and Príncipe stamp (figure 24) is shown being hunted by a spider. The Somali series "Carnivorous Plants" issued in 2000 (figure 25) includes a stamp with a *Drosera bulbosa* Hook (the red-leaved sundew) that has attracted what seems to be a *Zygaena transalpina* (KAE ID). Interestingly, while the plant is endemic to Western Australia, the moth is only found in Europe.

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Table 1. Zygaenidae stamps issued worldwide until September 2022.

	Country	Year	ID verbatim	ID adjusted	Stamp number	Classification
1	Switzerland	1956	-	*Zygaena carniolica*	B258	Zygaeninae, Zygaenini
2	Taiwan	1958	[Chinese common name]	*Erasmia pulchella*	1186	Chalcosiinae, Chalcosiini
3	Romania	1964	-	*Zygaena* sp. (VN ID)	1703	Zygaeninae, Zygaenini
4	Lebanon	1965	*Erasmia sanguiflua*	*Amesia sanguiflua*	C434	Chalcosiinae, Chalcosiini
5	Hungary	1966	*Zygaena carniolica*	*Zygaena carniolica*	1730	Zygaeninae, Zygaenini
6	Sharjah	1967	-	*Adscita* sp. (stylized) (VN ID)	Mi: AE-SH 370A-372A	Procridinae, Procridini
7	Dubai	1968	*Erasmia pulchella*	*Erasmia pulchella*	Mi: DB 296	Chalcosiinae, Chalcosiini
8	Afghanistan	1971	*Epizygaenella* species	*Epizygaenella caschmirensis* (KAE ID)	844	Zygaeninae, Zygaenini
9	Ajman	1972	-	*Amesia sanguiflua*	Mi: AJ 2385A	Chalcosiinae, Chalcosiini
10	Liberia	1974	*Erasmia pulchella*	*Erasmia pulchella*	685	Chalcosiinae, Chalcosiini
11	Equatorial Guinea	1975	Zigena de las escabiosas	*Zygaena osterodensis*	74-256, Mi: GQ1168	Zygaeninae, Zygaenini
12	Equatorial Guinea	1976	*Chrysiridia madagascariensis*	*Erasmia pulchella* (VN ID)	7702, Mi: GQ A1026	Chalcosiinae, Chalcosiini
13	North Vietnam	1976	*Gynautocera papilionaria* Guér.	*Gynautocera papilionaria*	800	Chalcosiinae, Chalcosiini
14	Germany, Berlin	1984	"Widderchen"	*Zygaena carniolica*	9NB210	Zygaeninae, Zygaenini
15	Monaco	1984	*Zygaena vesubiana*	*Zygaena brizae*	1427	Zygaeninae, Zygaenini
16	Japan	1986	*Elcysma westwoodii*	*Elcysma westwoodii*	1688	Chalcosiinae, Agalopini
17	São Tomé and Príncipe	1992	-	*Zygaena* sp. (VN ID)	1082	Zygaeninae, Zygaenini
18	Mongolia	1993	*Agrumaenia* [sic] *carniolica*	*Zygaena carniolica*	Mi: MN 2459	Zygaeninae, Zygaenini
19	Ireland	1994	-	*Zygaena* sp. (VN ID)	934a, 934b	Zygaeninae, Zygaenini
20	Alderney	1994	*Zygaena filipendulae*	*Zygaena filipendulae*	79	Zygaeninae, Zygaenini
21	Azerbaijan	1995	-	*Zygaena tamara* (stylized)	473a	Zygaeninae, Zygaenini
22	Pakistan	1995	Érasmie	*Erasmia pulchella*	843a	Chalcosiinae, Chalcosiini
23	Italy	1996	*Zygaena rubicundus*	*Zygaena rubicundus*	2097	Zygaeninae, Zygaenini
24	Tanzania	1996	*Zygaena laeta*	*Zygaena laeta*	1452	Zygaeninae, Zygaenini
25	Eritrea	1997	*Psaphis eusehemoides*	*Psaphis euschemoides*	290a	Chalcosiinae, Chalcosiini
26	Nevis	1997	*Zygaena occitanica*	*Zygaena occitanica*	1014	Zygaeninae, Zygaenini
27	Congo Brazzaville	1999	*Campylotes desgodinsi*	*Campylotes desgodinsi*	CONGROVE # Z001d	Chalcosiinae, Agalopini
28	Georgia	1999	-	*Zygaena* sp. (stylized)	219	Zygaeninae, Zygaenini
29	Somalia	2000	-	*Zygaena transalpina* (KAE ID)	Mi: SO 853	Zygaeninae, Zygaenini
30	Gambia	2001	-	*Zygaena occitanica* (KAE ID)	2401	Zygaeninae, Zygaenini
31	Maldives	2001	*Campylotes desgodinsi*	*Campylotes desgodinsi*	Stampworld # 3864	Chalcosiinae, Agalopini
32	Maldives	2001	*Zygaena occitanica*	*Zygaena occitanica*	Stampworld # 3863	Zygaeninae, Zygaenini
33	Palau	2001	-	*Zygaena occitanica*	620	Zygaeninae, Zygaenini
34	Palau	2001	*Zygaena occitanica*	*Zygaena occitanica*	620d	Zygaeninae, Zygaenini
35	Saint Vincent & the Grenadines	2001	*Campylotes desgodinsi*	*Campylotes desgodinsi*	2998	Chalcosiinae, Agalopini

36	Sierra Leone	2001	-	*Zygaena* sp.	2487	Zygaeninae, Zygaenini
37	Gambia	2002	*Zygaena carniolica*	*Zygaena hilaris* (KAE ID)	2573e	Zygaeninae, Zygaenini
38	Gambia	2002	*Zygaena carniolica*	*Zygaena filipendulae* (stylized) (Cosgrove ID)	2572d	Zygaeninae, Zygaenini
39	Sierra Leone	2002	-	*Zygaena* sp. (VN ID)	2529	Zygaeninae, Zygaenini
40	Turks and Caicos Islands	2002	*Adscita statices*	*Jordanita* sp. (KAE ID)	1377b	Procridinae, Procridini
41	Iran	2003	*Zygaena* sp.	*Zygaena filipendulae*	Mi: IR 2917IIA	Zygaeninae, Zygaenini
42	Maldives	2004	*Amesia sanguiflua*	*Amesia sanguiflua*	2840b	Chalcosiinae, Chalcosiini
43	Guinea-Bissau	2005	-	*Zygaena tamara*	Yt: GW BF295	Zygaeninae, Zygaenini
44	Montserrat	2006	-	*Zygaena filipendulae*	1152	Zygaeninae, Zygaenini
45	São Tomé and Príncipe	2006	*Eterusia repleta*	*Eterusia repleta*	1603c	Chalcosiinae, Chalcosiini
46	São Tomé and Príncipe	2007	-	*Zygaena filipendulae*	1701d	Zygaeninae, Zygaenini
47	Denmark	2009	*Zygaena purpuralis*	*Zygaena purpuralis*	1432	Zygaeninae, Zygaenini
48	Spain	2010	*Zygaena rhadamanthus*	*Zygaena rhadamanthus*	3686	Zygaeninae, Zygaenini
49	Guinea-Bissau	2012	*Zygaena tamara*	*Zygaena tamara*	Mi: GW 6183	Zygaeninae, Zygaenini
50	Mozambique	2013	*Erasmia pulchella*	*Erasmia pulchella*	2940	Chalcosiinae, Chalcosiini
51	Mozambique	2013	*Erasmia sanguiflua*	*Amesia sanguiflua*	2910	Chalcosiinae, Chalcosiini
52	CAR	2014	*Levuana iridescens*	*Levuana iridescens*	Mi: CF BL1162	Procridinae, Artonini
53	Guinea	2014	*Zygaena filipendulae*	*Zygaena filipendulae*	Mi: GN 10674	Zygaeninae, Zygaenini
54	Marshall Islands	2014	Leaf Skeletonizer	*Zygaena* sp. (stylized)	1078f	Zygaeninae, Zygaenini
55	Nepal	2014	*Campylotes histrionicus*	*Campylotes histrionicus*	Mi: NP 1155	Chalcosiinae, Agalopini
56	Nepal	2014	*Erasmia pulchella*	*Erasmia pulchella*	Mi: NP 1158	Chalcosiinae, Chalcosiini
57	Nepal	2014	*Eterusia aedea edocla*	*Eterusia aedea edocla*	Mi: NP 1159	Chalcosiinae, Chalcosiini
58	Nepal	2014	*Gynautocera papilionaria*	*Gynautocera papilionaria*	Mi: NP 1161	Chalcosiinae, Chalcosiini
59	CAR	2015	*Zygaena filipendulae*	*Zygaena filipendulae*	Mi: CF BL1300	Zygaeninae, Zygaenini
60	Belarus	2016	*Zygaena filipendulae*	*Zygaena filipendulae*	1017	Zygaeninae, Zygaenini
61	Belarus	2016	*Zygaena filipendulae*	*Zygaena filipendulae* (+ caterpillar)	Mi: BY 1155KB	Zygaeninae, Zygaenini
62	CAR	2016	*Eterusia repleta*	*Eterusia repleta*	Mi: CF 6605-6608KB	Chalcosiinae, Chalcosiini
63	Chad	2017	*Zygaena carniolica*	*Zygaena carniolica*	Mi: TD 3226	Zygaeninae, Zygaenini
64	São Tomé and Príncipe	2017	*Eterusia repleta*	*Eterusia repleta*	Mi: ST 7225	Chalcosiinae, Chalcosiini
65	São Tomé and Príncipe	2017	*Zygaena filipendulae*	*Zygaena filipendulae*	Mi: ST 7040	Zygaeninae, Zygaenini
66	Portugal	2018	*Zygaena trifolii*	*Zygaena trifolii* (+ caterpillar)	Mi: PT L110	Zygaeninae, Zygaenini
67	Netherlands	2019	*Zygaena filipendulae*	*Zygaena filipendulae*	Mi: NL 3831	Zygaeninae, Zygaenini
68	Moldova	2022	*Zygaena filipendulae*	*Zygaena filipendulae*	Colnect MD 2022.07.29-04	Zygaeninae, Zygaenini


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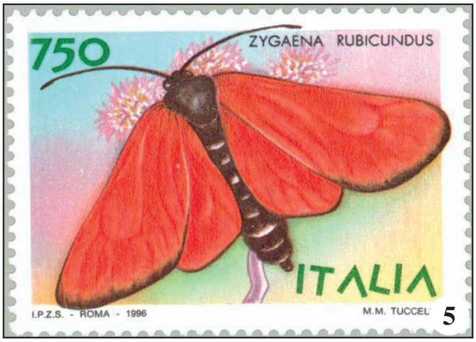
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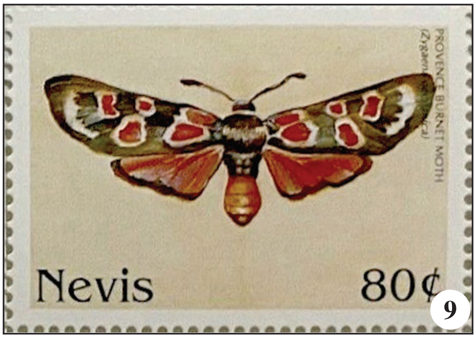
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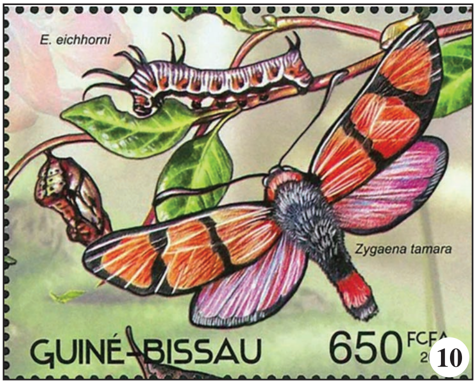
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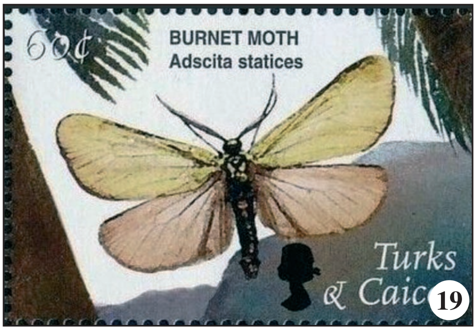

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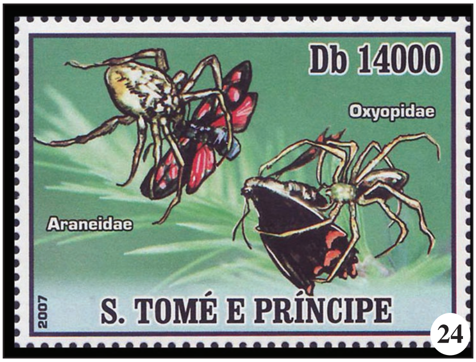
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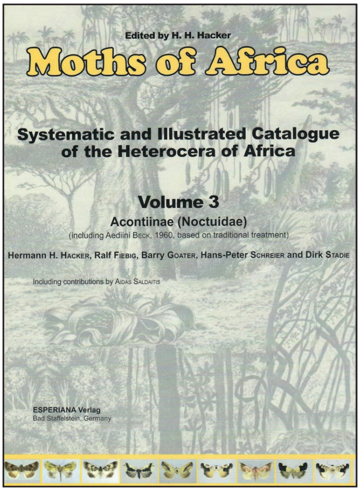
SHILAP Revista de lepidopterología, 51 (202) junio 2023: 338 eISSN: 2340-4078 ISSN: 0300-5267

REVISIÓN DE PUBLICACIONES
BOOK REVIEWS



H. H. Hacker
Moths of Africa. Systematic and Illustrated Catalogue of the Heterocera of Africa. Volume 3. Acontiinae (Noctuidae)
695 páginas
Formato: 24,0 x 17’5 cm
ESPERIANA Verlag, Bad Staffelstein, 2022
ISBN: 978-3-9820357-3-4

Tenemos en nuestras manos el segundo volumen de esta nueva serie que bajo el título *Moths of Africa*, pretende estudiar la interesante fauna africana continental, incluida la fauna del norte de África, la isla de Madagascar y las islas adyacentes.

En este volumen se trata la subfamilia Acontiinae Grote, 1895, con 44 especies, Hypeninae Herrich-Schäffer, 1851, con 198 especies, Herminiinae Leach, [1815] 1830, con 290 especies e Hypenodinae Forbes, 1954, con 30 especies.

Este trabajo aumenta su importancia, si tenemos en cuenta que se describe un género nuevo *Meriderminia* Hacker, 2021, así como 253 especies y seis subespecies nuevos para la Ciencia.

Después de la Introducción, nos hablan sobre la Evolución de la diversidad de la flora y fauna, así como de las unidades biogeográficas de África, con profusas fotografías y mapas a todo color.

Ya dentro de la parte taxonómica de estas cuatro subfamilias, de cada uno de los géneros considerados, nos dan las reseñas sinonímicas y notas aclaratorias sobre la especie tipo, la genitalia y la referencia bibliográfica. De cada especie nos da las referencias bibliográficas, sobre el material examinado, su distribución, bionomía, diagnosis y descripción, genitalia, así como fotografía de la genitalia del macho y de la hembra en 135 planchas, seguidas de dos planchas de datos biológicos, otras cuatro planchas, casi todas las fotos en blanco y negro, de algunos tipos y además de 59 planchas a todo color de los adultos, finalizando con una bibliografía específica y un índice.

No podemos terminar estas líneas, sin felicitar al autor, por tan detallado trabajo sobre la fauna africana, así como a ESPERIANA que apoya tan importante y esencial obra, que deseamos tenga una larga vida y pueda completar este importante obra, por lo que recomendamos vivamente su adquisición y no pudiendo faltar en cualquier biblioteca que se precie, sobre todo para aquellos interesados en esta magnífica fauna.

