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Editorial

Dear reader,

We would like to make your journal more appealing and enjoyable to read for a wider audience of lepidopterists, and encourage a broader spectrum of authors to contribute to Nota lepidopterologica. In agreement with Council, we will now welcome short communications (half a page or more) in a less formal style with original information on lepidopteran ecology, systematics, conservation, faunistics, and biogeography, as well as on topics such as breeding, life cycle, and new European records. There will not be a strict division of topics based on the nature of the material submitted, and short communications on taxonomy, for example, will be as welcome as longer articles on distribution. The focus on Palaearctic Lepidopterology will remain.

We look forward to receive your submissions, long or short!

The editorial team
Bernard, Matthias, and Paul

Extraordinary moths and an extraordinary moth researcher: An essay review of G. S. Robinson's *Biology, distribution and diversity of tineid moths* *

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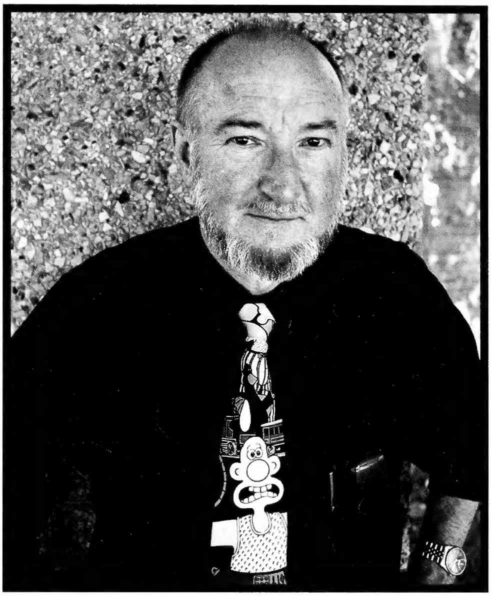
* **Robinson, G. S. 2009. Biology, distribution and diversity of tineid moths.** – Southdene Sdn Dhd, P.O.Box 10139, 50704 Kuala Lumpur, Malaysia & Natural History Museum, London. – 143 pp., 16 coloured pls. – Price 55 £.

Members of the family Tineidae are extraordinary moths from a number of perspectives, but most of all because of the feeding habits of their larvae. The point is made repeatedly in current writings on insect diversity, that the Lepidoptera (at least the non-micropterigid Lepidoptera, hence >>99% of the extant members of the order) are the most species-rich clade of herbivorous animals – and the family Tineidae is the principal lepidopteran lineage whose members have on a large scale adopted alternative food sources. A few tineid species are probably the only micro-moths known to almost everybody (and have been so for millennia, as testified by references in the myths of the Old Testament), and of course they owe this recognition to the capacity of their larvae to live on substrates as unusual as keratins (fibrous structural proteins), and hence to become troublesome textile destroyers. Ironically, therefore, in several languages the vernacular name for a tineid moth will be the one by which most people will refer to all kinds of smaller moths, which in their biology mostly are so different, and so much more 'typical' members of the order.

Tineids are of outstanding interest for other reasons as well, in as much as they are the most overall generalized ditrysian Lepidoptera, and a knowledge of their structure therefore of crucial significance for any attempts of reconstructing the ancestor which gave rise to the most species-rich lepidopteran lineages in what appears to have been very rapid succession – judging from the difficulties facing current attempts of resolving their interrelationships through analysis of sizable samples of carefully selected genetic markers (Regier et al. 2009). Tineid moths are diverse in morphology and appearance, and their general non-herbivory notwithstanding they are also biologically diverse. Getting a handle on this diversity would, therefore, appear to be an obvious priority in systematic/evolutionary lepidopterology.

In recent decades three milestone publications have appeared which serve exactly this purpose, and the London *Natural History Museum* (previously, and still in the mind of many naturalists, the *British Museum* (*Natural History*) – BMNH) lepidopterist Gaden S. Robinson was the driving force behind all of them. First, in 1993, came the outstanding book on *Tineid Genera of Australia* coauthored by Robinson and Ebbe S. Nielsen. In 1998 followed Robinson's treatment of the family in the first Lepidoptera volume of the *Handbook of Zoology*. Finally, in late 2009, the international lepidopterists' community received the book highlighted in the headlines here, only a short time after receiving the news that its author untimely – aged 60 – had succumbed to an untimely but aggressive illness. He lived to see the proofs and had dearly wanted to see the book printed, an event, alas denied him. In fellow-countrymen's obituary writings (e.g., Beccaloni et al. 2009) Robinson was repeatedly referred to as being "clubbable" (a delightful expression that was new to the English vocabulary of both of us), but despite this characteristic, for one reason or another he never joined the *Societas Europaea Lepidopterologica*, and only on very few occasions did he attend a European Congress of Lepidopterology. But since from the onset of his BMNH career he was in charge of a sizable proportion of the micro-moth collections of that matchless institution, he was destined to become a central figure in the minds of European (and indeed extra-European) micro-moth researchers, whose work was often promoted by his insights, and with a number of whom he developed a genuine personal friendship. The appearance of *Biology, distribution and diversity of tineid moths* is, then, an appropriate occasion to reminisce about its author in the SEL Journal.



Clubbable Gaden Robinson; photograph 2008 by Phil de Vries.

Gaden Sutherland Robinson had a colourful personality and was a man of many talents. As a lepidopterist he was an apple not fallen far from the tree: his father, Hugh S. Robinson, was a keen amateur Lepidoptera collector and inventor (jointly with his similarly-minded brother Peter) of the renowned 'Robinson trap' which was instrumental in revolutionizing moth collecting techniques in the mid 20th century. The paternal impact on the early shaping of Gaden's entomology interest vividly transpires from the brilliant and very 'Gadenish' contribution (Robinson 2009a) to the recent *Letters to Linnaeus* volume, and while his later professional commitment and writings were focused on the micro-moth grade, he long retained a broad genuine interest in the British Lepidoptera as a whole and continued light trapping and 'sugaring' at/near his Essex homes. Another impact came from Hugh Robinsons' later appointment to the colonial civil service in S.E. Asia and eventually Fiji: Gaden's Ph.D. work was an account of the Macrolepidoptera (in a broad sense) of Fiji and Rotuma, and the fauna of S.E. Asia and Australasia remained a theme of focal interest throughout his scientific career.

Attractive tenured positions in systematic biology were not yet scarce in the mid-1970s, and aged 25 Gaden found himself employed as a scientific officer (a position combining curatorial and researcher duties) in the micro-moth section of the BMNH Entomology Department. The decision that work on 'lower' micro-moths with special reference to Tineidae should be a core activity of the new employee was made at managerial level before the successful applicant was hired, and it was prompted partly by the lacunae in expertise among already-present staff members, partly because of the economic importance of tineids (K. Sattler, pers. comm.). The challenge was enthusiastically accepted by Gaden. Over the years he published a series of high-quality taxonomic studies on tineids, with occasional digressions into other lower-grade moth groups (including a book on the hepialids of austral S. America, Nielsen & Robinson 1983). To several tineid workers worldwide Gaden was the 'court of last resort' in taxonomic questions; his enormous knowledge was highly valued and his advice will be sorely missed.