El precio de este libro es de 165 euros y los interesados deben dirigirse a:

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A review on heat stress altering the insect life history strategies and underlying mechanisms: Special reference to an economically important Lepidoptera, *Bombyx mori* (Linnaeus, 1758) (Lepidoptera: Bombycidae)

Hashim Ashraf & Ayesha Qamar

Abstract

Lepidoptera is an order belonging to class Insecta consisting of Rhopalocera and Heterocera. *B. mori* belongs to this order and is the backbone of sericulture. Sericulture, the culture, rearing and maintenance of *Bombyx mori* (Linnaeus, 1785) for silk production, is widely practiced in India, contributing to its economy and providing livelihoods to many, especially those from lower socioeconomic backgrounds. Temperature and humidity affect silk production greatly. Heat shock genes and proteins protect *B. mori* to a certain extent from increased heat stress. However, outside this range, silkworm biology suffers. The silkworm adapts to heat by upregulating thermotolerance genes and proteins, especially heat shock proteins (HSPs). Produce different heat-resistant proteins at different temperatures. Larvae, embryos, and cocoons are affected by heat stress. Given the silkworm's sensitivity to temperature and humidity and the alarming pace of climate change and global warming faced by the earth, it is necessary to consider solutions that will allow *B. mori* to adapt in the future decades. Molecular and enzymatic markers may help screen thermotolerant silkworm breeds. Given this insect's temperature sensitivity, global warming and climate change may harm it even more than other insects. Therefore, to save this insect and the sericulture sector, steps must be taken in this direction.

Keywords: Lepidoptera, Bombycidae, thermo-tolerance, Heat shock proteins, biomarkers, global warming.

Una revisión sobre el estrés térmico que altera las estrategias vitales de los insectos y los mecanismos subyacentes: Especial referencia a un Lepidoptera de importancia económica, *Bombyx mori* (Linnaeus, 1758) (Lepidoptera: Bombycidae)

Resumen

Lepidoptera es un orden perteneciente a la clase Insecta que consiste en Rhopalocera y Heterocera. *B. mori* pertenece a este orden y es la columna vertebral de la sericultura. La sericultura, el cultivo, la cría y el mantenimiento de *Bombyx mori* (Linnaeus, 1785) para la producción de seda, se practica ampliamente en la India, lo que contribuye a su economía y proporciona medios de subsistencia a muchos, especialmente a aquellos de entornos socioeconómicos más bajos. La temperatura y la humedad afectan en gran medida la producción de seda. Los genes y proteínas de choque térmico protegen a los gusanos de seda hasta cierto punto del aumento del estrés por calor. Sin embargo, fuera de este rango, la biología del gusano de seda sufre. El gusano de seda se adapta al calor regulando al alza los genes y las proteínas de termotolerancia, especialmente las proteínas de choque térmico (HSP). Los gusanos de seda producen diferentes proteínas resistentes al calor a diferentes temperaturas. Las larvas, los embriones y los capullos se ven afectados por el estrés por calor. Dada la sensibilidad del gusano de seda a la temperatura y la humedad y el ritmo alarmante del cambio climático y el calentamiento global que enfrenta la tierra, es necesario considerar soluciones que permitan a *B. mori* adaptarse en las próximas décadas. Los marcadores moleculares y enzimáticos pueden ayudar a detectar razas de gusanos de seda termotolerantes. Dada la sensibilidad a la temperatura de este insecto, el calentamiento global y el cambio climático pueden dañarlo incluso más que a otros insectos. Por lo tanto, para salvar a este insecto y al sector de la sericultura, se deben tomar medidas en esta dirección.

Palabras clave: Lepidoptera, Bombycidae, termo-tolerancia, proteínas de choque térmico, biomarcadores, calentamiento global.

Introduction

Lepidoptera belongs to the Class Insecta which is the second-largest order of this order. It includes Heterocera and Rhopalocera. According to a recent study, 157,424 Lepidopteran species have been reported globally belonging to 124 families (van Nieukerken et al. 2011). Moths are agricultural pests, food for birds, bats, and insects, and night pollinators. Lepidoptera, being closely related with their surroundings, can be employed as ecological indicators to monitor destruction of the environment (Dar & Jamal, 2021a; Dar et al. 2022; Sheikh et al. 2022). They serve as research models for biodiversity conservation, evolution, genetics, ethology, and genetics (Samways, 2007). *Bombyx mori* (Linnaeus, 1758), also known as the silkworm, is a Lepidoptera insect that is used for producing silk and is the backbone of the silk industry. During its larval stage, *B. mori* consumes exclusively mulberry leaves as its sole food source. Sericulture is the rearing of *B. mori* for the production of silk. It is mainly practiced in China and India's northern and southern belts, with the northern region producing bivoltine silk from bivoltine *B. mori* that are only suitable for temperate climates (Rathnam et al. 2013). Although the southern belt produces most of India's silk, it mainly relies on multivoltine sericulture, which is based on the culture of multivoltine *B. mori* (Taufique et al. 2021). Multivoltine *B. mori* are hardy and temperature tolerant than bivoltine *B. mori*.

Looking at the current situation on a worldwide scale, we are confronted with climate change and global warming concerns. Extreme weather events, such as increased forest fires, increased precipitation, and higher temperatures, are a noticeable result of these worldwide (Frame et al. 2020). Climate change has already started to affect some insect populations, like moths, whose population has declined a lot, and climate change has played a considerable part in this decline (Dar & Jamal, 2021b). We are seeing more of these unusual occurrences these days. When we consider the worldwide scenario, it can readily be concluded that global warming is progressing at an alarming rate and will continue to do so in the following decades. As a result, a study of the effects of global warming on "life on Earth" is required.

Given that *B. mori* is particularly sensitive to the temperature fluctuations of its surroundings, we have addressed the topic of global warming and climate change concerning *B. mori* and the mulberry sericulture sector in India in this review. This review also summarizes the effects of high temperatures on the biology and economic characteristics of the silkworm *B. mori*. We also detail the proteins and genes involved in these worms' thermotolerance and supplement previously published reviews with new data.

Heat stress effects on *B. mori* biology

B. mori life cycle and general biology are greatly dependent on the environment it grows in. Some breeds are naturally more tolerant to temperature and other abiotic stresses (Kumaresan et al. 2012). Some Indian indigenous silkworm breeds can tolerate the temperature extreme of up to 32ºC e.g., Nistari breed of *B. mori* has a pupation percentage, which is indicative of a measure of thermotolerance, of 84% and 80% in unfavourable wet summer and dry summer respectively compared to 94% in favourable season (October-March) (Moorthy et al. 2007). An increase in temperature harms *B. mori* e.g., hatchability of eggs in Nistari breed dropped to zero under a stress of 43ºC (Sinha & Sanyal, 2013). A crossbreed of *B. mori* (PM X CSR2) when kept at 30ºC and 40ºC in lab setting didn't lay eggs at 30ºC and died at 40ºC (Wanule & Balkhande, 2013). Thermal stress also leads to oxidative damage in the body of *B. mori* as was studied in Polyvoltine (Nistari and Sarupat) and bivoltine (SK6 and SK7) by exposing them to temperatures of 35ºC and 40ºC (Makwana et al. 2021).

To successfully breed *B. mori*, temperature and humidity play the most crucial role. An increase in ambient temperature causes adverse effects on average growth and development and also affects the cocoon characters. Cocoon weight is highest when *B. mori* (Pure Mysore and NB4D2) is cultured at 25ºC and with the increase in temperature the cocoon weight decreases (Khan, 2014). Tanjung et al. (2017) found that heat stress given to *B. mori* larva (C301 strain) for a brief period (3 hours in the IVth instar) accelerates its larval stages thereby directly affecting the larval development thus, reducing productivity. Different instars of *B. mori* larvae tolerate and respond to thermal stress differently. Studies on some strains of silkworm (NB4D2, NP2, CSR2, KSO1and CSR4), showed resistance to heat shock (35ºC, 40ºC, and 45ºC for 2 hours), increased with larval development from Ist instar to Vth instar with Ist, IInd and IIIrd instars of NB4D2, NP2, CSR2, KSO1and CSR4 being more sensitive to high temperatures of 35ºC and 40ºC than IVth and Vth instars (Chavadi et al. 2006). However, the study also showed that heat shock affects the effective rearing rate (ERR) at a higher temperature and increases the cocoon and shell weight (Chavadi et al. 2006). High temperature affects silkworm not only in the larval stages but also in the embryonic stages. When exposed to high temperatures (40oC for 2 hours), Eggs significantly reduced their hatching percentage in a study (Taha, 2013). A decrease in fecundity was also observed when the silkworm breed (CSR18) was reared above 42ºC. Temperature above 42ºC greatly affects the development of ovaries and reproductive performance in adult moths of *B. mori* (Paul & Keshan, 2016). The impact of high temperature is not only limited to silkworm economic characteristics or health of *B. mori,* but it has also been found that high temperature affects the gut flora of silkworm (Diazo strain), decreasing the abundance of the flora as the temperature rises (Sun et al. 2017).

B. mori, has different breeds, and all of them don't behave similarly. Some are more sensitive to environmental stresses than others. Thiagarajan et al. (1993) evaluated some breeds of *B. mori* for their season-specific variation. They selected those that performed well in particular seasons (European, 14M for spring, JC2P for summer, and M2 for autumn performed well for most of the characters selected). Lakshmi et al. (2012) showed the difficulty in a culture of bivoltine breeds in tropical environments of West Bengal. The increased temperatures of the tropics directly affected and decreased the quantitative characteristics like viability and cocoon quality of bivoltine silkworm thus making it difficult for commercial breeding of bivoltine *B. mori* in those areas. High temperature also harms the larval survival rate apart from reducing cocoon and shell weight (Kato et al. 1998). The extreme sensitivity of *B. mori* to heat stress makes it imperative to grow in a particular range of temperatures successfully and comfortably. A temperature falling between 20ºC and 28ºC is optimum for bivoltine silkworm culture. However, for better productivity temperature range from 23ºC to 28ºC proves lucrative for this industry. A rise in temperature above 30ºC or a drop in temperature below 20ºC both prove detrimental to *B. mori,* affecting their health and making them susceptible to diseases. Both these factors are directly proportional to loss in productivity (Rahmathulla et al. 2012).

Kumar et al. (2001) found that Silkworm hybrids (F1) between a polyvoltine (Mori breed) and bivoltine races (N137, C146) are more thermotolerant than pure breeds. It was also observed that "maternal effect" also has a role to play in thermotolerance, because of the increased performance and thermotolerance of those hybrids where female parent used, was more thermotolerant. The increased better performance was seen in characteristics like pupation rate, cocoon weight, shell weight, and shell ratio. However, overall, the performance decreased as the larvae were exposed to 48ºC continuously, indicating a specific limit of thermotolerance for heat stress. The fact that *B. mori* can tolerate only a narrow range of temperatures and an increase in temperature directly affects the biology of *B. mori*, having effects on cocoon characters, larval development, etc. can be exploited to screen thermotolerant silkworm breeds as was demonstrated in a study by Chandrakanth et al. (2015) by selection of bivoltine breeds based on their pupation percentage after exposing to temperatures of 20ºC, 32ºC, 34ºC, and 36ºC. Based on their evaluation, SK4C and BHR3 were thermotolerant bivoltine breeds out of 20 selected initially in their study. *B. mori,* under lab conditions, was exposed to different stress like starvation, cold, and heat stress, and their combination affected its thermal tolerance in different ways. Starvation on the one hand improved cold tolerance but decreased heat tolerance, indicating trade-offs between these two stresses (Mir & Qamar, 2018). It is evident from the literature that thermal stress harms *B. mori* biology. However, to negate and protect its body from thermal stress up to a certain level, the body of a silkworm responds to heat stress *via* the expression of a particular class of proteins called heat shock proteins (HSP). Figure 1 summarises the negative effects of heat shock on *Bombyx mori* in general.

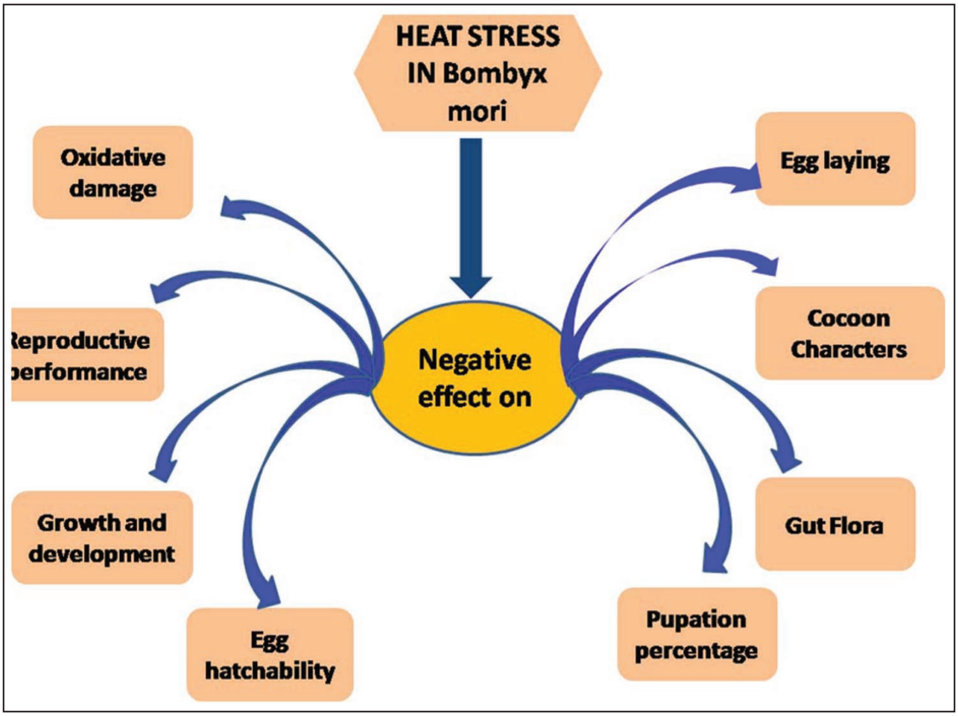

Figure 1. Summarization of negative effects of heat stress on *B. mori.* Heat stress negatively affects various parameters like egg laying, Cocoon characters, Gut flora, Pupation percentage, Egg hatchability, Growth and development, Reproductive performance and also leads to oxidative damage.

Proteins involved in thermotolerance of *B. mori*

Response to heat shock in the silkworm body is led by heat shock proteins (HSPs) which are expressed in response to heat shock in each organ of silkworm body. Heat shock proteins (HSPs) are a family of proteins that are evolutionary conserved, increasing their expression in an organism's body to varied environmental insults (Kundapur et al. 2009). Another class of heat shock proteins namely small heat shock proteins (sHSPs) play a crucial part in the control of a variety of biological processes, including temperature stress, abiotic stress, immunological responses, metamorphosis, and embryo development. sHSPs are conserved among insects (Liu et al. 2018). Silkworm strains including multivoltine (KNT, CFP, GCM, CLPF, GLPF, PAF, GFP-C, AP-White, ISK, CDFP, IIA, GDFP) and bivoltine silkworm strains (BD2S, BO2, SOF-Br, BO1S, BO1N, SOC-B, BO3BL) when given heat stress (40ºC and 45ºC for 1 hour) and subsequent analysis of protein content in the haemolymph of treated and control done, revealed that protein content in haemolymph increased many folds compared to control (Kumari et al. 2020). An increase in protein content in haemolymph may be due to an increase in the level of heat shock proteins. With temperature shock, every silkworm strain/breed responds by increasing the expression of heat shock proteins. However different strains/breeds or races express these heat shock proteins (HSPs) with some variations. A different set of heat shock proteins expressed in different strains in response to heat stress makes them able to tolerate the rise in temperature to a few degrees. However, there is a limit to the thermal tolerance of silkworm races. Different researchers have worked to elucidate the foreplay of proteins involved in the heat stress of *B. mori*. Joy et al. (1995) studied the heat shock response of multivoltine silkworm strains (*C. Nichi* and *Pure Mysore*) and a bivoltine strain (NB4D2) and observed the consequent appearance of a 93KDa protein (HSP) to heat shock in fat body, cuticle and haemolymph in both multivoltine and bivoltine breeds of silkworm, however, with a slight difference in timing of their appearances. Another protein (HSP) having a molecular mass of 70kDa was found to be present, however, constitutively in fat body and cuticle of all the strains under study (*C. Nichi, Pure Mysore* and NB4D2). Li et al. (2012) explored proteomic analysis of the posterior silk gland of hybrid silkworm strains (Qiufeng x Baiyu) and its parents, Qiufeng and Baiyu, under high-temperature treatment (42ºC for varied periods ranging from 10 min to 3 days) and found temperature stress induces expression of small heat shock proteins (sHSP) viz. hsp20.4, hsp20.8, alpha-crystallin. Proteome analysis done via peptide mass fingerprinting revealed this information. Thermotolerance was more in hybrids (Qiufeng x Baiyu) compared to their parents (Qiufeng and Baiyu) as was evident from the higher upregulation of proteins involved in heat stress in hybrids compared to parents. Heat greatly affected the silk synthesis as protein involved in silk metabolism identified in posterior silk gland viz adenosine kinase (ADK), ribosomal protein P0, P2, elongation factor 1b' (EF-1b'), EF-1 delta and fibroin L-chain were affected with heat stress and its effects were more pronounced in hybrids where they got down-regulated than parents indicating that hybrids although more tolerant to heat stress, however, are more prone to receive effect on silk production by heat stress. Kundapur et al. (2009) compared protein expression in silk gland of normal and heat-shocked bivoltine silkworm strains (NB4D2) and found that SDS-PAGE of heat shock treatment of silkworm had 29 proteins overexpressed compared to control silkworm indicating silk glands produce heat shock proteins in response to heat stress thus protecting its physiology. Howrelia et al. (2011) studied the effect of temperature treatment (38ºC and 42ºC for 3 hr followed by 3 hr recovery) on the heat shock protein expression of *B. mori* cross breed (multivoltine PM x CSR2 bivoltine). SDS-PAGE analysis revealed the expression of eight protein polypeptides (119 kDa, 90 kDa, 67 kDa, 49 kDa, 43 kDa, 39 kDa, 27 kDa, and 25 kDa) in hemolymph in the IVth instar. When compared between IVth and Vth instars, down-regulation of protein profiles of Vth instar larvae in response to elevated heat shock conditions was seen. However, the eight identified proteins in hemolymph showed no change in expression with respect to heat stress. In the Vth instar, the expression of 90kDa protein was down-regulated but very pronounced in the IVth instar hemolymph of the silkworm. Heat shock at different temperatures also induced expression of proteins in the fat body, with molecular mass of 90 kDa, 73 kDa, 65 kDa, 44 kDa, 37 kDa, 22 kDa, and 18 kDa were observed in IVth instar in *B. mori* cross breed PM x CSR2. The increase in resistance to heat shock was directly proportional to the increase in larval development, which was achieved by the induction of HSP 72 in the haemolymph of Vth instar larvae.

Some strains are acclimatized to the higher temperatures as is the case with the indigenous Nistari breed of the silkworm. This multivoltine breed shows late-stage larvae exhibiting more tolerance than adult moths and eggs. The temperature of 43ºC was lethal to eggs, larvae, and adults. However, the temperature of 33ºC was tolerated well. When given, heat stress (17ºC, 33ºC, and 43ºC for 3 consecutive days with a 1-hour duration) affects the HSPs in hemolymph, with the kinetics of 72kDa being different in IVth and Vth instars. There is an increased appearance of 95kDa protein in Vth instar consequent to heat shock, as was revealed by SDS-PAGE). Heat shock proteins provide it enough thermotolerance to survive the high ambient temperature of its surroundings (Sinha et al. 2013). Sinha et al. (2013) also studied the persistence of 72KDa in hemolymph in IVth instar of Nistari after exposure to 43ºC and its absence in hemolymph after 17ºC and 33ºC temperature treatment. This indicated the role of HSP 72 in facilitating breed Nistari silkworm larvae with thermotolerance against heat shock. Vth instar larval hemolymph, however, expressed 72kDa protein constitutively. When given heat shock, its expression increased, thus proving the different behavior of silkworm larvae in terms of HSP expression in different stages. This also explains the phenomenon of higher temperature tolerance in late-age *B. mori*. Exposure of bivoltine silkworm (strain p50) eggs to 40ºC for 4 hours increased levels of 70kDa and 27kDa and increased tolerance to heat shock in larval stages. Exposure to 48ºC proved to be lethal. However, exposure to 10ºC lowered heat tolerance and did not affect 70kDa and 27kDa protein levels. Increased hardening of eggs at mild temperatures increased heat tolerance in subsequent larval stages. The importance of 70kDa and 27kDa in the thermotolerance of silkworm eggs (strain p50) was revealed (Matsuoka et al. 2018). In another study, the effect of mild heat shock treatment of silkworm strains (CSR2 and CSR4) at 30ºC for 1 hour at blastokinesis stage proved beneficial for hatching, (97%). Heat shock treatment above 45ºC was lethal, reducing the hatching percentage to below 50%. SDS-PAGE revealed overexpression of 30kDa in a 3-day embryo at 30ºC heat shock. Some protein synthesis got inhibited at and above 45ºC (84kDa, 49kDa, 22kDa, and 21kDa) in the 4-day-old embryo. Late embryonic stages are thermotolerant than early embryonic staged up to blastokinesis (Manjunatha et al. 2007). Heat stress (27ºC or 35ºC for 18 h,) has also been found to have negative effects on the important metabolic pathways of bivoltine silkworm (strain 932 and HY) like glucose metabolism, lipid metabolism, and oxidative phosphorylation and during early continuous heat stress, several heat shock proteins (HSPs) are upregulated viz. HSP19.9, HSP23.7, HSP40-3, HSP70, HSP90 and HSP70 (Li et al. 2014). *B. mori* heat shock proteins, Bmhsp 19.9 got overexpressed in bmE cell line of *B. mori* upon challenged with BmNPV (*B. mori* nuclear polyhydrosis virus) and high temperature thereby protecting bmE cells against BmNPV infection (Jiang et al. 2021). Sosalegowda et al. (2010) analysed and identified heat shock proteins in 70 tropical bivoltine and polyvoltine strains of silkworm and found the expression of 90kDa HSP in the Ist, IInd and IIIrd instars and the expression of 84kDa HSP in IVth instars. However, other HSPs like 90kDa, 84 kDa, 62 kDa, 60 kDa, 52 kDa, and 33 kDa HSP were predominantly found in Vth instars. Literature is rife with the upfront role of heat shock proteins in thermotolerance, but another class of heat shock proteins, namely small heat shock proteins (sHSP) have also been found to play their part in thermotolerances of *B. mori*. *B. mori* has the greatest number of insect small heat shock proteins (sHSP) characterized among class insects. 16 sHSP genes have been identified by the genome-wide analysis, which is the most among insects (Li et al. 2009). In p50 strain of silkworm, cDNAs encoding sHSPs viz. sHsp19.9, sHsp20.1, sHsp20.4, sHsp20.8, sHsp21.4, sHsp23.7 and sHSP 21.4 were isolated. A substantial increase in the transcript level of sHSPs was seen after a heat shock, except for sHSP 21.4. The study revealed the role of small heat shock proteins (sHSP) in heat shock. Also, it gave an idea about the groups of heat shock proteins operation in *B. mori* body (p50 strain). It was inferred that possibly two classes of small heat shock proteins are involved in giving heat shock resistance to silkworm, one being sHSP 21.4 and the other the larger group including the mentioned sHSPs (sHSPs viz. sHsp19.9, sHsp20.1, sHsp20.4, sHsp20.8, sHsp21.4, sHsp23.7) (Sakano et al. 2006). Downregulation of HSP 70 and upregulation of small heat shock proteins (sHSP) viz sHSP 19.9 and sHSP 20.4 was seen in Nistari and jingsong strain under temperature stress of 41ºC and 45ºC for 1 to 2 hours (Li et al. 2012). In another study, the expressions of HSP70-1, HSP70-2, and HSP70-3 were upregulated in response to thermal (37ºC and 42ºC) and cold (2ºC) stressors. (Fang et al. 2021). Table1 summarises the different proteins (heat shock proteins) involved in thermotolerance in different tissues and different life stages of different silkworm, *B. mori* strains. The involvement of heat shock proteins in thermotolerance is a phenomenon found in most organisms. Table 2 briefly summarizes the different heat shock proteins involved in temperature tolerance in organisms other than.

Table 1. Different heat shock proteins involved in thermotolerance of different silkworm breeds of *Bombyx mori* and their location/stage of life cycle.

***Bombyx mori* (breed/strain)**	**Heat shock proteins(HSP) involved in thermotolerance**	**Organ of body of stage of life cycle**
C. Nichi, Pure Mysore, NB4D2	93kDA, 70 kDA	Fat body, Cuticle and hemolymph.
PMxCSR2	119 kDA, 72 kDA,90 kDA, 67 kDA, 49 kDA, 43 kDA, 39 kDA, 27 kDA, 25 kDA	Hemolymph
PMxCSR2	73 kDA, 65 kDA, 44 kDA, 37 kDA, 22 kDA, 18 kDA.	Fat body
Nistari	72 kDA, 95 kDA	Hemolymph
P50	70 kDA, 27 kDA,	Egg
CSR2	30 kDA, 84 kDA,	Embryo
CSR4	49 kDA, 22 kDA, 21 kDA	Embryo
	Small Heat Shock Proteins (sHSP)	
***Bombyx mori* (breed/strain)**	**Heat shock proteins(HSP) involved in thermotolerance**	**Organ of body of stage of life cycle**
932 and HY	19.9 kDA. 23.7 kDA,	Midgut
Qiufeng x Baiyu, Qiufeng and Baiyu.	20.4 kDA, 20.8 kDA, alpha crystalin	Posterior silk gland
Jingsong and Nistari	19.9 kDA and 20.4 kDA	Fat body, testis and ovary

Table 2. Involvement of different heat shock proteins (HSPs) for heat tolerance in different organisms.

Organism	**Heat shock protein (HSP)**	**Role played in the organism**	**Reference**
Drosophila subobscura	HSP 70	Thermotolerance	Calabria et al. 2012
Drosophila melanogaster	HSP 70, HSP 22	Thermotolerance	Shilova et al. 2020
Brachionus manjavacas	HSP40, *HSP60, HSP70,*	Thermotolerance and survival after heat shock	Smith et al. 2012
Livestock	HSP70, HSP90 and HSP27 a	Protective role during heat stress	Archana et al. 2017
Leishmania donovani	23 kDA HSP	Prevention from heat stress	Hombach et al. 2014
Tharparkar cattle	HSP 70	Thermotolerance	Bhat et al. 2016
Italian Holstein cows	Hsp70.1	Different cellular stresses	Basiricò et al. 2011
Laodelphax striatellus	LSHSP20.1, LSHSP21.2, LSHSP21.4, and *LSHSP22.0*)	Heat stress tolerance	Wang et al. 2019
amphipods	Hsp 70	Thermotolerance	Shatilina et al. 2011
Domestic Ruminants	HSP60, 70, 90, 110, 27	Thermotolerance	Hyder et al. 2017
Bemisia tabaci	hsp40, hsp70, and hsp90	Temperature stress	Jiang et al. 2017
Frankliniella occidentalis	HSP70s	Thermotolerance	Jing et al. 2018
Colorado potato beetle	Hsp70	Thermotolerance	Chen et al. 2016
Ectomyelois ceratoniae	HSP70 and HSP90	Heat and cold tolerance	Farahani et al. 2020

Genetics of thermotolerance in *B. mori*

Upon a temperature rise, the level of heat shock proteins (HSP) increases automatically in different tissues of the *B. mori*. All this is governed by the foreplay of gene expression in the background. Studies have found that, apart from normal gene expression of HSP genes in response to heat stress, epigenetics also plays a role in thermotolerance in *B. mori* (Knobbed & 7532). A study about comparative analysis of DNA methylation profiles between these two silkworm strains of different heat tolerances via whole genome bisulfite sequencing (WGBS) revealed the involvement of 10 DMG (DMR-related genes) in heat-humidity stress, indicating the role of DNA methylation in response to silkworm to environmental insults (Chen et al. 2020). Transcriptome profiling analysis of the same silkworm strains (KNOBBED and 7532) when done at continuous high-temperature treatment (6h, 24h, 48h) and then compared, a total of 4944 differentially expressed genes (DEGs) were identified. 12 DEGs were found to have their contributions in heat-humidity stress. Four genes, BGIBMGA003739, BGIBMGA005876, BGIBMGA011821, and Novel01749, were differentially expressed between the two strains at all time points (Xiao et al. 2017). In another study, it was found that the expression of HSP90 and HSP70 genes almost always got upregulated during heat stress (45ºC for 35 min) in *B. mori* {(103 x 104 and 107 x 110) & (110 x 107 and 104 x 103)} (Mousavi et al. 2017). Wang et al. 2014 found BmHsp (*B. mori* heat shock protein) 27.4 gene has an important role in high-temperature heat stress in silkworm (variety 7532). BmHsp 27.4 gene was found on chromosome number 5 with an open reading frame (ORF) of 741 bp and expressed in fat bodies, brain and eyes. Moreover, its mRNA expression was found to increase with increasing temperature. Ubiquitous expression of HSP 90 mRNA in almost all tissues, viz. wing disc and dorsal abdominal epidermis during the larval stage, and fat body and ovary during the pupal stage is seen in the *B. mori*. At mild stress (39ºC and 42ºC), the expression of HSP 90 increases with heat stress. However, the expression level was found to change within the different organs under study. When the temperature reaches the severe category or lethal category (45ºC), the expression HSP 90 is stopped indicating the vital role of HSP 90 in the thermotolerance of *B. mori* (Keshan et al. 2014). Heat stress in DZ-37 breed affects genes involved in the immune system, like BmRel and BmSerpin-2, downregulating them and thus making the silkworm prone to infections (Guo et al. 2018).

Climate change and the silk industry

Climate change, which is the result of “Global Warming” or a rise in global temperature, is currently impacting worldwide. The increase in concentrations of greenhouse gases (GHGs) such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (NOx) is primarily responsible for the rise in global atmospheric temperature. The combustion of fossil fuels, fast industrialization, deforestation, agricultural operations, luxury/modernization of living style (home appliances), space explosion, grazing, wetland degradation, and land use change are all linked to increased GHG emissions (Figure 2) (Ram et al. 2016). Global warming has wreaked havoc in 2022 alone, causing forest fires, droughts, flooding, and other natural disasters. Forest fires in Europe have caused chaos on a significant expanse, claimed lives, destroyed property worth millions, and destroyed the habitat of numerous kinds of organisms that had been living there (https://www.theguardian.com/environment/2022/aug/08/the-new-normal-how-europe-is-being-hit-by-a-climate-driven-drought-crisis). Wildfires in the south of France have destroyed an area equal to 22000 acres (https://www.nytimes.com/2022/07/16/world/europe/uk-europe-heat-wave.html). A record-breaking heat wave that affected much of Europe started the wildfires. Throughout just 2022, 1.27 million acres of land burnt in Europe. (https://www.theguardian.com/environment/ng-interactive/2022/jul/26/how-europe-has-been-hit-by-record-fire-damage-and-temperatures). A record heat wave with temperatures reaching 50 C occurred in India and Pakistan due to climate change in south-east Asia. This unusually sweltering heat wave, made 30 times more likely by global warming, was a direct outcome of climate change and impacted crops like maize and farmers’ output. (https://www.theguardian.com/environment/2022/may/23/deadly-indian-heatwave-made-30-times-more-likely-by-climate-crisis). An unprecedented record monsoon downpour in Pakistan produced massive flooding that submerged 1/3 of the country, killed many people, destroyed vast amounts of property, and damaged critical infrastructure, bringing agony to the people there. (https://www.theguardian.com/commentisfree/2022/aug/29/the-guardian-view-on-climate-chaos-in-pakistan-adapt-to-survive). The root cause of all these catastrophic events in one, climate change.