Gaden's extensive empirical work was not restricted to revisionary taxonomy, but ranged from science history/classical collections over lepidopteran host associations to biodiversity assessment issues. Endowed with exceptional verbal skills he enjoyed writing for readerships outside the restricted circle of fellow scientists, and for example his many reviews of entomology books in the *Times Literary Supplement* won wide acclaim. Reference may be made to the above-mentioned Beccaloni et al. (2009) obituary article for more information about his personality and scientific achievements, and a complete list of his scientific publications is accessible (for free to subscribers to *Systematics and Biodiversity*) at www.journals.cup.org/abstract_S1477200009990247.

Biology, distribution and diversity of tineid moths (Robinson 2009b) was written in Gaden's last years, when his health state was in rapid decline. It is an impressive, information-packed piece of writing – and moreover it is something as exceptional as a scientific text with distinctive literary qualities! In the first issue of *Antenna* ('house journal' of the Royal Entomological Society) the late Miriam Rothschild (1977) addressed the issue of contemporary scientific writing styles and rhetorically asked "Need we be such unmitigated bores?"– As hinted above, Gaden was one of those rare entomology writers who clearly demonstrated that the answer sometimes can be "no".

The book opens with a succinct 'Introduction' chapter with a number of sections, of which 'Problems and the past' highlights problems of a general nature, particularly lacking/inadequate illustrations and over-hasty species descriptions with following high synonymy ratios. The section entitled 'Why Tineidae – why pick on us?' is entertainingly presented as a conversation between the author and tineid moths, from which the outstanding features of the latter emerge. Here we are told what the emphasis of the book is – and what it is not. The moths "suppose you're now going to give them [the readers] all that dull spiel about biology, physiology, morphology and classifications and subfamily definitions, repeating yourself yet again from *Tineid Genera of Australia* and *Handbook of Zoology*?", but the author after stating that "I shall direct the patient reader to Robinson & Nielsen (1993) and Davis & Robinson (1999) for the full Monty..." tersely asserts that the present work " focuses on distribution and biology and if anyone wants any more morphology, or the like, then they can either look it up or sing it themselves. Besides it is bad form to recycle one's own work too often". While this last statement may have much to recommend it, and while editors/publishers of the *Monographs on Australian Lepidoptera* and *Handbook of Zoology* will welcome the promotion of the volumes referred to, one may still ask whether the principle here has been carried to the extreme. We do believe a few pages of annotated morphology illustrations would have been justified and helpful. The need seems particularly obvious for instance in the case of the female genitalia, because neither the *Handbook* nor the Australian volume provide labelled illustrations of certain noteworthy structures referred to in the following text section. Here one otherwise finds a succinct, but informative, account of adult family characteristics, while the immatures are given short shrift: just references to the two above-mentioned treatises. While the next section heading reads "How Tineidae are defined", one actually here finds no attempt of identifying groundplan autapomorphies of the family, and indeed the author may well have continued to doubt that it has any (this doubt is expressly stated in Robinson & Nielsen 1993: 2), and therefore may well prove eventually to be a non-monophyletic assemblage. It is straightforward to assume, that when the tineids are told that "You do have a fossil record – there are plenty of Tineidae known from the Baltic amber, about 55 mya..." this plenitude also comprises stem-lineage members of other ditrysian families.

We also submit that it would not have been unjustified to 'recycle' (and where appropriate, update) at least a number of the *key references* on tineid physiology given in the works already mentioned. Although the subject is clearly outside the scope of the present work, there seems to be a merit in highlighting more strongly that exactly the Lepidoptera-wise very unusual life histories of members of this family render them outstandingly interesting model organisms to biologists outside the systematists/biodiversity researchers' circles; here they can serve inquiries into mycophagy, coprophagy, keratin digestion, adaptations to extreme dryness – and in particular, into the pathways leading to these physiological capabilities.

The introductory section is closed with an account of the 16 currently recognized tineid subfamilies of which, however, two, viz., the Meessiinae and Myrmecozelinae remain, as it is said, "undoubtedly polyphyletic". The account is more detailed than that in the *Handbook*, less detailed than that in the Australian volume – and of course it is updated relative to these accounts. The challenging task of unravelling the interrelationships between the subfamilies, and hence in placing the said ecological/physiological specializations in evolutionary context (arguably among the greatest strengths of contributions from 'the museum approach' to comparative biology) is left to future workers: subfamily interrelationships were presented as completely unresolved in the previous contributions, and "Little has been added since these publications" (Preface, p. 7). As something new the section enumerates all genera (with global species numbers) assigned to the individual subfamilies. A bonus also not found elsewhere is a list, arranged by zoogeographical regions, of the tineid genera not yet placed in any subfamily; there are no less than 119 (81 monobasic) of these.

The bulk of the book is taken up by the chapter on 'Distribution, diversity and biology'. It is a genus-for-genus account of known (published and in some cases unpublished, e.g. label information on museum specimens) bionomics of world tineids, organized on a geographical basis, and within geographical units arranged by subfamilies. The first subsection is devoted to "Islands, isolates and invaders" and comprises as many as 40 pages, while 62 are devoted to the predominantly continental faunas, arranged according to conventional zoogeographical regions. The background for this apparent imbalance is not just that the author always took a special interest in faunas of isolated islands, but also that tineids with their larval dependence on fungal rather than plant material are exceptional colonisers by Lepidoptera standards. Arguably the particularly extensive treatment of the St Helena tineid fauna would have benefited from treatment in a separate full journal article, with only a quite condensed summary in the present book. We make this point not because of the lengthy treatment of the subject, but simply because we found the whole story, including its historical/biographical aspects so fascinating (as well as delightfully presented) that it deserved the wider readership, which could have been attracted if the account had been flagged with a title of its own. Confined to the book it is likely to be found only by micro-moth workers.

The material presented in this central chapter of the book is an impressive compilation of data. Each regional account is opened by a condensed survey of the relevant available literature resources, often accompanied by brief assessments on the quality/usefulness of the works in question – useful 'consumer's guidances', which in some cases come in the form of forthright criticism; the account (p. 80–81) of the Gozmány & Vári book (1973) on Afrotropical tineids is an example. Implicit in this criticism (which we consider well founded) is, then, an emphasis of the need for a new treatment, complying with current 'best practice' of the tineid fauna of this region, from which much new material has been procured in recent years. In a general way the treatments of the regional tineid faunas highlight the need for future comprehensive manuals. European workers will feel a particular need for a comprehensive account of the Oriental tineids, like the forthcoming Davis monograph on the Nearctic taxa is indeed „eagerly awaited" (p. 57), because close links to the Palaearctic fauna are known to exist.

The written account of the global biological diversity of tineid moths is supplemented by a pictorial guide to the diversity in form and colour patterns of the moths. It is presented in 16 plates of colour photographs on which exemplars of a sizable proportion of the world genera (272 out of 341) are depicted in altogether 500 illustrations; the missing ones are consistently 'rarae aves' not present (at least as specimens at all suitable for photography) in the NHM collections "or otherwise unavailable for photography in the time-frame available..." (p.8). The pictures are overall good, although the reproduction technique has not enabled them to match the best micro-moth photographs published these years; in several cases they would have benefited from a somewhat higher magnification. The magnification varies considerably between figures which are almost identically sized irrespective of the size of the specimens in question, and while the actual size of the latter can be immediately seen in the captions facing the plates, the variable magnifications do detract from the ease of appreciation of the diversity of the moths depicted. Occasionally the choice of illustrated specimens is debatable, as e.g., fig 278, which illustrates a near-unicolorous dark *Neurothaumasia ankerella*, while the most typical/abundant morph of this taxon has a bold black/white pattern; the congener *N. fasciata* (fig. 279) is similarly variable, but the generic account (p. 74) does not mention this variablity.

One of us (NPK) had the opportunity to see a draft of the manuscript and suggested some changes/additions to it. Some of these were followed, others not. As events turned out, one cannot help being satisfied that the author decided against making any time-consuming additions, such as a compilation of extra references and an extra figure section (and also searching for more photogenic specimens for some plate figures, such as could with certainty have been located in other collections), because every single of them might have compromised the very completion of the book. He was well aware of potential shortcomings but equally of the circumstances under which he was completing the manuscript: "This may well be a valedictory work and if you want it at all, you get it warts and all" was his final statement in the 'Preface'. His aims and promises, as clearly spelled out in the 'Introduction' appear in our judgment to have been overall fulfilled admirably: the book is indeed a comprehensive account of the "biology, distribution and diversity" of the tineid moths of the globe – and as such it will prove an invaluable source of information, and inspiration, to curators, systematists and field biologists (professionals and amateurs alike) for a very long time to come.

"*He has left us an extraordinary legacy, for he was an extraordinary man*" was the closing sentence in Gaden Robinson's (1986) essay about Edward Meyrick's writings on phylogeny. Very much the same can be said about Gaden himself. *Biology, distribution and diversity of tineid moths* is a fitting copestone to this extraordinary legacy.

Acknowledgements

We are grateful to Drs Malcolm J. Scoble and Klaus Sattler for information and comments.

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New and poorly known Palaearctic Microlepidoptera (Tineidae, Acrolepiidae, Douglasiidae, Epermeniidae)

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Abstract. A study of 216 specimens of Tineidae, Acrolepiidae, Douglasiidae, and Epermeniidae establishes 73 first country records, three first records apart from the type series, one first record for Europe, and one first record for the Nearctic region. *Infurcitinea iberica* sp. n., *Infurcitinea corsica* sp. n., and *Tinagma asymmetricum* sp. n. are described as new species. A lectotype is designated for *Tineola macropodella* Erschoff, 1874, which is a new synonym of *Pararhodobates syriacus* (Lederer, 1857). *Infurcitinea romanica* CapuÕe, 1966, hitherto a synonym of *Infurcitinea olympica* Petersen, 1958, is reinstated as a valid species. The taxon *kirghiztana* Zagulajev, 2002, described in *Fermocelina*, is transferred to *Reisserita*. The author of *Reisserita zelleri* is Zagulajev, 1992, not Caradja, 1920.

Introduction

Following previous publications on the results of my long-standing faunistic and taxonomic studies on palaearctic members of the families mentioned in the title (Gaedike 2007, 2009) I am able to provide new records for several countries, to describe some new species, and to establish new synonymies. The hitherto known distribution of the species of the families dealt with in this paper can be found in Gaedike (2009) (Fauna Europaea, vers. 2.1).

The material studied comes from collecting trips of several colleagues, and is now deposited in various museums or in the private collections of the collectors, as listed below.

Abbreviations

coll. B. Bengtsson	collection Bengt Å. Bengtsson, Färjestaden, Sweden
coll. G. Derra	collection Georg Derra, Reckendorf, Germany
coll. S. Gomboc	collection Stanislav Gomboc, Kranj, Slovenija
coll. M. Hellers	collection Marcel Heller, Bissen, Luxembourg
coll. M. Lasan	collection Mojmir Lasan, Ljubljana, Slovenija
coll. H. Roweck	collection Hartmut Roweck, Kiel, Germany
coll. W. Schmitz	collection Willibald Schmitz, Bergisch-Gladbach, Germany
coll. F. Theimer	collection Franz Theimer, Berlin, Germany
coll. W. Wittland	collection Wolfgang Wittland, Dalheim-Wegberg, Germany
coll. M. Zerafa	collection Michael Zerafa, Naxxar, Malta
FMNH	Finnish Museum of Natural History (Lauri Kaila), Helsinki, Finland
MHNL	Musée national d'histoire naturelle (Marc Meyer), Luxembourg, Luxembourg
MNHN	Muséum National d'Histoire Naturelle (J. Minet), Paris, France
RMNH	Nationaal Natuurhistorische Museum ("Naturalis") (Erik van Nieukerken), Leiden, The Netherlands
SDEI	Senckenberg Deutsches Entomologisches Institut, Müncheberg, Germany
SMNK	Staatliches Museum für Naturkunde (Robert Trusch), Karlsruhe, Germany
ZMUC	Zoological Museum (Ole Karsholt), Copenhagen, Denmark

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TINEIDAE

Rhodobates unicolor (Staudinger, 1870)

Material. 1♂, France: **Corsica**, 3 km SE of Bonifacio, 1 km N of Capo Pertusato, 23.ix.2003, leg. P. Skou; ZMUC; 2♂, Corsica, 4 km N of Solenzara, Marine de Solaro, 21.ix.2003, leg. P. Skou; ZMUC. First record for Corsica.

Pararhodobates syriacus (Lederer, 1857)

= *Tineola macropodella* Erschoff, 1874, **syn. n.**

In his paper summarising the results of the Fedschenko-Expedition to Turkestan, published in 1874, Erschoff described on p. 98 "*Tineola*" *macropodella*. The systematic position of this taxon was for a long time unknown. In the revision of the Eriocottidae of the USSR (1988) Zagulajev mentioned this taxon under the genus-name *Deuterotinea*. It has been impossible for me to assertain, who transferred the taxon to the genus *Deuterotinea*. Zagulajev studied the specimen, that was (and is still) located in the collection of the Zoological Museum of the Moscow State Lomonossow-University (see Antonova 1981: 224).

According to Zagulajev's determination label, he considered the species to be conspecific with *Pararhodobates syriacus*. He does not established this synonymization in a formal way with the designation "syn. nov.", and until now this synonymy has not been formally published or used in any systematic lists, catalogues or databases of Tineidae. To fill this gap, *Tineola macropodella* Erschoff, 1874 is now designated as new synonym of *Pararhodobates syriacus* (Lederer, 1857).

Through the courtesy of my colleague A. V. Sviridov at the Zoological Museum of the Moscow State Lomonossow-University it was possible for me to examine a picture of the male genitalia of the specimen of *macropodella* which was studied by Zagulajev.

I now designate this specimen as the lectotype of *Tineola macropodella* according to ICZN (Article 74.7.), to prevent nomenclatural confusion in the interpretation of this taxon.