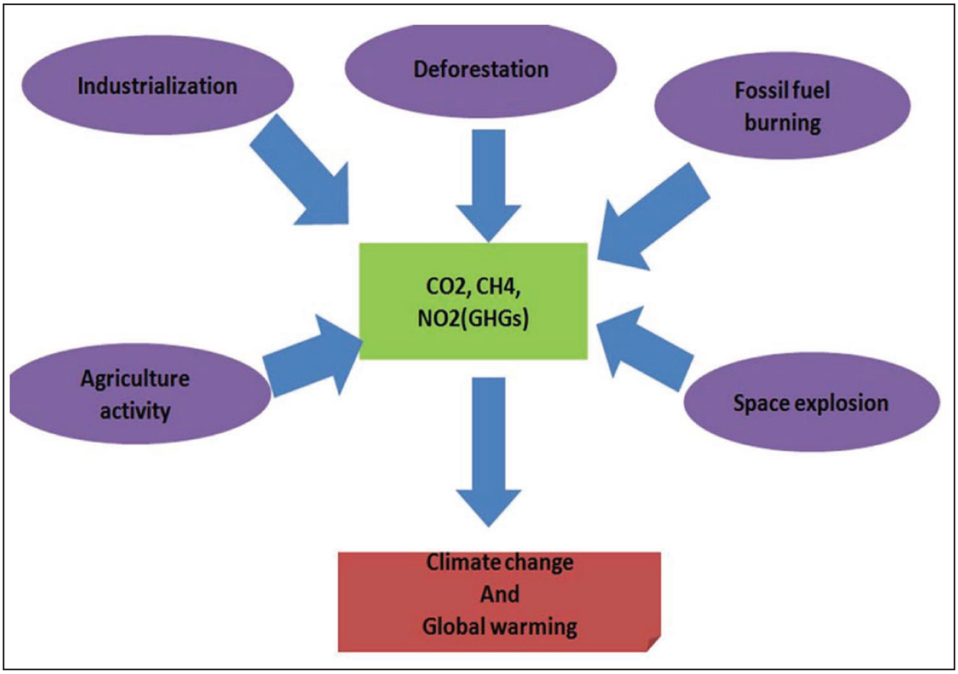

Figure 2. Activities leading to increase in greenhouse gasses (GHGs) viz., CO_2, CH_4, NO_2 which in-turn lead to climate change and global warming.

Because life on Earth is inextricably linked to the climate, every change in it impacts all forms of life. Climate change is the key predictor of agricultural productivity, which directly impacts global food production (Malini et al. 2018). The maximum temperature in India has risen during the previous century, with varying degrees of growth in different parts of the country. The maximum temperature on India's west coast increased by about 1.2ºC, in the northeast by about 1ºC, in the Western Himalayas by about 0.9ºC, in the north central by about 0.8ºC, in the northwest by about 0.6C, and on the east coast by about 0.6ºC (Dash et al. 2007). Using different climate models, scientists have predicted a temperature increase of 4.0ºC to 5.8ºC in the next few decades (Chauhan et al. 2014). IPCC (Intergovernmental panel on climate change) reported global warming of 1.4^{o}C to 5.6^{o}C by 2100 (Sathaye et al. 2006). With the rapid and threatening pace of climate change and warming, some scientists believe that keeping the global rise in temperature below 2ºC seems complicated (Peters et al. 2013). A surge in 2ºC and its effects could be unpleasant, but some studies estimate that at the end of the 21st century, a global rise of 4^{o}C is also possible, which could be simply disastrous (Betts et al. 2011). A consensus between different studies implies a global rise in temperatures greater than 2ºC before the start of the next century.

Although climate change harms all life, here we will focus on insects in general and *B. mori* in particular. Insects and the ecosystems they depend on are at risk due to climate change, whether they are terrestrial (Burrows et al. 2011), freshwater (Woodward et al. 2010), or subterranean (Mammola et al. 2019). When we consider the overall picture of insect extinctions, we lose a lot more than simply species. Insect diversity, abundance, and biomass are lost over large networks of biotic interactions, as well as significant chunks of the tree of life, unique ecological features, and ecological functions. As a result of these losses, essential ecosystem functions on which civilization depends are deteriorating

(Cardoso et al. 2020). Because insects rely on environmental temperature to regulate their physiological functions, continuous exposure to maximum temperatures makes it extremely difficult for them to survive. As a result, an atmosphere with a rising temperature due to global warming will be unsuitable for insect life (González Tokman et al. 2020). Many species' distributions and abundances are expected to shift due to climate change, affecting other species in the newly exposed region (Mclaughlin et al. 2002). With global warming, significant changes in insect diversity, regional distribution of insect pests, and insect population dynamics are projected (Sharma et al. 2014) (Karuppaiah et al. 2012). Increased temperature, changing precipitation patterns, and rising CO2 levels impact insects, greatly expanding their range and causing epizootics (Raza et al. 2015). Geographic range losses caused by climate change resulting in a 3.2ºC increase in temperature may result in a loss of more than 50% of the geographic range of 49 percent of insects (Warren et al. 2018).

Based on predictions from various scientists, an increase of 0.5ºC to 4ºC is expected in various parts of India. Silkworm, *B. mori* being a poikilothermic insect and being so sensitive to the ambient temperature for its growth and development, is directly affected by environmental factors especially, temperature. Sericulture in India is practiced mainly in tropical belts such as Karnataka, Andhra Pradesh, Tamil Naidu, and West Bengal, and bivoltine sericulture practiced in the temperate belt like Jammu and Kashmir and Uttrakhand, will then get a hit due to climate change and rise in temperature, thus incurring a huge loss on the economic sector related to sericulture of those areas (Ram et al. 2016). Silkworm *B. mori* of multivoltine breed cultivated in the tropics are naturally more thermotolerant than bivoltines. A permanent rise in temperature of a few degrees, however, will be outside of their tolerance range as heat shock proteins which normally come into play as the worm encounters heat shock, can't however work if the temperature is above the tolerance range for a more extended period. Effects of increased temperature on silkworm biology as well as yield can be incurred. A decrease in the yield of cocoon crops and sometimes failure of a crop due to disease has been noticed in *B. mori* due to global warming and abnormal rainfall patterns (Sharma et al. 2020). A temperature rise shortens the immature development of *B. mori* (M2P2 variety) (Islam, 2018). Larval mortality in silkworm breed (CSR2 x CSR4) increased with an increase in temperature, and the best growth was at 22ºC to 24ºC with a relative humidity of 80-85% (Verma et al. 2011). It is clear from the literature that *B. mori* gets negatively affected by a rise in temperature. Based on this and research about silkworm thermotolerance, we predict that a harsh impact on silkworm biology and crop production from sericulture will be felt due to temperature rise by global warming in the coming decades.

An increase in temperature can also have a disastrous effect on non-mulberry sericulture, like the muga silk industry and muga silkworm *Antheraea assamensis*. Annually giving six crops out of which two are commercial, muga silk farming needs optimum temperature for productivity. An increase in temperature or change in humidity status can be detrimental to this industry. A study conducted provides evidence that is in line with the fears mentioned above. In the survey, cocoon yield, moth emergence, hatching percentage m fecundity, and cocoon yield were studied, and it was observed that in the year 2008, cocoon yield was 45/dfl as compared to 76/dfl in 1995. Also, moth emergence was highest in 1995 compared to 2000, which experienced the highest temperature variation. On total fecundity, hatching percentage, moth emergence, and cocoon yield were decreased compared to previous years, all of this due to a rise in slight temperature (Zamal et al. 2010).

Biomarkers for thermotolerance in *B. mori* and their prospect concerning global warming

ISSR & SSR MARKERS: Some silkworm races are tested for their tolerance to thermal stress using quantitative traits, while the heat shock response in *B. mori* has previously been examined through the induction of heat shock proteins. Kumar et al. (2001) and Koundinya et al. 2003 reported that any *B. mori* race or breed showing a pupation rate above 80% at 36ºC might be considered as thermo-tolerant. Nowadays, new molecular techniques like the use of PCR-based DNA markers are used to screen *B. mori* for thermotolerance. Using molecular markers like ISSR (Inter Simple Sequence Repeats) for identification of thermotolerant silkworm breeds during breeding programs provides a viable option for screening thermotolerant varieties, as demonstrated in an experiment in which 15 silkworm races were tested for thermotolerance and pupation rates. In a lab setting, the thermal stress of 36ºC for six h a day daily until spinning was given and was used as an indicator of thermotolerance. Six breeds (A4e (86%), MH-MP(Y) (84.5%), CB5 (84%), race O (83%), race B (82%), and Kolar Gold (81%) were selected as thermotolerant on the basis of pupation rate (=81%). Subsequent DNA extraction and PCR- ISSR analysis on all 15 races revealed that a total of five bands showing a correlation with pupation rate after thermal stress and was in line with the above thermotolerant races detected from pupation rates. With the backing of strong statistical analysis of the data generated, it was confirmed that these 5 ISSR markers could be used as markers for thermotolerance and thus can help in breeding programs for the development of thermotolerant breeds (Shrivastava et al. 2007).

Chandrakanth et al. (2015) used marker-assisted selection and identified SSR (Simple Sequence Repeats) sequences to screen thermotolerant breeds. With the help of bulk segregation analysis (BSA), which reduces many markers to a few specific and highly linked to the trait, researchers identified and narrowed down target marker SO816, which can be used for screening during the breeding process for selection of thermotolerant bivoltine breeds. In another study, under lab setting on Vth instar larvae, two microsatellite primer pairs viz., S0803 and S0816 were reported to be linked to thermotolerance in silkworm and were used to screen thermotolerant breeds. Thermotolerant and thermos-susceptible breeds were successfully screened via amplification of these two molecular markers. The study concluded that silkworm breeds like B.Con-1, B.Con-4, SK6, and SK7 are tolerant to high temperatures (Chandrakanth et al. 2018). Thus, taking advantage of these techniques, we can identify thermotolerant silkworm breeds and use them as parents during breeding programs to develop new thermotolerant breeds that are expected to be more thermotolerant than their parents as was shown by Kumar et al. (2001).

ESTERASES AND CATALASE: Esterases are found in the whole of living organisms ubiquitously and play a slew of roles in plants, animals, and microorganisms. In insects, it has a significant role in defense. The part of esterase has been found in toxic detoxifying materials in various breeds like Nistari*,* Kollegal Jawan, and Hosa Mysore. Thus, it can be used as a biomarker for determining genetic hardiness in response to toxic materials (Priya & Somasundaram, 2019). The role of esterase in the thermotolerance of silkworm has been studied. Two *B. mori* breeds Hoya mysori and Ap12 have been studied for the role of esterases in providing hardiness to these breeds (Vishnupriya & Somasundaram, 2012). The presence of esterases in haemolymph of *B. mori* has also been detected and their role in thermotolerance of both multivoltine and bivoltine races studied. An experiment conducted in lab setting showed the tolerance of esterase from silkworm to temperatures of 70ºC for 10 minutes, therefore, indicating their possible role in the thermotolerance of *B. mori* (Patnik et al. 2012). Genomic organization of blood esterase gene of silkworm races (pure Mysore, PMX, NB4D2, and CSR 19) indicated the presence of two exons of 192 bp and 524 bp and a long intron of 2124 bp (Ponnuvel et al. 2008). When exposed to five different temperature regimes viz. 25 ± 1ºC, 32 ± 1ºC, 34 ± 1ºC, 36 ± 1ºC and 38 ± 1ºC for 6h per day, breeds Nistari and Cambodge, D6(P) and SK4, D6(P)N and SK4C (near isogenic lines) and identification of heat stable esterase done by incubating the electrophoresed acrylamide gel containing haemolymph to 60ºC for 15 minutes. The experiment was successful in identifying five different isoforms of alpha esterase. Esterase 2 and esterase 3 as heat stable (Moorthy et al. 2016). In selected tropical silkworm breeds (CB5 and its syngenial lines CB5Lme-1, CB5Lm-2, and CB5Lm-5), esterase isozyme polymorphism has been found in esterases in haemolymph and digestive juice (Chattopadhyay et al. 2001). Two heat-stable esterases were found in both multivoltine and bivoltine selected breeds and their near-isogenic lines (Moorthy et al. 2016). Apart from these biomarkers, catalase biomarker has also been found to have a positive correlation with thermotolerance of silkworm breeds JROP, KA, and NB4D2 breeds (Nabizadeh et al. 2011).

The use of these biomarkers, whether enzymatic or molecular, will prove handy during the screening of thermotolerant varieties of *B. mori*. These screening methods if done on a large scale and supported by strong government policies can serve as a prelude for the distribution of more thermotolerant varieties to farmers. This will, in turn, make the silk industry well prepared for the coming global warming effects, i.e., rise of a few degrees in temperature. Although global warming and a permanent rise in temperature will be harmful for the silk industry, steps taken now to prepare and counter the expected should be encouraged.

Global warming effects on other organisms

By extending the geographic range of currently harmful species and selecting for adaptive thermotolerance in species with high pathogenic potential that are currently non-pathogenic due to mammalian temperatures, global warming will cause novel fungal infections in mammals (Garcia-Solache et al. 2010). Increased temperatures will have an impact on interactions between heterotrophs and autotrophs (such as pollination and seed dispersal) as well as between heterotrophs (such as predators-prey, parasites/pathogens-hosts). These interactions will generally have a negative impact on essential ecosystem services (tasks that directly benefit human society, like pollination), and there is a possibility that species co-extinction rates will increase (Traill et al. 2010). Although it is frequently noted that temperature tolerance phenotypic plasticity (thermal acclimation) is a crucial aspect of acute and evolutionary adaptation to temperatures in insects, in some insect species, such as Drosophila, the plasticity of upper thermal limits is small in magnitude, evolves slowly, and acclimation ability is weakly correlated with latitude and environmental heterogeneity. As a result, upper thermal limit plasticity is unlikely to adequately buffer the consequences of global warming for species that are already close to their upper thermal limits (Sørensen et al. 2016). Climate change is also shifting the gene arrangement frequencies in *Drosophila subobscura*. In Europe and South and North America, but it remains unclear why (Rezende et al. 2010).

Mass deaths of Mediterranean benthic marine invertebrates were recorded in places with positive temperature trends with cnidarians and sponges being most affected. Western Mediterranean mass deaths are most common. The two most dramatic episodes (1,000 km of coastline and 30 macro-benthic species, including sponges, cnidarians, bivalves, ascidians, and bryozoans) occurred in the north-western Mediterranean coasts in 1999 and 2003. These two episodes coincided with 3-4ºC above-average temperatures and late summer water column stability (Rivetti et al. 2014). Both rising ocean temperatures and greater CO_2 levels appear to be harmful to coral reef fish. Despite variances in heat sensitivity among species, the majority of species studied so far appear to dwell near their thermal optimum. Even slight increases in average temperature reduce aerobic scope, causing growth, reproductive output, swimming ability, and, in certain circumstances, survival to suffer (Munday et al. 2012). In aquatic environments, phytoplankton is the primary source of energy and omega-3 (n-3) long-chain essential fatty acids (EFA). Their growth and biochemical makeup are influenced by their surroundings, particularly temperature, which continues to rise as a result of climate change. The temperature was found to be closely linked to a decrease in n-3 long-chain polyunsaturated fatty acids (LC-PUFA) and an increase in omega-6 and saturated fatty acids. As a result of reduced production of these EFA as a result of climate change, animals that rely on these chemicals for optimal physiological function are expected to suffer (Hixson et al. 2016).

In recent decades, animal populations have experienced significant decreases. These decreases have happened in the context of rapid, human-caused environmental change, such as climate change. We discovered that losses in avian and mammalian population abundance are greater in locations where the mean temperature has grown more rapidly and that this effect is more pronounced for birds (Spooner et al. 2018).

Conclusion

Bivoltine *B. mori* generates higher-quality silk but are more susceptible to severe temperatures than multivoltine *B. mori*, which produce lower-quality silk. Changes in thermotolerance are caused by differences in the expression of heat shock genes and proteins in bivoltine and multivoltine *B. mori*. *B. mori* responds to heat shock by boosting the expression of heat shock proteins. Different organs express different heat shock proteins differently and of different types. Heat shock proteins protect the body of silkworm from the insults of heat shock but only up to a certain limit above which their protective effect fails. A rise in temperature above the optimal growing temperature of silkworm affects the life cycle as well as the economic characters of *B. mori*. Owing to the global increase in temperature of ~1.5ºC to = 2ºC in the coming decades and up to 5ºC at the start of the next century, may wreak havoc on the silk industry generally practiced by marginalized and economically weaker sections of society. The negative consequences will be much more pronounced in bivoltine *B. mori*, as they are exclusively adapted to a temperate climate and even a small increase in temperature can be harmful. Therefore, the future challenge of global warming warrants measures to increase the thermotolerance of *B. mori*. Some bivoltine worms are more thermotolerant than their other counterparts, increased commercialized culture of these worms on large scale and more inter-breeding between the thermotolerant breeds should be preferred. Taking advantage of molecular markers like ISSR and SSR markers and enzymatic markers like esterases and catalases, thermotolerant varieties should be screened and bred. Research should also focus on searching for new molecular markers in the silkworm genome associated with thermotolerance, which may help in the easy screening of thermotolerant breeds. These suggested methods might come in handy when devising the policies of silkworm breeding and advising farmers which in turn can thwart the potential ill effects of a rise in temperature due to global warming. Although with global warming, *B. mori* will not be the only organism that will get affected. Other organisms will also get affected, mostly in a negative way. However, here in this article, we focused mainly on the *B. mori* in this regard. Therefore, the predictions on harmful effects of temperature rise on *B. mori* should not be generalized to other organisms.