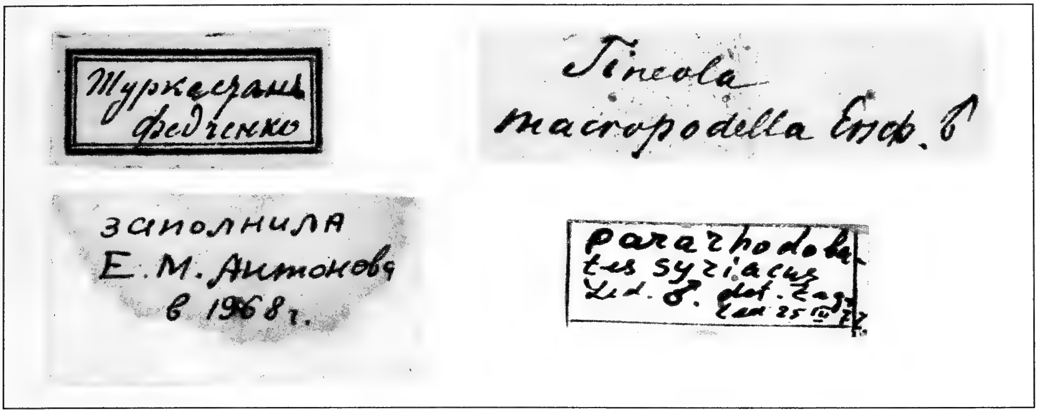
The labels of the lectotype are shown on Figures 1 and 2. The following two labels were added: "[red paper] Lectotypus ♂ Tineola macropodella Ersch., des. R. Gaedike 2009, "Pararhodobates syriacus Led., det. R. Gaedike 2009".

Euplocamus anthracinalis (Scopoli, 1763)

Material. 2♂, **Luxembourg**, Roost-Essingen, 20.v.1999, leg. et coll. M. Hellers. New country record.

Montescardia tessulatella (Zeller, 1846)

Material. 1♂, **Luxembourg**, Blaschette, 1.vii.2006, leg. et coll. M. Hellers. New country record.



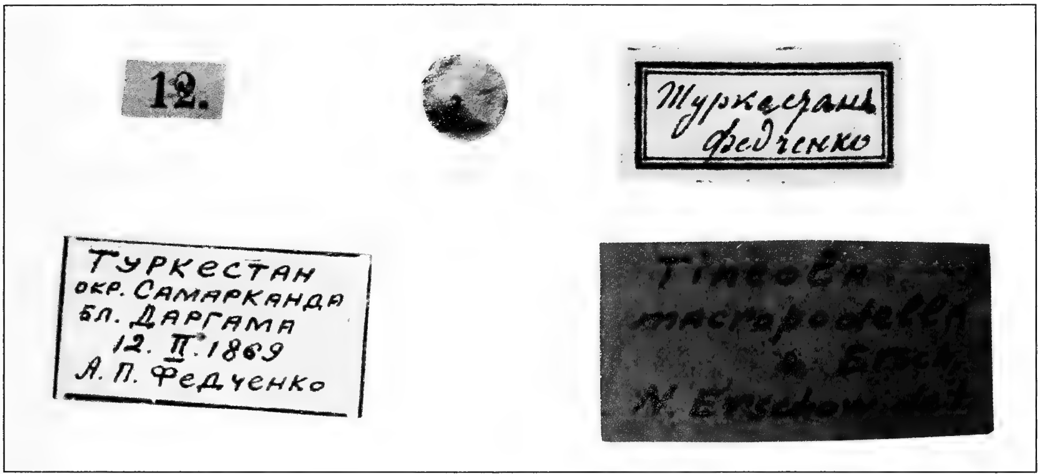
Туркестанъ
Федченко

Tineola
macropodella Ersch. ♂

заполнила
Е. М. Антонова
в 1968 г.

Pararhodobates syriacus
Led. ♂. det. Zag.

Fig. 1. Labels of lectotype of *Tineola macropodella* Erschoff, 1874; labels with cyrillic alphabet: label 1. <Turkestan' Fedschenko>; label 3: <zapolnila E. M. Antonova v 1968 g.> [completed by E. M. Antonova in 1968].



12.

Туркестанъ
Федченко

ТУРКЕСТАН
окр. САМАРКАНДА
бл. ДАРГАМА
12. II. 1869
А. П. Федченко

Tineola
macropodella
♂ Ersch.
N. Erschoff det.

Fig. 2. Labels of lectotype of *Tineola macropodella* Erschoff, 1874; labels with cyrillic alphabet: label 4. <Turkestan okr. Samarkanda [surroundings of Samarkand]; bl.[izi] Dargama [near to Dargam], 12.II.1869, A. P. Fedschenko>.

Triaxomera parasitella (Hübner, 1796)

Material. 1♀, **Luxembourg**, Frisange-Aspelt, 4.vi.1996; 1♀, Weller la Tour, 5.vi.1996, leg. M. Meyer; MHNL. New country record.

Nemapogon cloacella (Haworth, 1828)

Material. 1♂, **Luxembourg**, Eisenborn, 27.v.1996, leg. M. Hellers; 1♂, Oberanven, 15.vi.1999, leg. M. Hellers; 1♂, 1♀, Lielig, Stengigefeld, 20.v.1993, leg. M. Hellers; 4♂, Oberschlinder, 8.vi.1996, 23.vi.1999, leg. M. Hellers; 1♂, Kautenbach, 24.vi.1995, leg. M. Hellers; 1♂, Bastendorf, 2.vi.1996, leg. M. Hellers; 1♂, Goebelsmühle, 19.vi.1993, leg. M. Hellers; 3♂, Brandenbourg, 15.v.1990, 20.v.1999, leg. M. Hellers; 2♂, Lellingen, 12.vi.1994, leg. M. Hellers; 13♂, 2♀, Kandel, Mai, Juni, Juli, leg. M. Hellers; all coll. Hellers. New country record.

Nemapogon wolffiella Karsholt & Schmidt Nielsen, 1976

Material. 1♂, **Luxembourg**, Vianden, Mont-St-Nicolas, 18.vi.1998; 2♂, Tandel, 21.vi.1996; 1♂, Stegen-Mouschberg, 2.vi.1998; 1♂, Bastendorf, 2.vi.1996, all leg. et coll. M. Hellers. New country record.

Nemapogon nigralbella (Zeller, 1839)

Material. 1♀, **Greece**, Prov. Ioánina, 4 km W Agia Paraskevi, 750 m, 26.viii.2008, leg. P. Skou; (det. O. Karsholt); ZMUC. New country record.

Nemapogon ruricolella (Stainton, 1859)

Material. 1♂, **France**, Corsica, Cargèse, 15.–16.v.1999, leg. O. Karsholt; ZMUC. First record for Corsica.

Nemapogon clematella (Fabricius, 1781)

Material. 1♂, **Luxembourg**, Mersch-Schoenfels, 18.vi.2002; 1♀, Frisange-Aspelt, 5.viii.1996, leg. M. Meyer; MHNL. New country record.

Nemapogon granella (Linnaeus, 1758)

Material. 1♂, **Luxembourg**, Luxembourg, 25.ix.2002; 1♀, Steinfort-Kleinbettingen, 2.vi.1987, leg. M. Meyer; MHNL. New country record.

Nemapogon levantina Petersen, 1961

Material. 1♂, **Greece**, Crete, W. Omalos, 1100–1200 m, 28.vii.–2.viii.2001, leg. M. Fibiger et al.; ZMUC. First record for Crete.