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REVISIÓN DE PUBLICACIONES
BOOK REVIEWS

H. Chiba, G. C. Bozano & X. L. Fan
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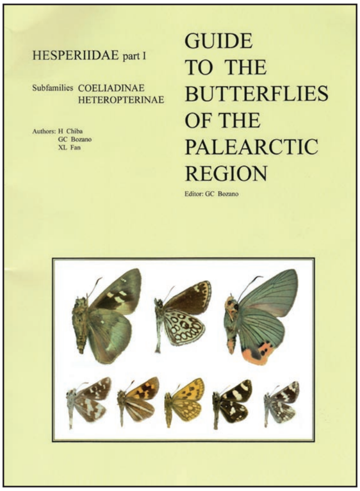

Tenemos en nuestras manos, una nueva entrega de esta interesante serie conocida como *Guide to the Butterflies of the Palearctic Region*, concretamente se trata de la primera parte de los Hesperiidae Latreille, 1809, estudiándose las subfamilias Coeliadinae Evans, [1937] y Heteropteronae Aurivillius, [1925] y, dentro de ellas, los géneros *Burara* Swinhoe, 1893, *Choaspes* Moore, 1881, *Hasora* Moore, 1881 y *Pyrrhiades* Londsey & Miller, 1965, en la primera y *Heteropterus* Duméril, 1806, *Leptralina* Mabille, 1904, *Pilchroptera* Hou, Fan & Chiba, 2021 y *Carterocephalus* Lederer, 1852, en la segunda.

En esta entrega se tratan 30 especies y se describe una nueva especie Carterocephalus trifasciatus Della Buena & Bozano, 2023, procedente de China.

De todas y cada una de las especies, nos presentan la descripción original, así como de todas las sinonimias consideradas, al igual que ocurre con las subespecies que los autores consideran como válidas en este trabajo. También nos encontramos con las principales características que nos permiten diagnosticarlas, datos sobre la morfología de la genitalia del macho, interesantes notas taxonómicas, datos sobre su distribución (que podemos ver en un mapa de la región Paleártica) y las principales referencias bibliográficas consideradas.

Es importante destacar, que se presentan excelentes fotografias de los ejemplares, no sólo de la especie original, si no de un gran número de subespecies consideradas.

Termina la obra con una detallada bibliografia específica, que recoge todas las referencias contempladas a lo largo del trabajo y que consideramos imprescindibles en su conjunto.

No podemos terminar estas líneas, sobre este excelente trabajo y, de la que ya podemos considerar como una serie clásica, sin felicitar a los autores por la realización de tan importante trabajo, así como a la Editorial una vez más, por su dedicación en publicar esta obra básica, que no debe de faltar en ninguna biblioteca que se precie, tanto institucional como particular.

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DNA barcoding relationships and habitat description of *Psorosa ferrugatella* Turati, 1924 in Spain (Lepidoptera: Pyralidae, Phycitinae)

Manuel Garre, John Girdley, Rosa M. Rubio, Juan J. Guerrero & Antonio S. Ortiz

Abstract

First DNA barcode sequences of *Psorosa ferrugatella* Turati, 1924 from the Iberian Peninsula is published and compared with other European *Psorosa* and closely related species. Three different habitats where *P. ferrugatella* inhabits are described.

Keywords: Lepidoptera, Pyralidae, Phycitinae, *Psorosa ferrugatella,* taxonomy, occurrence, cytochrome oxidase, mitocondrial DNA, habitat, Murcia, Spain.

ADN Código de barras genético y descripción de los hábitats de *Psorosa ferrugatella* Turati, 1924 en España (Lepidoptera: Pyralidae, Phycitinae)

Resumen

Se publica las primeras secuencias del código de barras genético (barcode) de *Psorosa ferrugatella* Turati, 1924 de la península ibérica comparándolo con otras especies europeas de *Psorosa* y especies sistemáticamente relacionadas. Se describen tres hábitats diferentes donde *P. ferrugatella* ha sido observada.

Palabras clave: Lepidoptera, Pyralidae, Phycitinae, *Psorosa ferrugatella,* taxonomía, presencia, citocromo oxidasa, ADN mitocondrial, hábitat, Murcia, España.

Introduction

The genus *Psorosa* Zeller, 1846 belongs to the tribe Phycitini of the subfamily Phycitinae in the family Pyralidae. The world fauna of this genus includes 24 species (Slamka, 2019). Seven of them were reported for Europe (Leraut, 2014; Slamka, 2019). *Psorosa* species are distributed mostly in southern areas of the European region except *P. nucleolella* (Möschler, 1866) known from Central Europe. In the Iberian Peninsula, the genus was represented by two species: *P. dahliella* (Treitschke, 1832) and *P. mediterranella* Amsel, 1953 until Corley (2019) added one specimen of *Psorosa ferrugatella* (Turati, 1924) from Portugal to the first record of a specimen captured in Granada on 14-VI-1914 and deposited in the Museum of Natural History in Vienna (Slamka, 2019), thus confirming its presence in the Iberian Peninsula. Recently, Girdley et al. (2020) recorded a preliminary data of *P. dahliella* and *P. ferrugatella* flying simpatrically in Murcia (Southeastern Iberian Peninsula) which were later updated in Garre et al. (2022). Even more recently, Ranki et al. (2022) have found *P. ferrugatella* in the Trebujena Marshes (Cádiz).

The biology of almost all species of the genus is poorly known with preimaginal stages and hostplants unknown and inhabiting in open arid habitats and various types of steppes. Different *Psorosa* species can be very similar in appearance, so that genitalia examination is often necessary for determination.

In this article, we provide the first DNA barcoding of *Psorosa ferrugatella* collected in the wetlands of the Humedal del Ajauque and Rambla Salada (Murcia, Spain) and these mtDNA sequence (COI) were used to assess genetic divergence with *Psorosa* species and other systematically related species from Europe. Additionally, the habitats where *Psorosa* species live are characterised.

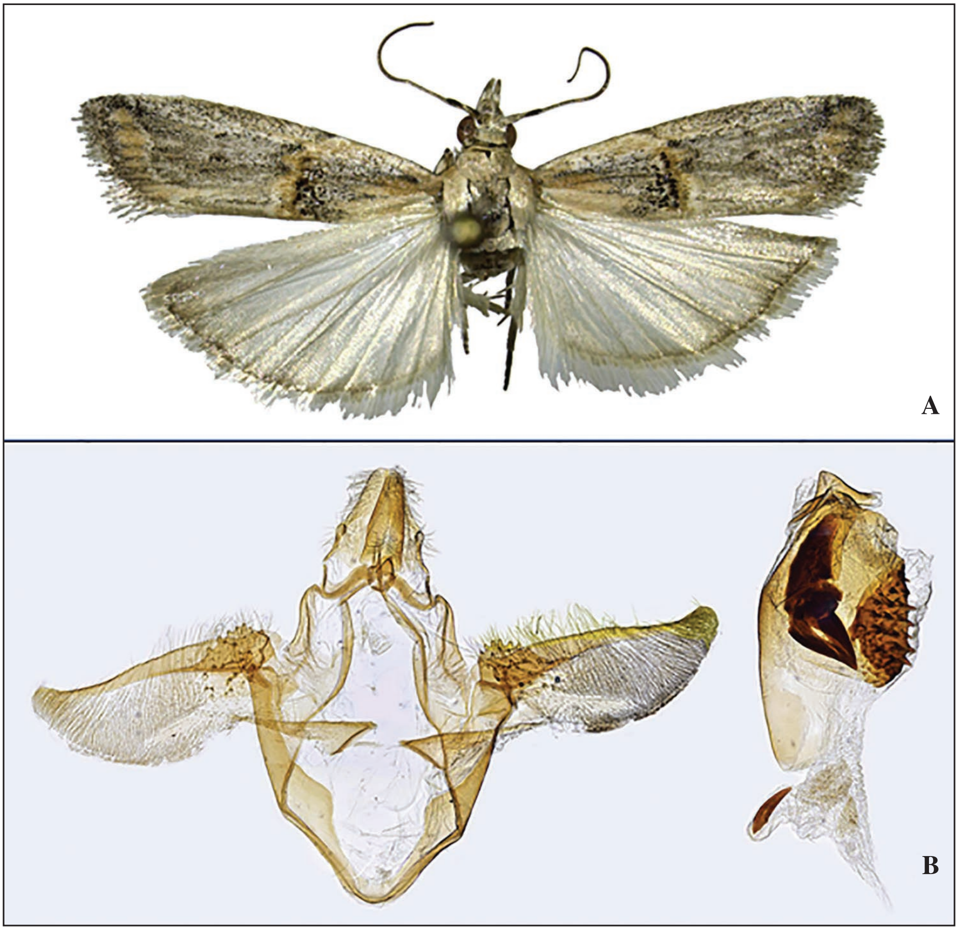

Figure 1. A. Adult of *Psorosa ferrugatella*, Rambla Salada, Murcia, 14-IV-2017, leg. M. Garre. Photographed by J. J. Guerrero. **B.** Male genitalia of *Psorosa ferrugatella* from the Playa de la Llana, 29-V-2017, leg. J. Girdley. Photographed by Peter Hall.

Materials and methods

Specimens examined: SPAIN. Murcia, Fortuna, Humedal del Ajauque y Rambla Salada, 30SXH62, 150 m, (38.176; -1.101), 17-IV-2017, 1 ♂; 9-VI-2017, 2 ♂♂, 1 ♀; 28-VI-2017, 1 ♂, 1 ♀;

29-IV-2018, 1 ♂; 18-V-2018, 2 ♂♂; 12-VI-2018, 1 ♀; 3-IV-2019, 1 ♂; 1-V-2019, 1 ♂; 9-V-2021, 2 ♂♂, 1 ♀, M. Garre leg.; San Pedro del Pinatar, Playa de La Llana, 30SXG98, 0 m, (37.807; -0.756), 29-V-2017, 1 ♂, J. Girdley leg.; Murcia, Huerta de Alquerías, 30SXH70, 30 m, (38.006; -1.032), 21-IV-2021, 1 ♂, M. Garre leg.

Morphological study

All specimens were examined externally to evaluate possible differences in their colouration and wing shape. Furthermore, they were dissected using standard procedures (Hausmann, 2001) with minor modifications. Male adult image (Figure 1A) was taken with a Nikon D70 digital camera and were z-stacked using Zerene software. Morphology of genital structures (Figure 1B) were studied using a Zeiss Stemi 508 stereomicroscope with a Zeiss Axiocam ICc5 digital camera. All specimens are deposited in the Research Collection of Animal Biology (RCBA-UMU) in the Department of Zoology and Physical Anthropology of the Universidad de Murcia (Spain).

Molecular procedures

Psorosa specimens used for mitochondrial gene cytochrome oxidase subunit 1 (COI) sequencing are reported in Table I. For DNA extraction, two or three legs were removed from the specimens to sequence the 658 base-pair long barcode segment of the mitochondrial COI gene (cytochrome c oxidase 1, 5' terminus). The tissue samples were submitted to the Canadian Centre for DNA Barcoding (CCDB, Biodiversity Institute of Ontario, University of Guelph) to obtain DNA barcodes using the high-throughput protocol described in deWaard et al. (2008) which can be accessed at www.dnabarcoding.ca/pa/ge/research/protocols. The DNA extracts are currently stored at the CCDB, and the sequences are deposited in GenBank according to the iBOL data release policy (Table I). Sequences were compared with a reference library of Lepidoptera barcodes using the identification engine (BOLD-ID). The reference barcode database for Pyralidae used by BOLD-ID is continually validated by specialists to ensure accurate identifications and is particularly well parameterised due to a global campaign to barcode more than 2,563 species of the family (Ratnasingham & Hebert, 2007).

Table I. List of DNA barcoded (COI 5') specimens of *Psorosa ferrugatella* (Turati, 1924) used for comparison and tree construction.

	Sample ID	Process ID	BIN	GenBank nr
P. ferrugatella	AOC Lep 01310	IBLAO1318-20	AEF6784	OP270249
P. ferrugatella	AOC Lep 01530	IBLAO1538-20	AEF6784	OP270251
P. ferrugatella	AOC Lep 01531	IBLAO1539-20	AEF6784	OP270250

Voucher data, images, sequences, and trace files are publicly available on the Barcode of Life Data System (BOLD) (Ratnasingham & Hebert, 2007). Sequence divergences for the barcode region were calculated using the Kimura 2-parameter (K2P) model and the degrees of interspecific genetic variation were calculated using the analytical tools of BOLD. All the new and related species sequences were downloaded and aligned with the CLUSTAL algorithm of the MEGA6 program (Tamura et al. 2013). In order to assess the COI divergences between *P. ferrugatella* and the other systematically related species from Europe, we included all sites with the pairwise deletion option (Table I). Our sequences of *P. ferrugatella* (BOLD:AEF6784; n=3 seqs) and the public ones of *P. nucleolella* (BOLD:AAU2037; n=1) and *P. dahliella* (BOLD:ACA9753; n=1) and, closely related species according to (Slamka, 2019): *Alophia combustella* (Herrich-Schäffer, 1852) (BOLD:ADK9057; n=2), *Catastia kistrandella* Opheim, 1963 (BOLD:AAI7381; n=3), *Catastia marginea* ([Denis & Schiffermüller], 1775) (BOLD:AAE9528; n=18), *Rhodophaea formosa* (Haworth, 1811) (BOLD:AAC8900; n=30), and *Selagia spadicella* (Hübner, 1796) (BOLD:AAE1543; n=24) were obtained from BOLD. Neighbour-Joining (NJ) and

Maximum Likelihood (ML) trees were calculated to visualise similarity among selected species. All trees presented the same topology and were practically identical, therefore, only the ML tree is presented here (Figure 2). Due to the fact that one gene is too few for reasonable phylogenetic analysis (Gatesy et al. 2007), the trees presented here do not reliably illustrate evolutionary relationships among the sequenced taxa. For the parameter values considered (e.g., sensitivity to codon bias and unequal rates of evolution) the statistical inconsistency of Maximum parsimony (MP) method may occur and was not performed in this study.

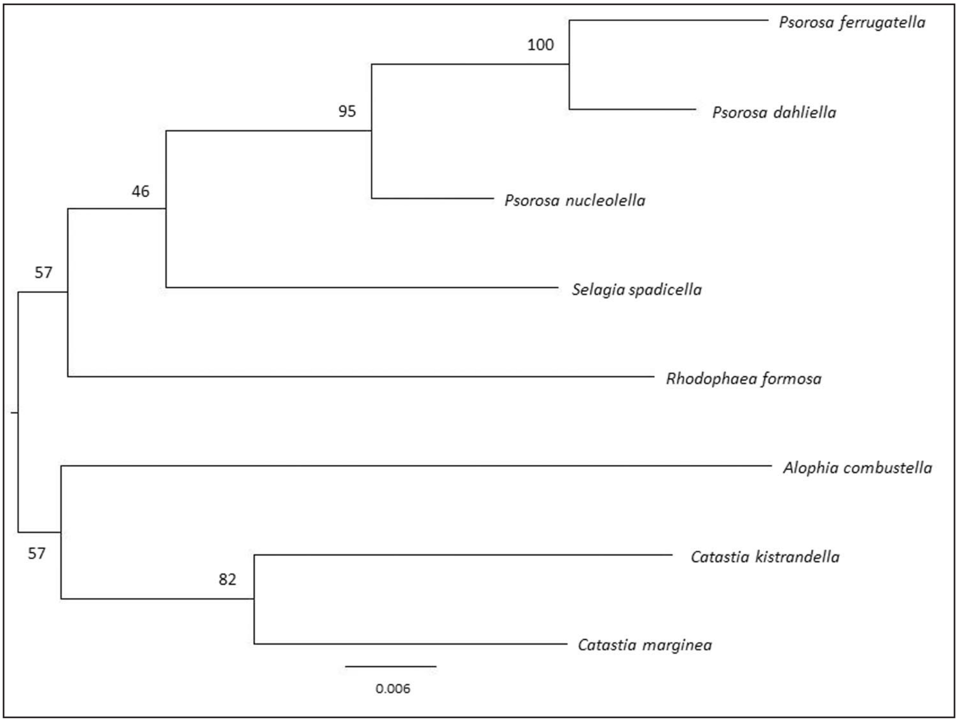

Figure 2. Maximum Likelihood (K2P; constructed with MEGA6; COI 5’ > 600 bp) including 5 sequences of selected *Psorosa* species, rooted and compared with seventy-seven sequences of *Alophia combustella*, *Catastia kistrandella*, *Catastia marginea*, *Rhodophaea formosa* and *Selagia spadicella* as outgroups. The depth of each branch shows divergence between lineages. The scale bar represents 0.006 genetic difference. Bootstrap values > 45% are provided at major nodes.