Triaxomasia caprimulgella (Stainton, 1851)

Material. 1♂, **Spain**, Zaragoza, 5 km N Tosdos by Rio Huerva, 750 m, 16.vii.1988, leg. M. Fibiger; ZMUC; 1♀, Pyrenäen, Prullans, 900 m, 2.vii.1980, leg. et coll. Derra. New country record.

Gaedikeia kokkariensis Sutter, 1998

Material. 1♂, **Greece**, Lakonia, Palaeopanagia, 12 km S Sparti, 350 m, 23.vii.1998, leg. B. Skule & D. Nilsson; ZMUC. 1♀, **Cyprus**, Moniatis, N. Limassol, 850 m, 23.–29.vi.1997, leg. P. Svendsen et al.; ZMUC. 1♀, **France, Corsica**, above Lozzi, 1150 m, 18.vii.2004, leg. P. Skou; ZMUC; 1♂, Corse, 22 km W Solenzara Vacca, La Solenzara, 550 m, 23.vi.2005, leg. B. Skule; ZMUC. New country records, and first record for Greek mainland; hitherto known only from the Greek Islands of Samos and Rhodos, and from Spain.

Neurothaumasia macedonica Petersen, 1962

Material. 1♂, **Italy**, Puglia, 5 km SW of Manfredonia, 26.v.2005, leg. P. Skou; ZMUC. New country record.

Tenaga nigripunctella (Haworth, 1828)

Material. 1♀, **France**, Nantes, 12.vii.1919, MNHN. New country record.

Tenaga rhenania (Petersen, 1962)

Material. 1♀, **France**, Corsica, Castiria, 12 km N Corte, 400 m, 20.vi.1994, leg. B. Skule & P. Skou, ZMUC. 1♀, **Spain**, Balearic Islands, Ibiza, 28.viii.2004, leg. U. Deutschmann; SDEI. First records from Corsica and Balearic Islands.

Matratinea rufulicaput Sziraki & Szöcs, 1990

Material. 1♂, **Greece**, Molivos lesvos, 8.vi.1994, leg. J. P. Baungaard, ZMUC. First record other than the type (Hungary).

Eudarcia (Meessia) pagenstecherella (Hübner, 1825)

Material. 1♂, **Luxembourg**, Goebelsmühle, 23.vi.1999, leg. et coll. M. Hellers. New country record.

Eudarcia (Obesoceras) graeca (Gaedike, 1985)

Material. 2♂, **Greece**, Lakonia, Palaeopanagia, 12 km S Sparti, 350 m, 23.vii.1998, leg. B. Skule & D. Nilsson; ZMUC. First record other than the holotype.

Infurcitinea iberica sp. n. Figs 3, 6–8, 20

Material. Holotype ♂, '**Spanien**/Almeria, Rambla Tabernas, 100 m, 5.3. [20]03, leg. W. Schmitz', 'Gen.präp. [genitalia slide] Gaedike Nr. 5601', 'Holotypus ♂, *Infurctitinea iberica* sp. n. det. R. Gaedike 2009', SDEI. – Paratypes: 1♂, 'Spanien/Almeria, Cabo de Gata, 300 m, 08.03.2008, leg. J. Viehmann', 'prep. [genitalia slide] Gaedike 6408', coll. W. Schmitz; 1♂, same location, 300 m, 88.03.2009, leg. J. Viehmann, 'prep. [genitalia slide] Gaedike 6658', coll. W. Schmitz; 1♂, 'Hispania, Andalusia, Arriate, 12 km Ø Rhonda, Casa Alta, 640 m, 5.v.1991, leg. E. Traugott-Olsen', 'prep. [genitalia slide] Gaedike 5388', ZMUC; 1♂, 'Spain, prov. Granada, 36°45'00"N, 03°40'13"W, Almunecar Moscaril, 150 m, 6.–12.v.2000, C. Hviid & B. Skule', 'Coll. ZMUC Copenhagen, DK', 'Gen.präp. [genitalia slide] Gaedike NR. 6851', SDEI; 1♀, 'SPAIN, prov. Granada 25 km N Almunecar Moscaril, 500 m, 28.viii.–9.ix.2004, G. Jeppesen', 'Coll. ZMUC Copenhagen, DK', 'Gen.präp. [genitalia slide] Gaedike NR. 6852', ZMUC.

Diagnosis. In the structure of the genitalia there are similarities to *I. megalopterella* Petersen, 1964, but the truncated uncus, and the shape of the anellus are distinctive for the new species.

Description (Fig. 3). Wingspan 8–9 mm; head pale yellowish, antenna on inside of scapus of same coloration, outside of scapus and flagellum dark grey; thorax pale yellowish, base of tegulae somewhat darker; forewing whitish, overlaid with numerous darker scales, without clear patterning, most darker scales at base and on first half of costa.

Male genitalia (Figs 6–8). Uncus truncated, vinculum ventrally invaginated, laterally rounded; valva basally broad, after 1/2 narrower, costal arm bristled, pointed proximally, ventrally with thin, long processus, with very long narrow transtilla; phal-

lus basally bulbus-shaped, proximally curved, narrow, anellus twice as long as phallus, consisting of two apically rounded folds, connected with phallus.
Female genitalia. (Fig. 20). Anterior apophyses short, unforked, eighth segment stronger sclerotized than other segments, ductus bursae below ostium with numerous small, sclerotized rounded tubercles; first part of this tuberculous area something widened, with ring-like strong sclerotized edges.
Etymology. Named after the collection locality of the type series.

Infurcitinea corsica sp. n. **Figs 4, 9–11**

Material. Holotype ♂, 'Corsica, Haut Asco, 1200–1400 m, 23.vi.1994, leg. B. Skule & P. Skou', 'Gen.präp. [genitalia slide] Gaed.[ike] Nr. Präp. 5421', 'Holotypus ♂ *Infurcitinea corsica* sp. n. det. R. Gaedike 2009', ZMUC.

Diagnosis. In the structure of the genitalia this species is similar to *I. belviella*, described from Sardinia, but the shape of the valva with the characteristic sclerotizations at the apex, and the phallus (as long as valva; the subapical tooth-like sclerotization) are distinctive for the new species.
Description (Fig. 4). Wingspan 10 mm; head whitish, scales between eyes darker, antenna dark grey, inside of scapus whitish; thorax pale, overlaid with dark grey scales, tegulae dark grey; ground colouration of forewing pale whitish, with pattern of dark grey scales consisting of unclearly delineated transverse stripe at 1/2, spot on base of dorsum (dorsal edge), and nearly whole apical half. Fringe pale whitish; hindwing white.
Male genitalia (Figs 9–11). Uncus long, narrow; vinculum laterally with two narrow processi, apically convex; valva basally broad, with long, narrow transtilla, in second half becoming narrow towards rounded apex, costal edge convex, ventral edge concave, apex with tooth-like sclerotizations; phallus as long as valva, basally bulbous, apically forked, one arm (anellus?) shorter, bristled on inside, longer arm slightly curved, narrow, subapically on inside with small tooth-like sclerotization.
Female genitalia. Unknown.
Etymology. Named after the island of Corsica, the location of the type locality.