Results and discussion

The *P. ferrugatella* specimens showed morphological traits typical of European individuals according to diagnosis in Slamka (2019). Previously *P. dahliella* specimens referred in Girdley et al. (2020) were re-identified as *P. ferrugatella* and sequenced to match correct identification. Integrating the evidence from COI mitochondrial DNA sequences and adult morphology, we conclude that the *P. ferrugatella* specimens collected in the wetlands of the protected landscape of Humedal del Ajauque and Rambla Salada (Murcia) are genetically different to those co-generic species previously sequenced from Europe based on mitochondrial data. Molecular data indicates significant divergence between *P. ferrugatella* with 2.1% mean distances to *P. dahliella,* 2.9% to *P. nucleolella* (Table II, Figure 2).

Divergence between *Psorosa* and the other closely related species varies between 4.2% and 8.1% (mean 6.6%; Table II) where the highest interspecific values were found between *P. ferrugatella* and *P. dahliella* with *Alophia combustella* (8.1% and 7.9%, respectively), whereas the lowest one was found between *P. nucleolella* and *Selagia spadicella* (4.2%). Differences among the other genera varies with the highest interspecific values between *Rhodophaea formosa* and *Alophia combustella* (8.2%) and the lowest one between *Catastia marginea* and *Rhodophaea formosa* with *Selagia spadicella* (5.9% and 6.1%, respectively) (Table II, Figure 2). The total number of nucleotide substitutions between species is 106 variable sites. In this sense, it seems that *Psorosa* is more closely related to *Selagia* (mean divergence: 5.3%) and with *Catastia* (mean: 6.3%) and *Rhodophaea* (mean: 6.5%).

Habitat description and biology

P. ferrugatella is a species previously known from across North Africa, with records from Morocco, Algeria, Tunisia, and Libya. The Portuguese specimen was recorded in the Algarve (Southwest of the Iberian Peninsula) at the salt marsh in the estuary of the Guadiana River, while the new specimens were recorded in a salt ravine in the protected landscape Humedal del Ajauque y Rambla Salada, in the La Llana beach in the Regional Park of Salinas y Arenales de San Pedro del Pinatar and in the Huerta de Alquerías in the plain of Murcia (Huerta de Murcia) (In the Southeast of the Iberian Peninsula).

Table II. Interspecific mean K2P (Kimura 2-Parameter) divergences (mean pairwise distances) based on the analysis of COI fragments (>600 bp).

	Catastia kistrandella	***Catastia marginea***	***Psorosa ferugatella***	***Psorosa dahliella***	***Psorosa nucleolella***	***Selagia spadicella***	***Rhodophaea formosa***
Alophia combustella	7.4	7.0	8.1	7.9	7.4	7.6	8.2
Catastia kistrandella		4.7	6.5	6.5	5.6	6.7	7.1
Catastia marginea			7.0	6.7	5.6	5.9	7.1
Psorosa ferugatella				2.1	3.3	5.8	7.1
Psorosa dahliella					2.9	5.9	6.5
Psorosa nucleolella						4.2	6.1
Selagia spadicella							6.1

The landscapes of the riverside plain of the Guadalquivir River, in the furthest point south of the Iberian Peninsula where *P. ferrugatella* was recorded by Ranki et al. (2022), are characterised by the irregular regime of water inputs, which can go from flooding the marshland to turning it into a desert dryland. These circumstances, and the marine influence due to its proximity to the river mouth, produce soils with varied salinity content that characterise the vegetation. This habitat is characterised by a series of hyperhalophilic Mediterranean-Ibero-Atlantic thermomediterranean edaphohygrophilic vegetation (EH20) which forms estuaries, salt marshes and marshes with a mixture of salty and fresh waters which is represented by the communities *Spartinetum maritimae, Puccinellio-Sarcocornietum perennis, Halimiono-Sarcocornietum alpini, Cistancho-Arthrocnemetum macrostachyi, Polygono-Limoniastretum monopetali* and, on the edge of the estuaries, the halonitrophilic community, *Cistancho-Suaedetum verae*. Sometimes, a plantation of *Polygono-Tamaricetum africanae* may appear. The land use bordering the habitat are mainly agricultural fields (Figure 3A) (CMAOT, 2015).

The Humedal del Ajauque y Rambla Salada is an area characterised by semi-desert landscapes around seasonal or sporadic water courses at 150 m above sea-level with halophytic habitats in a semi-arid, thermo-Mediterranean bioclimatic environment, colonised by highly specialised fauna and flora adapted to the extreme conditions imposed by soil moisture and salinity which is represented by the plant association *Frankenio corymbosae-Arthrocnemetum macrostachyi* including the main following plants: *Arthrocnemum macrostachyum* (Moric.) Moris, *Sarcocornia fruticosa* (L.) A. J. Scott, *Frankenia corymbosa* Desf., *Suaeda vera* Forssk. ex J. F. Gmel., *Halimione portulacoides* (L.) Aellen, *Tamarix boveana* Bunge, *Lygeum spartum* L., *Limonium caesium* (Girad) Kuntze, *L. cossonianum* Kuntze, *Inula crithmoides* L. and *Phragmites australis* (Cav.) Trin. ex Steud (Figure 3B).

Figure 3. General images of the different habitats. **A.** Saltmarshes of Adventus near Trebujena, Cádiz, Spain (Photographed by Manuel Pozas). **B.** The beach of La Llana in the Salinas y Arenales de San Pedro del Pinatar Regional Park (Photographed by A. S. Ortiz). **C.** The Humedal del Ajauque y Rambla Salada (Photographed by M. Garre). **D.** Agricultural landscape of Huerta of Alquerías (Photographed by M. Garre).

The beach of La Llana in the Salinas y Arenales de San Pedro del Pinatar Regional Park is integrated in a sand dune system composed of mobile sands (strandline, embryo, and mobile dunes) and consolidated sands (semi-fixed and fixes dunes) and alternating with these dune slacks are formed. This ridge of dunes delimits a salt marsh. The vegetation that colonises sand dunes is adapted to limiting factors such as sand burial, salt spray and xeric conditions, so few plant species can survive in these environments. The specimen was caught on the semi-fixed dunes in the domain of the plant association *Loto cretici-Crucianelletum maritimae*. Chamaephytes such as *Teucrium dunense* Sennen, *Crucianella maritima* L., *Helichrysum stoechas* subsp. *caespitosum* (C. Presl.) DC. and *Ononis natrix* subsp. *ramosissima* (Desf.) Batt. in Batt. & Trab. are the most characteristic species (Figure 3C).

The Huerta of Alquerías is an agricultural territory irrigated by the Segura River through an ancient network of canals. Citrus groves are the main crops and natural vegetation is restricted to the margins of paths, borders of crops, abandoned fields and banks of irrigation canals. Nitrophilous and ruderal species are predominant, besides some hygrophilous plants such as *Tamarix canariensis* Willd., *Cynanchum acutum* L., *Phragmites australis* (Cav.) Trin. ex Steud., *Arundo donax* L. and *Apium nodiflorum* (L.) Lag (Figure 3D).

The characteristics of these habitats suggest that *Psorosa ferrugatella* inhabits habitats that are not conditioned by the prevailing macroclimate, but to edaphic conditions, particularly soil moisture, salinity gradient and soil structure, that determine the selection of several plant communities of a non-climax character.

In relation to the biology of the species, Slamka (2019) states that it flies from March to October in several generations, while in our territory sightings took place from early April to late June. Host plant and early stages are also unknown.

We emphasise again the combination of traditional morphological analysis and ecological traits with the additional dataset of DNA sequences for those taxonomic groups whose identification is particularly difficult due to the small size, handling and that it is mainly based on differences in the genitalia.

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Confirmation of the presence of *Hestina persimilis zella* Butler, 1869 from Union Territory of Jammu and Kashmir, India after 110 years (Lepidoptera: Nymphalidae)

Taslima Sheikh & Muhammad Asghar Hassan

Abstract

Two subspecies of the genus *Hestina* Westwood, 1850 are known to occur in India: *H. persimilis persimilis* (Westwood, [1850]) and *H. persimilis zella* Butler, 1869. Of these, *H. persimilis persimilis*, is widely distributed throughput the Himalayan Mountain range in India, Nepal, and Bhutan. In India, it is recorded from the northwestern (Jammu & Kashmir), eastern (Orrisa) and northeaster parts (Sikkim and Arunachal Pradesh). On the other hand, *H. persimilis zella* is a little-known species that is only reported from the northwestern parts (Jammu & Kashmir and Uttarakhand) of India and northern areas of Pakistan (Khyber Pakhtunkhwa and Islamabad). The present study provides the first confirmation of new locality data in Jammu and Kashmir after its original description, which dates back to 1912.

Keywords: Lepidoptera, Nymphalidae, *Hestina persimilis*, India.

Confirmación de la presencia de *Hestina persimilis zella* Butler, 1869 en el territorio de la Unión de Jammu y Cachemira, India, después de 110 años (Lepidoptera: Nymphalidae)

Resumen

Se conocen dos subespecies del género *Hestina* Westwood, 1850 en la India: *H. persimilis persimilis* (Westwood, [1850]) y *H. persimilis zella* Butler, 1869. De ellas, *H. persimilis persimilis* está ampliamente distribuida por la cordillera del Himalaya en India, Nepal y Bután. En la India, se ha registrado su presencia en el noroeste (Jammu y Cachemira), el este (Orrisa) y el noreste (Sikkim y Arunachal Pradesh). Por otro lado, *H. persimilis zella* es una especie poco conocida de la que sólo se tiene constancia en las zonas noroccidentales (Jammu y Cachemira y Uttarakhand) de India y en las zonas septentrionales de Pakistán (Khyber Pakhtunkhwa e Islamabad). El presente estudio proporciona la primera confirmación de datos de una nueva localidad en Jammu y Cachemira después de su descripción original, que data de 1912.

Palabras clave: Lepidoptera, Nymphalidae, *Hestina persimilis*, India.

Introduction

Se conocen dos subespecies del género *Hestina* Westwood, 1850 en la India: *H. persimilis persimilis* (Westwood, [1850]) y *H. persimilis zella* Butler, 1869. De ellas, *H. persimilis persimilis* está ampliamente distribuida por la cordillera del Himalaya en India, Nepal y Bután. En la India, se ha registrado su presencia en el noroeste (Jammu y Cachemira), el este (Orrisa) y el noreste (Sikkim y Arunachal Pradesh). Por otro lado, *H. persimilis zella* es una especie poco conocida de la que sólo se tiene constancia en las zonas noroccidentales (Jammu y Cachemira y Uttarakhand) de India y en las zonas septentrionales de Pakistán (Khyber Pakhtunkhwa e Islamabad).

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Palabras clave: Lepidoptera, Nymphalidae, *Hestina persimilis*, India.

Introduction

In the Jammu and Kashmir history study of Lepidoptera fauna dates back to the middle of the 19th century when an Austrian entomologist Vincenz Kollar explored it and described many new taxa from this region (Kollar, 1844, 1848). During the British rule on the Indian subcontinent (1857-1947), Holland (1896) and Tytler (1926) deserve special mention in this regard. However, after Independence not much work has been done on this second largest insect order from Jammu and Kashmir. Over the last decade, only some regional researchers and photographers have explored some parts of the Union territory extensively and not only added to the known distributional records (Qureshi et al. 2013a, 2013b, 2014; Sharma & Sharma, 2017a, 2017b, 2018a, 2018b, 2020) but also published many new regional records for the Union Territory or new country records for India (Sharma & Sharma, 2017a, 2017b, 2018a, 2018b; Sheikh & Parey, 2019a, 2019b; Sharma & Sharma, 2020; Gupta & Sheikh, 2021; Sheikh, 2021; Singh & Sheikh, 2021; Parey & Sheikh, 2021; Dar et al. 2022a, 2022b; Sheikh & Mishra, 2022; Khan & Sheikh, 2022; Sheikh & Mishra, 2023). *Hestina persimilis* is legally protected in India under the Schedule II of the Wildlife (Protection) Act, 1972. Recent studies on the Rhopalocera fauna of Jammu and Kashmir and its surrounding states by Kumari & Sheikh (2021), Singh & Sheikh (2021), Sheikh & Gupta (2022), and Sheikh & Mishra (2023) contributed to the rediscovery of a few little-known Nymphalidae, Papilionidae, and Lycaenidae species, including *Stibochiona nicea* (Gray, 1846), *Papilio agestor* Gray, 1831, *Zesius chrysomallus* Hübner, 1819, and *Lycaena panava* (Westwood, 1852).

Two subspecies of *Hestina persimilis* are found in India: *Hestina persimilis persimilis* and *Hestina persimilis zella. Hestina persimilis zella* is rare found along Himalayas with altitude ranging from 750-2100 m, from northeastern parts of Kyber Pakhtunkhwa (Hazara and Manshera) province to Islamabad Capital (Margalla Hills) in Pakistan through Jammu and Kashmir, Himachal Pradesh to Uttarakhand in India. Whereas *Hestina persimilis persimilis* is rarely found in Northeastern Ghats in northeastern Orissa (Meghasani Hills, 1150 m), and also rarely found along Himalayas with altitude ranges from 500-2000 m to Nepal through Sikkim to West Bengal, Bhutan to Arunachal Pradesh and Hills of northeastern India to Brahmaputra (Meghalaya, Nagaland, and Manipur.

In Varshney & Smetacek (2015) catalogue, *Hestina persimilis persimilis* is found in Odhisa; Sikkim to Northeast India and *Hestina persimilis zella* is found from Jammu and Kashmir to Uttarakhand.

In Jammu and Kashmir, its distribution was mentioned as Kashmir by Fruhstorfer (1912), later this was cited by many authors, like Varshney & Smetacek (2015) and Gasse (2018) in India.

Materials and Methods

On 11-IX-2022, the first author during her survey on exploring the butterfly fauna of Salana area of Bani tehsil in Kathua district of Jammu and Kashmir Union Territory where she found *Hestina persimilis zella* (Figures 1-2) mudpuddling on soil and rock. Later on, she again found three more individuals mudpuddling on soil. Later, she took the field photographs of *Hestina persimilis zella* by a Canon Eos 1300 D and recorded the coordinates of the area (32º44'48.8'' N, 74º48'37.4'' E) at an altitude of around 1500 m a.s.l. Kathua district is located between 75.5173º E longitude and 32.3865º N latitude. The average annual rainfall is 1360 mm. The study area experiences a sub-tropical climate. It shares border with Punjab (Pakistan) and Himachal Pradesh (India). The vegetation around the sighting was; *Isodon rugosus* (Schrad. Ex Benth.) Spach (Lamiaceae), *Prinsepia utilis* Royle D. Potter*, Rubus niveus* Thunb., *Rubus ellipticus* Sm. (Rosaceae), *Melia azedarach* L. (Meliaceae), *Alnus nitida* (Spach)

Endl. (Betulaceae), *Berberis lycium* Royle (Berberidaceae), *Juglans regia* L. (Juglandaceae), *Cedrus deodara* (Roxb.) G. Don (Pinaceae), and many more.

Hestina persimilis zella was identified based on Evans (1932), Wynter-Blyth (1957), Kehimkar (2016), and Smetacek (2018). The distribution map was prepared with ArcGIS 10.5 software (Esri, Redlands, CA) by using the original base map of India (Figure 3-4).