Infurcitinea rumelicella (Rebel, 1903)

Material. 1♂, **Turkmenistan**, W. Kopet Gad, 800 m, 40 km E Garrygala = Kara Kala, 21.v.1993, leg. V. Sruoga; ZMUC. New country record.

Infurcitinea sardica (Amsel, 1952)

Material. 1♀, **France**, Drôme, St. Restitut by St. Paul Trois Chateaux, 250 m, viii 1984, leg. Fibiger & Moberg; ZMUC. New country record.

Infurcitinea kasyi Petersen, 1962

Material. 1♂, **Greece**, Falakron-geb., Panorama, 1100 m, 26.v.2009, leg. et coll. W. Schmitz. New country record.

Fig. 3. *Infurcitinea iberica* sp. n., adult.

Fig. 4. *Infurctitinea corsica* sp. n., adult.

Infurcitinea banatica Petersen, 1961

Material. 2♂, **Greece**, Florina, 1 km NW Pisoderi, 1600 m, 14.vii.1998, leg. B. Skule & D. Nilsson; ZMUC. New country record.

Infurcitinea roesslerella (Heyden, 1865)

Material. 1♂, 1♀, **Andorra**, Arnizal, 1500 m, 1.viii.1997, leg. J. P. Baungaard; ZMUC. 3♂, **Luxembourg**, Lellingen, Lellgerbach, 20.vi.1998, 3.vi.2004; 2♂, Kautenbach Ueweschlaed, 1.vi.1995, leg. et coll. M. Hellers. New country records.

Infurcitinea hellenica Gaedike, 1997

Material. 1♂, **Greece**, Epidaurus, Korfos, 200 m, 21.v.2007, leg. W. Schmitz; SDEI. First record other than the holotype.

Infurcitinea atrifasciella (Staudinger, 1870)

Material. 1♂, 1♀, **Andorra**, St. Julia, 7., 8.vii.1982, leg. P. J. L. Roche; RMNH. New country record.

Infurcitinea albicomella (Stainton, 1851)

Material. 4♂, **San Marino**, 9.vii.1981, leg. P. Grotenfelt; FMNH. New country record.

Infurcitinea romanica Căpuşe, 1966, stat. rev.

Material. 1♂, **Romania**, Carao-Severin, 5 km S Seoca Montana, 44°51'N, 21°44'E, 525 m, 14.vii.2005, leg. B. Skule, C. Hviid, E. Vesterhede; ZMUC.

Remarks. Previously (Gaedike 1983) the species was listed as a synonym of *I. olympica* Petersen, 1958 (Figs 12–14). Recently, a more detailed study of the male genitalia revealed, that *romanica* (Figs 15–18) is a valid species. The shape of the apical part of the valvae and the shape of the anellus are quite different.

Infurcitinea teriolella (Amsel, 1954)

Material. 1♀, **Spain**, Granada, 10 km E Baza, 24. vi. 1989, leg. et coll. B. Å. Bengtsson. New country record.

Infucitinea parnassiella Gaedike, 1987

Material. 1♂, **Greece**, Parnass, 1900 m, 4.viii.2005, leg. Viehmann, coll. W. Schmitz. First record other than the type series (Greece: Parnass).

Lichenotinea pustulatella (Zeller, 1852)

Material. 1♀, **Spain**, Castellon de la Plana, 20 km SE Morella, 15.vi.1989, leg. B. Å. Bengtsson; ZMUC. 3♂, **Greece**, Ipiros, Konitsa area, below Smolikas, 700–1500 m, 21.–23.v.1994, leg. O. Karsholt; ZMUC. New country records.

Agnathosia mendicella (Denis & Schiffermüller, 1775)

Material. 1♂,1♀, **Luxembourg**, Mauternach, Op der Fels, 25.viii., 31.vii.2003; 2♂, Mersch, Schoenfels, 26.vii.2002, leg. M. Meyer; MHNL. New country record.

Myrmecozela ataxella (Chrétien, 1905)

Material. 1♂, **Spain**, Canary Islands, Fuerteventura, Bco. Esquinzo, 2.iii.–10.vi.2007, leg. R. Paas, coll. W. Schmitz. First record from the Canary Islands.

Ateliotum syriacum (Caradja, 1920)

Material. 1♂, **Greece**, Crete, Nom. Chania, 35°25'44"N, 23°55'22"E, Skines, 5.–11.vi.2004, leg. B. Skule, C. Hivid & E. Vesterhede; 1♂, GR, Crete, 4 km S Topolia, 300 m, 25.–29.vi.2000, leg. P. Svendsen; D. Nilsson; A. Madsen & M. Fibiger: ZMUC. First records for Europe.

Cephimallota tunesiella (Zagulajev, 1966)

Material. 4♂, 1♀, **Greece**, Crete, Sivas, 20.ix.–05.x.2008, leg. A. Blumberg, coll. W. Schmitz. New country record.

Ceratuncus danubiellus (Mann, 1866)

Material. 1♂, **Malta**, Mellieka, 20.–25.v.1994, leg. U. Seneca; coll. H. Roweck. New country record.

Ceratuncus kirghizstana (Zagulajev, 2002), comb. n.

In 2002, Zagulajev described a new species from Kirghizstan, *Fermocelina kirghizstana*. However the illustrations of the male genitalia show a very close affinity with members of the genus *Ceratuncus* Petersen, 1957 (shape of the uncus, absence of the gnathos arms). For this reason the taxon has to be considered a member of *Ceratuncus* Petersen and is transferred herewith to this genus.

Reisserita zelleri Zagulajev, 1992, not Caradja, 1920

Monopis imella, ab. *zelleri* Caradja, 1920

Material. 1♀, **Russia**, Tuva rep., ca 25 km W Erzin, steppe/stony slopes, 50°16'N, 94°54'E, 1250 m, 7.–11.vi.1995, leg. Jalava & Kullberg; FMNH. New country record.

Remarks. Zagulajev (1992) mentioned the taxon "*Reisserita zelleri* (Car.)", and referred to the description of "*Monopis imella*, ab. *zelleri*", which was published by Caradja (1920). This was an infrasubspecific description (ICZN: 45.6.2.), and the name was not available. In 1992 Zagulajev used "*zelleri*" in combination with the genus name *Reisserita* as the name for this taxon, and made it available from that date. He described this species in great detail on the basis of two specimens, the holotype (♂) is the specimen that Caradja named as ab. *zelleri*. The paratype (♀) was collected also in Kazakstan (Karagandinskaja obl. [region], gora [mountain] Koksengir, 19.vi.1958, leg. Zagulajev).

Anomalotinea liguriella (Millière, 1879)

Material. 3♂, **Greece**, Ofryonia, Kavalla, 9.vii.2007, leg. J. Viehmann; coll. W. Schmitz; 2♂, 14 km nw Kastoria, 1200 m, 10.vii.2007, leg. J. Viehmann; coll. W. Schmitz. New country record.

Anomalotinea gardesanella (Hartig, 1950)

Material. 2♂, 1♀, **Greece**, Samos, Pithagoria, 16.–24.vi.1997, leg. J. P. Baungaard; ZMUC. New country record.

Tineola bisselliella (Hummel, 1823)

Material. 1♂, **Luxembourg**, Bettel, June 2002, leg. et coll. M. Hellers. New country record.

Tinea pellionella Linnaeus, 1758

Material. 1♀, **Spain**, Canary Islands, La Palma, Tacande de Abajo, 6.iii.2007, leg. M. Meyer; MHNL. New country record.

Tinea semifulvella Haworth, 1828

Material. 3♂, **Luxembourg**, Wellenstein, 16.vii.1997, 19.vi.1998; 1♂, Dudelange, 17.vi.2000; 1♂, Bous-Heisbourgberhof, 21.vii.1998, leg. M. Meyer; MHNL. New country record.

Niditinea fuscella (Linnaeus, 1758)

Material. 1♀, 1 specimen without abdomen, **Andorra**, St. Julia, 31.v., 18.vi.1982, leg. P. J. L. Roche; RMNH. New country record.

Niditinea striolella (Matsumura, 1931)

Material. 1♂, **Luxembourg**, Manternach: Manternach Op der Fels, 31.vii.2003, leg. M. Meyer; MHNL. 1♂, **Portugal**, Beira Alto, Viseu, 8.vi.1972, leg. P. Grotenfelt; FMNH. New country records.

Niditinea tugurialis (Meyrick, 1932)

Material. 1♂, **Croatia**, Dalmatien: Herzegnovi, Igalo, 15.iv.1938, leg. Amsel; SMNK. New country record.

Proterospastis merdella (Zeller, 1852)

Material. 1♂, **Greece**, Samos, Pithagoria, 16.–24.vi.1997, leg. J. P. Baungaard; ZMUC. New country record.

Metatinea immaculatella (Rebel, 1892)

Material. 1♂, **France**, Corse, Calvi, 18.–19.viii.1998, leg. O. Karsholt; ZMUC. New country record, hitherto known only from Canary Islands.

Phereoeca allutella (Rebel, 1892)

Material. 1♂, **Italy**, Sardinia, Olbia, 4.ix.2007, leg. H. Roweck & N. Savenkov; coll. H. Roweck. New country record.

Monopis weaverella (Scott, 1858)

Material. 1♂, **Luxembourg**, Manternach, Zwirwel, 31.vii.2003, leg. M. Meyer; MHNL. New country record.

Monopis obviella (Denis & Schiffermüller, 1775)

Material. 2♂, **Andorra**, St. Julia, 15.vi.1981, 19.vii.1983, leg. P. J. L. Roche; RMNH. 27♂, 2♀, **San Marino**, 7.vi.1981, leg. P. Grotenfelt, FMNH. 1♂, **Luxembourg**, Mondorf les Bains, Altwies, Groufbierg, 10.vi.1998, leg. M. Meyer; MHNL. New country records.

Monopis imella (Hübner, 1813)

Material. 1♂, **San Marino**, 29.ix.1980, leg. P. Grotenfelt; FMNH. New country record.

Monopis monachella (Hübner, 1796)

Material. 2♂, **Greece**, Kavalla/Ofryonia, Strymon-Delta, 24.v.2009, leg. et coll. W. Schmitz. New country record.

Opogona omoscopa (Meyrick, 1893)

Material. 1♀, **Italy**, Sardinia, Siniscola, 5.viii.2007, leg. H. Roweck & N. Savenkov; coll. H. Roweck. New country record.

ACROLEPIIDAE

Digitivalva (Inuliphila) occidentella (Klimesch, 1956)

Material. 1♀, **Italy**, Sicily, 300 m, below Pollina, 22.iv.2006, leg. O. Karsholt; ZMUC. First record for Sicily.

Digitivalva (Inuliphila) granitella (Treitschke, 1833)

Material. 1♀, **Greece**, Fokida-Stausee, 700 m, 31.v.2006, leg. et coll. W. Schmitz. New country record.

Acrolepia autumnitella Curtis, 1838

Material. 1♀, **Slovenia**, Ljubljanska kotlina, Strañišce pod Smarjetno, 46°14', 14°21', 1.v.2005, leg. et coll. S. Gomboc. New country record.

DOUGLASIIDAE

Tinagma dryadis Staudinger, 1872

Material. 4♀, **Russia**, SW-Altai, 7 km N Katanda, 2200–2500 m, 20.–21.vii.1983, Exp. Mikkola, Hippa, Jalava leg.; FMNH. 1♀, **Canada**, Yukon T., 64°45' N, 138°15' W, Ogilvie Mnts, 1200 m, 6.vii.1985, leg. K. Mikkola; FMNH. 1♂, 1♀, **USA**, Alaska, Utukok R. 25.vi.1974, leg. Sotavalta; FMNH; 1♂, 2♀, Alaska, Eagle Summit. 20 vi.1974, leg. Sotavalta; FMNH. First records from the Nearctic and first record from Altai.

Tinagma hedemanni (Caradja, 1920)

Material. 1♀, **Turkey**, Aksehir, 30 km SW, 1200 m, 28.iv.1998, leg. S. Tabell; ZMUC; 1 specimen without abdomen, Egirdir, 5 km W, 28.iv.1998, leg. S. Tabell; ZMUC. New country record.

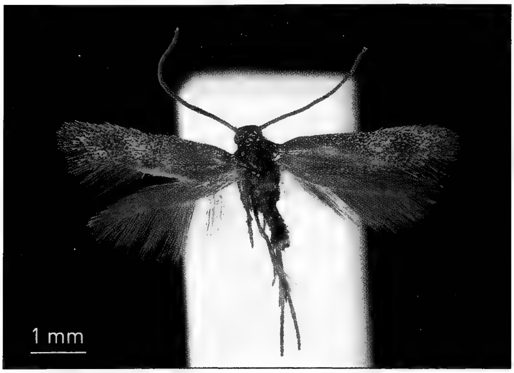


Fig. 5. *Tinagma asymmetricum* sp. n., adult.

Tinagma anchusellum (Benander, 1936)

Material. 1♀, **Hungary**, Leanyfala, 5.–10.vii.1997, leg. B. S. Larsen; ZMUC. New country record.

Tinagma balteolellum (Fischer von Roeslerstamm, 1841)

Material. 1♂, **Portugal**, Lusitania: Estremadura, pr. Lisboa, 8.v.1971, leg. P. Grotenfelt; FMNH. New country record.