Results

Hestina persimilis (Westwood, [1850])

Hestina persimilis zella Butler, 1869 (Figures 1-2)

In *Hestina persimilis zella*, the upper forewing black bar mid cell; under hindwing dorsum not yellow paler, white marking wider, but in *Hestina persimilis persimilis*, darker, white markings narrower. Apex forewing more produced.

Author found three individuals of *Hestina persimilis zella* Butler, 1869, (Figures 1a, 1b) mudpuddling on soil and one individual on rock and another was flying. Many other species like *Papilio machaon* Linnaeus, 1758, *Graphium cloanthus* (Westwood, 1841), *Graphium sarpedon* (Linnaeus, 1759), *Papilio protenor* Cramer, [1775], *Libythea celtis lepita* Moore, [1858], *Junonia iphita* (Cramer, [1779]), etc., were mudpuddling along with this species.

Discussion

The diversity and taxonomic studies on several Rhopalocera species have been studied in Jammu and Kashmir. In recent years, the following authors has reported several new records to the butterfly fauna of Jammu and Kashmir and India (Sheikh & Parey, 2019a; 2019b; Sharma & Sharma, 2020; Gupta & Sheikh, 2021; Sheikh, 2021; Singh & Sheikh, 2021; Parey& Sheikh, 2021; Dar et al. 2021; Sheikh & Gupta, 2022; Sheikh & Mishra, 2022). Work is done in other Indian states like Uttar Pradesh, a red spot (*Zesius chrysomallus* Hübner, 1821) is rediscovered after 108 years by Kumari & Sheikh (2021). Today's results of this finding coincide with the previous work done in Jammu and Kashmir and Uttar Pradesh by various authors and current study in this article is also adding a rediscovery of *Hestina persimilis zella* after 110 years in Jammu and Kashmir Union Territory. The immatures of *Hestina persimilis zella* feeds on *Celtis australis* (Cannabaceae) and authors are of the opinion that, the larval host plant was eaten by cattle like cow and sheep's and that's why *Hestina persimilis zella* was not seen in this long period of time. Now somewhere, this plant has started growing in wild and now has also appeared again. Forest authorities are directed to act on the lesser availability of its larval host plant. By protecting its larval host plant, we can restore a good population of *Hestina persimilis zella* in India.

Conclusion

Distribution of *Hestina persimilis zella* was initially reported from Kashmir by Fruhstorfer (1912), which later cited by many researchers, like Varshney & Smetacek (2015), Gasse (2018), and (Sheikh et al. 2021). After 1912, *Hestina persimilis zella* is recorded after 110 years from Jammu & Kashmir, India. Additional research and a comprehensive long-term survey are still required to get significant diversity of butterfly species in Jammu and Kashmir. In the Union Territory of Jammu & Kashmir, the majority of the areas are still unexplored; regular surveys in the future may result in several new records and rediscoveries.

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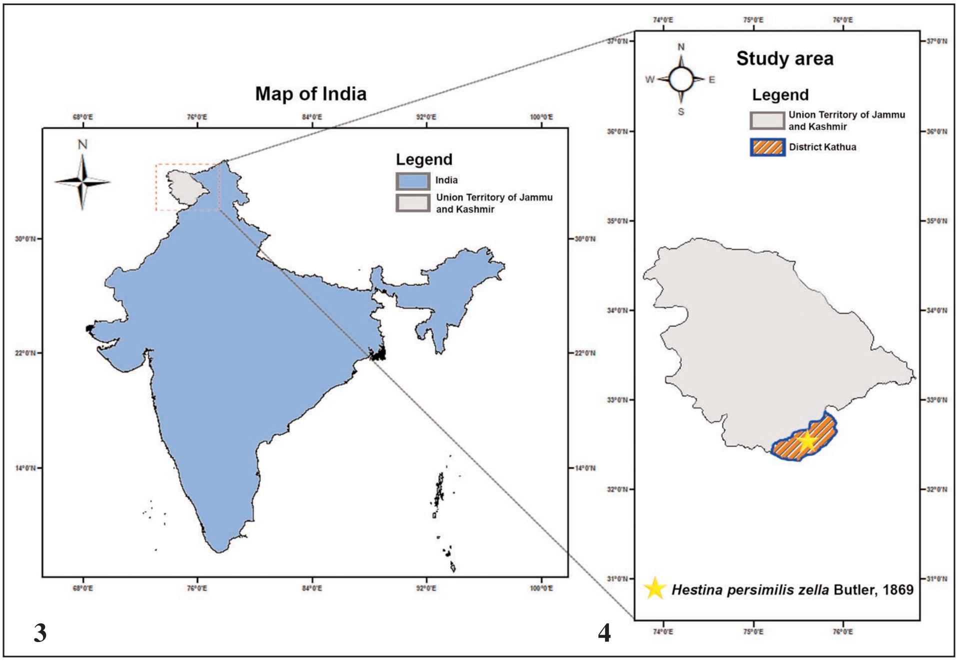
Figures 1-2. 1. *Hestina persimilis* (Westwood, [1850]) underwing. **2.** Openwing.



Figures 3-4. 3. Map of India. **4.** Map showing the distribution of *Hestina persimilis zella* Butler, 1869 in Kathua district of Jammu and Kashmir Union Territory.

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Synthesis and field testing of esters of (2*R*)-butan-2-ol and (2*S*)-butan-2-ol and monounsaturated fatty acids as sex attractants for the males of Procridinae species (Lepidoptera: Zygaenidae)

Konstantin A. Efetov, Elena E. Kucherenko, Alina V. Ivanovskaya & Mikhayl Y. Baevsky

Abstract

In the family Zygaenidae (Lepidoptera) with more than 1000 species a complete chemical analysis of the structure of female sex pheromones has been carried out for only three species of the subfamily Procridinae while sex attractants have been found for males of more than 60 species of two subfamilies: Procridinae and Zygaeninae. The synthesis of new sex attractants was performed from (*Z*)-dodec-5-enoic acid and *R*- and *S*-enantiomers of butan-2-ol at the Crimean Federal University in 2021. The biological activity of received esters was tested during fieldwork in the Crimean Peninsula. It has been proved that (2*R*)-butan-2-yl (*Z*)-dodec-5-enoate (named EFETOV-S-5) and (2*S*)-butan-2-yl (*Z*)-dodec-5-enoate (named EFETOV-S-S-5) are sex attractants for the males of *Jordanita* (*Tremewania*) *notata* (Zeller, 1847), while (2*S*)-butan-2-yl (*Z*)-dodec-5-enoate (EFETOV-S-S-5) is a sex attractant for *Adscita* (*Adscita*) *geryon* (Hübner, 1813). In addition, (2*R*)-butan-2-yl (*Z*)-hexadec-9-enoate and (2*S*)-butan-2-yl (*Z*)-hexadec-9-enoate were synthesised in 2022. However, these esters did not attract any of the Zygaenidae species which are common in the Crimea.

Keywords: Lepidoptera, Zygaenidae, Procridinae, *Adscita geryon*, *Jordanita notata*, EFETOV-S-5, EFETOV-S-S-5, sex attractant, Crimea.

Síntesis y pruebas de campo de ésteres de (2*R*)-butan-2-ol y (2*S*)-butan-2-ol y ácidos grasos monoinsaturados como atrayentes sexuales para los machos de especies de Procridinae (Lepidoptera: Zygaenidae)

Resumen

En la familia Zygaenidae (Lepidoptera) con más de 1.000 especies, se ha realizado un análisis químico completo de la estructura de las feromonas sexuales de las hembras para sólo tres especies de la subfamilia Procridinae, mientras que se han encontrado atrayentes sexuales para los machos de más de 60 especies de dos subfamilias: Procridinae y Zygaeninae. La síntesis de los nuevos atrayentes sexuales se llevó a cabo a partir del ácido (*Z*)-dodec-5-enoico y de los enantiómeros *R* y *S* del butan-2-ol en la Universidad Federal de Crimea en 2021. La actividad biológica de los ésteres recibidos se probó durante el trabajo de campo en la Península de Crimea. Se ha comprobado que el (2*R*)-butan-2-il (*Z*)-dodec-5-enoato (denominado EFETOV-S-5) y el (2*S*)-butan-2-il (*Z*)-dodec-5-enoato (denominado EFETOV-S-S-5) son atrayentes sexuales para los machos de *Jordanita* (*Tremewania*) *notata* (Zeller, 1847), mientras que el (2*S*)-butan-2-il (*Z*)-dodec-5-enoato (EFETOV-S-S-5) es atrayente sexual para *Adscita* (*Adscita*) *geryon* (Hübner, 1813). Además, en 2022 se sintetizaron (2*R*)-butan-2-il (*Z*)-hexadec-9-enoato y

(2*S*)-butan-2-il (*Z*)-hexadec-9-enoato. Sin embargo, estos ésteres no atrajeron a ninguna de las especies de Zygaenidae comunes en Crimea.

Palabras clave: Lepidoptera, Zygaenidae, Procridinae, *Adscita geryon*, *Jordanita notata*, EFETOV-S-5, EFETOV-S-S-5, atrayente sexual, Crimea.

Introduction

In recent years, there has been an increasing amount of literature on various approaches to the study of pheromone systems in Lepidoptera. Much of the current research on these attractant molecules pays particular attention to their chemical structure, isomerism and biosynthesis (El-Sayed, 2022). In the family Zygaenidae (Lepidoptera) which includes five subfamilies (Efetov, 1999, Efetov et al. 2014b; Efetov & Tarmann, 2017a) with more than 1000 species (Efetov, 1996a, 1996b, 1998, 1999, 2001, 2006, 2010; Efetov & Hayashi, 2008; Efetov et al. 2004, 2006, 2015a, 2019a, 2019c; Efetov & Knyazev, 2014; Efetov & Savchuk, 2009; Efetov & Tarmann, 1999, 2013a, 2013b, 2014a, 2014b, 2016a, 2016b, 2017a, 2017b; Knyazev et al. 2015) a complete chemical analysis of the structure of female sex pheromones has been carried out for only three species (all are pests) of the subfamily Procridinae (Efetov & Kucherenko, 2020; Subchev, 2014). There is a little more information on sex attractants (chemicals that are not naturally produced by the same species but found to be attractive in field or laboratory experiments) for Zygaenidae species. Sex attractants have been found for males of more than 60 species of two subfamilies Procridinae and Zygaeninae (Drouet et al. 2021; Efetov et al. 2010, 2011, 2014a, 2015b; Landolt et al. 1991; Priesner et al. 1984; Razov et al. 2017; Subchev, 2014; Subchev et al. 2010, 2012, 2013, 2016).

Previously, we had already synthesised (2*R*)-butan-2-yl dodec-2-enoate (named EFETOV-S-2, another name is (2*R*)-butyl 2-dodecenoate) and (2*S*)-butan-2-yl dodec-2-enoate (named EFETOV-S-S-2, another name is (2*S*)-butyl 2-dodecenoate). In different countries of the world field experiments with these esters (alone or in racemic mixture) have confirmed their attractive properties for almost 30 Zygaenidae species (Can et al. 2019; Can Cengiz et al. 2018; Efetov et al. 2014c, 2016, 2018, 2019b, 2020, 2022; Efetov & Kucherenko, 2021; Nahirnić-Beshkova et al. 2021; Vrenozi et al. 2019).

The aims of the present work were: 1) to synthesise esters of (2*R*)-butan-2-ol or (2*S*)-butan-2-ol and (*Z*)-dodec-5-enoic acid as well as (*Z*)-hexadec-9-enoic acid; 2) to test obtained esters as sex attractants for Zygaenidae species in the Crimean Peninsula.

Materials and methods

Synthesis of the target esters

Commercial chemicals (2*S*)-butan-2-ol, (2*R*)-butan-2-ol, (*Z*)-dodec-5-enoic acid were purchased from Sigma-Aldrich, USA and (*Z*)-hexadec-9-enoic acid from Toronto Research Chemicals, Canada. All chemicals were of 99% purity. Synthesis of (2*S*)-butan-2-yl (*Z*)-dodec-5-enoate and (2*R*)-butan-2-yl (*Z*)-dodec-5-enoate was performed in two stages: (1) synthesis of acyl chloride; (2) alcoholysis of acyl chloride.

1. Synthesis of (*Z*)-dodec-5-enoyl chloride. 5 g (0.025 mol) of (*Z*)-dodec-5-enoic acid was placed in a 50 ml round-bottom flask equipped with a water-cooled reflux condenser. 10 ml of anhydrous benzene, 0.5 ml of *N*,*N*-dimethylformamide and 2.2 ml (0.03 mol) of thionyl dichloride were added. The reaction mass was heated to boiling and maintained at boiling point for one hour. At the end of the reaction, the solvent (benzene) and excess of thionyl dichloride were removed under vacuum on a rotary evaporator. Acyl chloride was used at the stage of synthesis of the corresponding ester.

2. Synthesis of (2*S*)-butan-2-yl (*Z*)-dodec-5-enoate. 10 ml of anhydrous benzene, 3 ml (0.3 mol) of (2*S*)-butan-2-ol and 3 ml (0.03 mol) of pre-dried pyridine were added to a 50 ml round-bottom flask equipped with a water-cooled reflux condenser containing the previously synthesized (*Z*)-dodec-5-enoyl chloride and 0.5 ml of *N*,*N*-dimethylformamide. The reaction mass was heated to boiling and maintained at boiling point for one hour. After completion of the reaction, the pyridine hydrochloride was removed by filtration on a Schott filter under vacuum. The precipitate was washed with 20 ml of anhydrous benzene. The filtrate was washed on a separating funnel with two portions of 20 ml of 5% hydrochloric acid solution, separating the excess of pyridine. Then the filtrate was washed with two portions of 20 ml of 10% sodium hydroxide solution, with the aim of removing unreacted acid and alcohol. The benzene layer was separated. After removing the benzene on a rotary evaporator, 4.5 g of (2*S*)-butan-2-yl (*Z*)-dodec-5-enoate were obtained (85% purity according to high-performance liquid chromatography). Synthesis of (2*R*)-butan-2-yl (*Z*)-dodec-5-enoate (75% purity according to HPLC) was performed from (2*R*)-butan-2-ol by a similar procedure. As a result, two esters, viz. (2*S*)-butan-2-yl (*Z*)-dodec-5-enoate and (2*R*)-butan-2-yl (*Z*)-dodec-5-enoate, were obtained and called EFETOV-S-S-5 and EFETOV-S-5, respectively (Figures 1-2). EFETOV-S-S-5 was obtained two times and these samples were conventionally marked EFETOV-S-S-5(60) and EFETOV-S-S-5(85).

(2*S*)-butan-2-yl (*Z*)-hexadec-9-enoate and (2*R*)-butan-2-yl (*Z*)-hexadec-9-enoate were synthesised as described above but at the first stage (*Z*)-hexadec-9-enoyl chloride was obtained by treating (*Z*)-hexadec-9-enoic acid with thionyl dichloride.

PREPARATION OF LURES

Synthetic attractant candidate compounds were used without solvents in a dose of 50 µl for preparation each lure. Different types of esters were loaded on rubber dispensers which were fixed on cardboard rectangles after the attractant adsorption. All baits were marked as ‘EFETOV-S-5’ for (2*R*)-butan-2-yl (*Z*)-dodec-5-enoate, ‘EFETOV-S-S-5’ for (2*S*)-butan-2-yl (*Z*)-dodec-5-enoate, ‘EFETOV-S-9-16’ for (2*R*)-butan-2-yl (*Z*)-hexadec-9-enoate, and ‘EFETOV-S-S-9-16’ for (2*S*)-butan-2-yl (*Z*)-hexadec-9-enoate.

As a positive control, we used rubber caps impregnated with 50 µl of the sex attractant EFETOV-2 (the racemic mixture of (2*R*)-butan-2-yl dodec-2-enoate and (2*S*)-butan-2-yl dodec-2-enoate), which had been synthesised earlier according to the procedure published by Efetov et al. (2014c). The efficacy of baits with EFETOV-2 has been proven for seven species of Zygaenidae of the Crimean fauna (Efetov & Kucherenko, 2021). Empty rubber caps without any synthetic compounds were used as a negative control.

The lures with labelled cardboard holders were fixed in transparent plastic Delta traps containing removable sticky layers (Figure 3).

FIELD EXPERIMENTS

Attempts to observe the attraction of males of Zygaenidae species to synthetic esters were conducted in 2021 (with EFETOV-S-5 and EFETOV-S-S-5) and 2022 (with EFETOV-S-9-16 and EFETOV-S-S-9-16) at four localities of the Crimean Peninsula in biotopes corresponding to the preferred habitats of the target species (Efetov, 2005). The experimental and control traps were hung on bushes or trees at a height of 1.0-1.5 m above the ground. The distance between different types of traps was at least 10 meters. The traps were inspected on average once a week. Sometimes we just put the baits on rocks on the ground (the distance between the baits was not less than several meters). In this case, we collected attracted moths by catching them with a net near the rubber caps. All specimens (captured and glued moths) were determined by examination of the genitalia by K. A. Efetov.

The list of the studied localities of the Crimean Peninsula and the time of observations are presented below (Figure 4).

Locality 1: vic. Belogorsk, Mt. Sary-Kaya, 230-239 m, grassy slope near steep calcareous edge of the mountain (Figure 5). Periods of observation: 15-V-2021 - 15-VII-2021, one trap with EFETOV-S-5, one trap with EFETOV-S-S-5(60), one trap with EFETOV-S-S-5(85), and one control trap (without attractant); 06-V-2022 - 02-VII-2022, one trap with EFETOV-S-9-16, one trap with EFETOV-S-S-9-16, and one control trap (without attractant).

Locality 2: vic. Simferopol, Bitak, 320 m, grassy slope near steep calcareous edge of the mountain. Periods of observation: 16-V-2021 - 08-VII-2021, one trap with EFETOV-S-5, one trap with EFETOV-S-S-5(85), and one control trap (without attractant); 06-V-2022 - 01-VII-2022, one trap with EFETOV-S-9-16, one trap with EFETOV-S-S-9-16, and one control trap (without attractant).

Locality 3: Mt. Chatyr-Dag, 514 m, grassy slope near deciduous forest (Figure 6). Periods of observation: 16-V-2021 - 08-VII-2021, one trap with EFETOV-S-5, one trap with EFETOV-S-S-5(60), one trap with EFETOV-S-S-5(85), and one control trap (without attractant); 23-V-2022 - 29-VII-2022, one trap with EFETOV-S-9-16, one trap with EFETOV-S-S-9-16, and one control trap (without attractant).

Locality 4: vic. Luchistoye, NE of Alushta, 376 m, abandoned vineyard near the lake. Periods of observation: 16-V-2021 - 24-IX-2021, one trap with EFETOV-S-5, one trap with EFETOV-S-S-5(60), one trap with EFETOV-S-S-5(85), one trap with EFETOV-2, and one control trap (without attractant); 23-V-2022 - 04-VIII-2022, one trap with EFETOV-S-9-16, one trap with EFETOV-S-S-9-16, one trap with EFETOV-2, and one control trap (without attractant).

Results and discussion

During our field screening tests the attraction of two Procridinae species to the baits with new synthetic compounds EFETOV-S-5 and EFETOV-S-S-5 was recorded, viz. *Adscita* (*Adscita*) *geryon* (Hübner, 1813) and *Jordanita* (*Tremewania*) *notata* (Zeller, 1847) (Figure 3). No specimens were attracted by the lures EFETOV-S-9-16 and EFETOV-S-S-9-16. In addition, the males of *Theresimima ampellophaga* (Bayle-Barelle, 1809) were found in sticky traps with the baits EFETOV-2, which were used as a positive control in our experiments in 2021-2022. Traps without attractant (the negative control) were empty in all studied localities. The list of attracted specimens, type of lures, and the time of observation are provided below.

A. geryon (Hübner, 1813)

Locality 1, trap with EFETOV-S-S-5(60), 1 ♂, 20-V-2021; 1 ♂, 04-VI-2021; trap with EFETOV-S-S-5(85), 2 ♂♂, 20-V-2021; 1 ♂, 04-VI-2021; locality 2, trap with EFETOV-S-S-5(85), 1 ♂, 22-V-2021; locality 3, trap with EFETOV-S-S-5(60), 2 ♂♂, 29-VI-2021; trap with EFETOV-S-S-5(85), 1 ♂, 31-V-2021; 1 ♂, 22-VI-2021; near rubber cap with EFETOV-S-S-5(85), 1 ♂, 07-VI-2021.

J. notata (Zeller, 1847)

Locality 1, trap with EFETOV-S-5, 12 ♂♂, 20-V-2021; 9 ♂♂, 27-V-2021; 3 ♂♂, 04-VI-2021; 1 ♂, 12-VI-2021; trap with EFETOV-S-S-5(60), 2 ♂♂, 20-V-2021; 6 ♂♂, 27-V-2021; 8 ♂♂, 04-VI-2021; near trap with EFETOV-S-S-5(60), 1 ♂, 27-V-2021; trap with EFETOV-S-S-5(85), 13 ♂♂, 20-V-2021; 3 ♂♂, 27-V-2021; near trap with EFETOV-S-S-5(85), 4 ♂♂, 27-V-2021.

Th. ampellophaga (Bayle-Barelle, 1809)

Locality 4, trap with EFETOV-2, 17 ♂♂, 15-VII-2021; 7 ♂♂, 24-VII-2021; 2 ♂♂, 29-VII-2021; 7 ♂♂, 14-VII-2022; 8 ♂♂, 22-VII-2022; 3 ♂♂, 29-VII-2022.

In total, 25 males of *J. notata* were attracted to the baits EFETOV-S-5 and 37 males came to lures with EFETOV-S-S-5 (17 males to EFETOV-S-S-5(60) and 20 males to EFETOV-S-S-5(85)), whereas all 11 males of *A. geryon* were attracted only to EFETOV-S-S-5 (4 males to EFETOV-S-S-5(60) and 7 males to EFETOV-S-S-5(85)). No specimens of *J. notata* and *A. geryon* were found in sticky traps with EFETOV-S-9-16 and EFETOV-S-S-9-16. However, at the same time some males of both species were caught by a net near the rubber caps with attractant EFETOV-2 when we put them on the rocks on the ground during inspection of the traps. Previously, attractiveness of EFETOV-2 has been proved for both of these species (Efetov et al. 2016). Thus, only esters of butan-2-ol and (*Z*)-dodec-5-enoic acid, but not of (*Z*)-hexadec-9-enoic acid, can be considered new sex attractants for males of *J. notata* and *A. geryon*.

It should be noted that 44 males of *Th. ampellophaga* were found in sticky traps with sex attractant EFETOV-2, that was used as a positive control in 2021-2022 in locality 4. However, the males of this species were absent in traps with newly synthesized esters. Besides this, some other Zygaenidae species (observed in the biotopes on the wing) did not respond to the tested baits. These species were *Rhagades* (*Rhagades*) *pruni* ([Denis & Schiffermüller], 1775), *Jordanita* (*Roccia*) *budensis* (Speyer & Speyer, 1858), *J.* (*Jordanita*) *graeca* (Jordan, 1907), *J.* (*J.*) *chloros* (Hübner, 1813), *J.* (*J.*) *globulariae* (Hübner, 1793), *J.* (*Solaniterna*) *subsolana* (Staudinger, 1862) (all Procridinae) and *Zygaena* (*Mesembrynus*) *purpuralis* (Brünnich, 1763), *Z.* (*Agrumenia*) *viciae* ([Denis & Schiffermüller], 1775), *Z.* (*Lictoria*) *loti* ([Denis & Schiffermüller], 1775), *Z.* (*Z.*) *filipendulae* (Linnaeus, 1758) (all Zygaeninae).

Previously, Efetov et al. (2015b, 2016, 2020), Efetov & Kucherenko (2021), Razov et al. (2017), Subchev et al. (2010) have shown that the *R*- and *S*-enantiomers of 2-butan-2-yl dodec-2-enoate and 2-butan-2-yl dodec-7-enoate are sex attractants for males of *A. geryon*, *J. notata* and some other species. These esters differ from each other and from the esters (2*R*)-butan-2-yl dodec-5-enoate and (2*S*)-butan-2-yl dodec-5-enoate by the position of the double bond in the acid radical, but this change affects the attractive properties of the esters in relation to males of the same species.

In our fieldwork, *A. geryon* were attracted to the *S*-enantiomer of 2-butan-2-yl dodec-5-enoate. This is in good agreement with the data which have been obtained earlier in Bulgaria, Crimea, Hungary and Italy (Efetov et al. 2015b; Subchev et al. 2010), where males of this species were mainly attracted to the *S*-enantiomer of 2-butan-2-yl dodec-7-enoate alone or in a mixture with the corresponding *R*-enantiomer. In the case of (2*R*)-butan-2-yl dodec-7-enoate and (2*S*)-butan-2-yl dodec-7-enoate, the presence of the *R*-enantiomer does not influence the attractiveness of the *S*-enantiomer. The males of *A. geryon* were not found in sticky traps with the racemic mixture of 2-butan-2-yl dodec-2-enoate and its enantiomers alone. The males only flew up at a close distance of about 20-50 cm to the rubber caps with EFETOV-2 and then flew away. The main catches of this species in field trials with the enantiomers of 2-butan-2-yl dodec-5-enoate and 2-butan-2-yl dodec-7-enoate were recorded in sticky traps.

The main catches of *J. notata* were recorded in traps baited with (2*R*)-butan-2-yl dodec-2-enoate, (2*R*)-butan-2-yl dodec-5-enoate, (2*R*)-butan-2-yl dodec-7-enoate or in traps with lures containing these compounds in mixtures with other substances (Efetov et al. 2015b, 2016, 2020; Efetov & Kucherenko, 2021; Razov et al. 2017; Subchev et al. 2010). The presence of the corresponding *S*-enantiomers does not inhibit the attractiveness of the *R*-enantiomers for *J. notata.* It is clear that the stereoisomerism of the ester molecules is more important for their recognition by the olfactory receptors of males of this species than the position of the double bond in acid radicals.

In the Crimea in many localities two species, viz. *A. geryon* and *A. albanica* (Naufock, 1926), are sympatric and syntopic. When we performed experiments with *R*- and *S*-enantiomers of 2-butan-2-yl dodec-7-enoate and 2-butan-2-yl tetradec-9-enoate not only the males of *A. geryon* were attracted mainly to left isomers, but two males of *A. albanica* were attracted to mixtures containing (2*S*)-butan-

2-yl dodec-7-enoate (one male was in a trap with *S*- and *R*-enantiomers of 2-butan-2-yl dodec-7-enoate in 2006 and one male was in a trap with *S*-enantiomers of 2-butan-2-yl dodec-7-enoate and 2-butan-2-yl tetradec-9-enoate in 2007) (Subchev et al. 2010). It means that (2*S*)-butan-2-yl dodec-7-enoate is a sex attractant for *A. albanica*.

Conclusion

New sex attractants for two Procridinae species, viz. *Adscita geryon* and *Jordanita notata*, were found. *A. geryon* males reacted to lures with (2*S*)-butan-2-yl (*Z*)-dodec-5-enoate (EFETOV-S-S-5), while *J. notata* males were attracted to the both enantiomers of 2-butan-2-yl (*Z*)-dodec-5-enoate (EFETOV-S-5 and EFETOV-S-S-5).

(2*R*)-butan-2-yl (*Z*)-hexadec-9-enoate and (2*S*)-butan-2-yl (*Z*)-hexadec-9-enoate did not attract Zygaenidae moths, at least those species inhabiting the Crimea.

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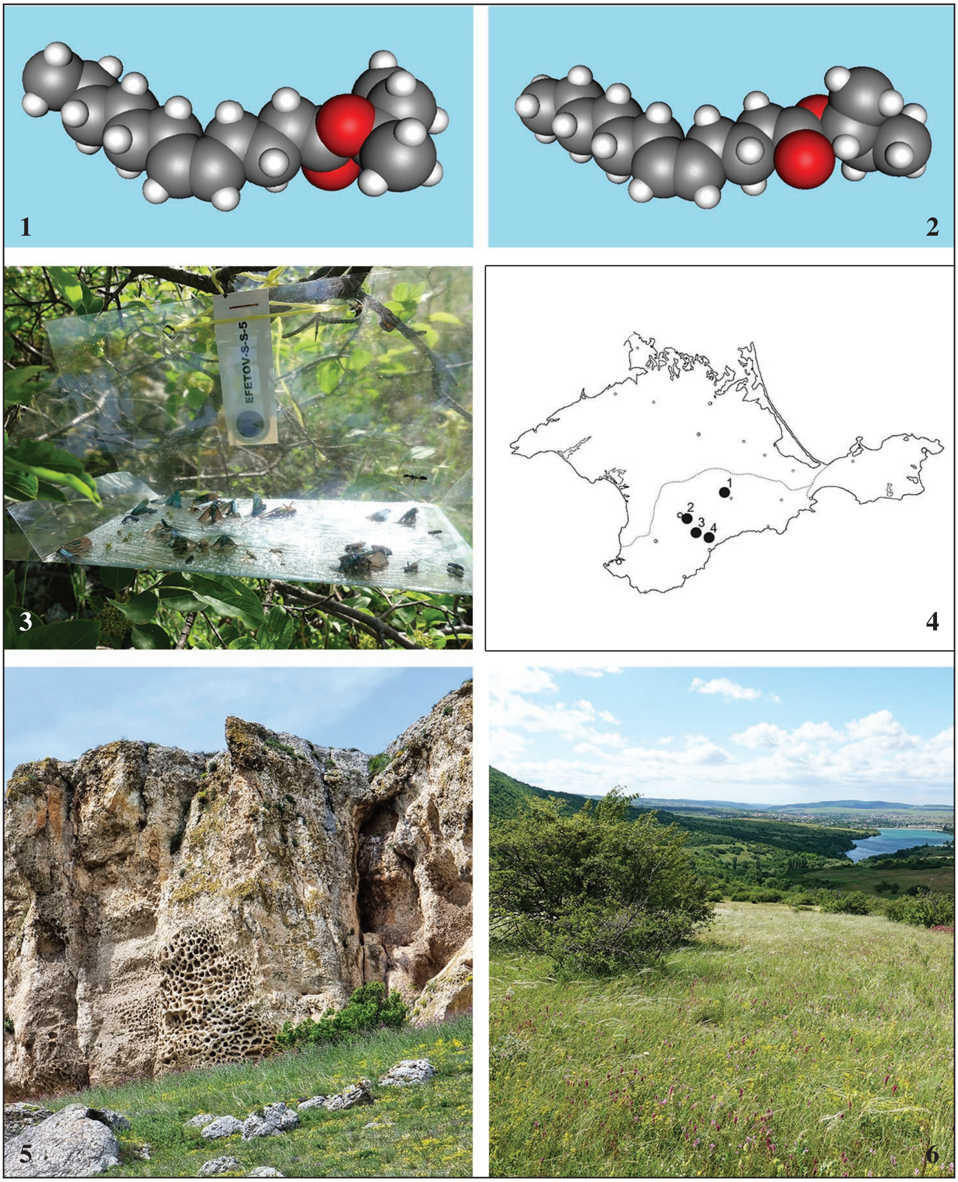

Figures 1-6. 1. (2*S*)-butan-2-yl (*Z*)-dodec-5-enoate (named EFETOV-S-S-5). **2.** (2*R*)-butan-2-yl (*Z*)-dodec-5-enoate (named EFETOV-S-5). Models were performed by the program ‘Chemistry. Virtual Laboratory’ (LLC ‘Virtual Spaces’, Yoshkar-Ola, RU). Oxygen atoms are marked in red. **3.** *J. notata* (13 ♂♂) and *A. geryon* (2 ♂♂) in sticky Delta trap with EFETOV-S-S-5 in locality 1, 20-V-2021. **4.** Map of the Crimean Peninsula showing the localities that were investigated using attractant traps: 1, vic. Belogorsk, Mt. Sary-Kaya; 2, vic. Simferopol, Bitak; 3, Mt. Chatyr-Dag; 4, vic. Luchistoye, NE of Alushta. **5.** Locality 1, Crimea, vic. Belogorsk, Mt. Sary-Kaya, photo: K. A. Efetov. **6.** Locality 3, Crimea, Mt. Chatyr-Dag, photo: K. A. Efetov.