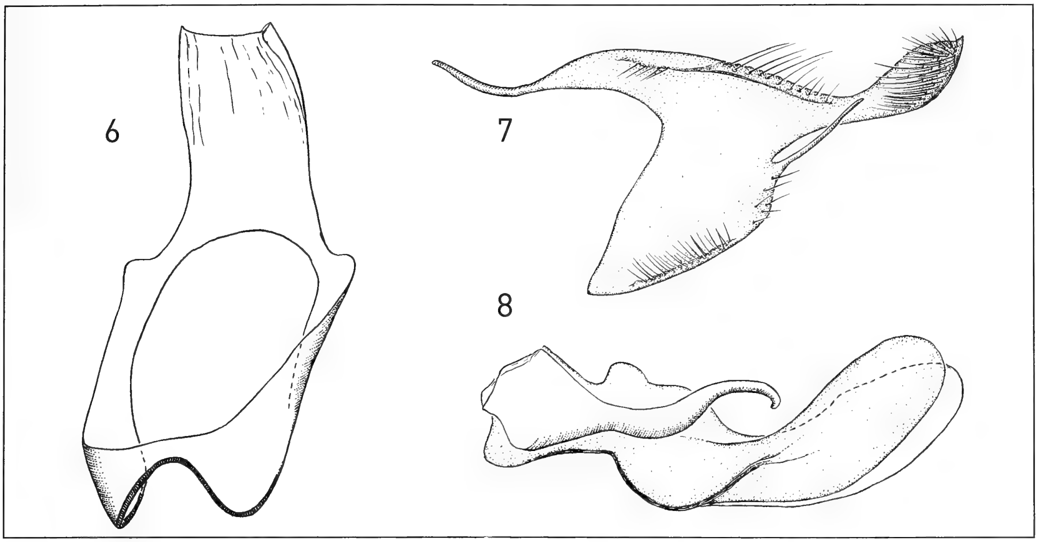
Tinagma asymmetricum sp. n. Figs 5, 19

Material. Holotype ♂, 'RMNH / EvN no. 93092 **ESPANA** (Valencia) 6 km N Bétera: Canade de Bigarra. 24 APR 1993, 30S YJ1792 100 m. van Nieukerken & Koster', 'Open mattoral with Pinus pinea; netted in sunshine RMNH / EvN no. 93092', 'Gen.präp.[genitalia slide] Gaedike NR: 6644', 'Holotypus ♂ *Tinagma asymmetricum* sp. n. det. R. Gaedike 2010', RMNH. – Paratypes: 1♂ with same data, 'Paratypus ♂ *Tinagma asymmetricum* sp. n. det. R. Gaedike 2010', RMNH; 1♂ with same data, Gen.präp. [genitalia slide] Gaedike NR: 5698, 'Paratypus ♂ *Tinagma asymmetricum* sp. n. det. R. Gaedike 2010', SDEI.

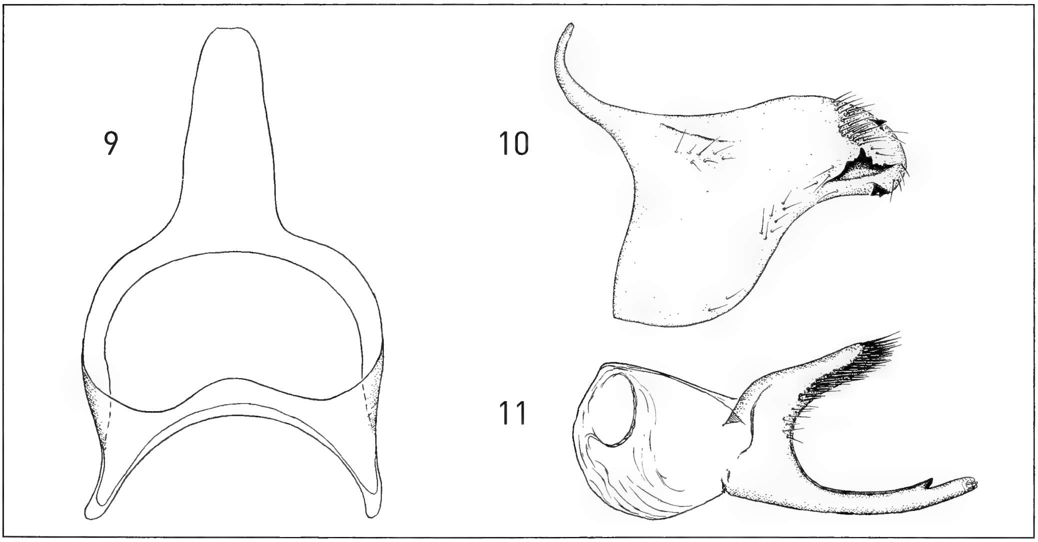
Diagnosis. Superficially somewhat similar to *Tinagma hedemanni* (Caradja, 1920) and *T. anchusellum* (Benander, 1936), but the structure of the genitalia (asymmetric valvae, and very long saccus) distinguish the new species from all other known members of the genus.

Description (Fig. 5). Wingspan 7.0–8.0 mm; head dark grey, tips of scales whitish; laterally antenna and below eyes more whitish; antenna ventrally white, dorsally dark grey, palpi short, inner side more whitish than outer side; thorax also with dark grey scales with whitish tip; forewing with same coloration, base more grey, at 1/2 with shadow-like large dark dot, nearly without any whitish spots, fringe with long white scales with dark grey tips; hindwing dark grey.

Male genitalia (Fig. 19). Uncus characteristic for genus, nearly triangular, vinculum narrow, saccus extremely long, more than half of length of phallus; valvae nearly rectangular, apically slightly rounded, subapically with some rows of thick truncated bristles, ventrally folded; one valve with arrow-shaped process, as long as valva, folded to innerside, other valva without any process; phallus very long, nearly three times longer than valva.



Figs 6–8. *Infurcitinea iberica* sp. n., male genitalia. **6.** Uncus-tegumen-vinculum. **7.** Valva. **8.** Phallus with anellus.

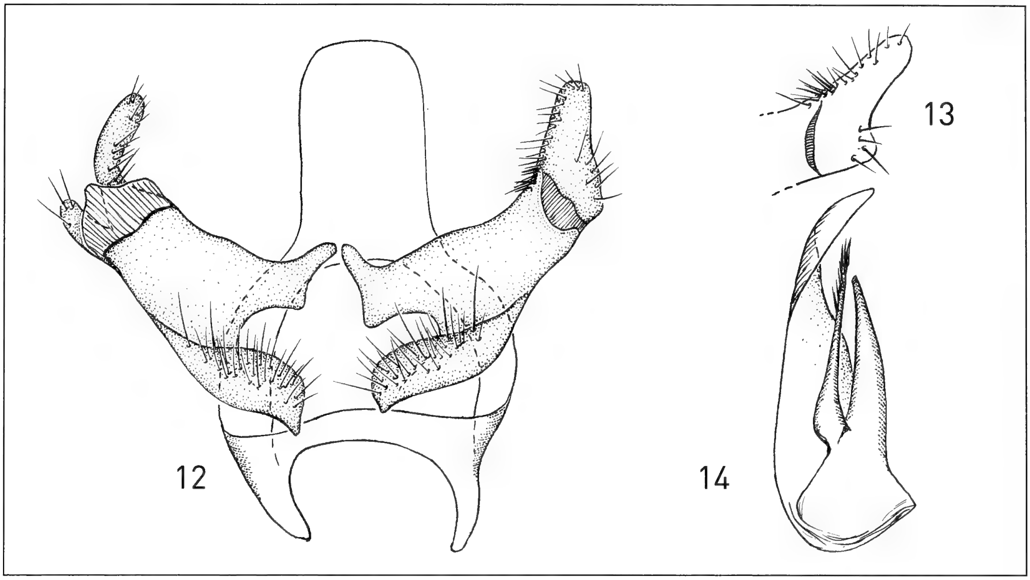


Figs 9–11. *Infurcitinea corsica* sp. n., male genitalia. **9.** Uncus-tegumen-vinculum. **10.** Valva. **11.** Phallus with anellus.

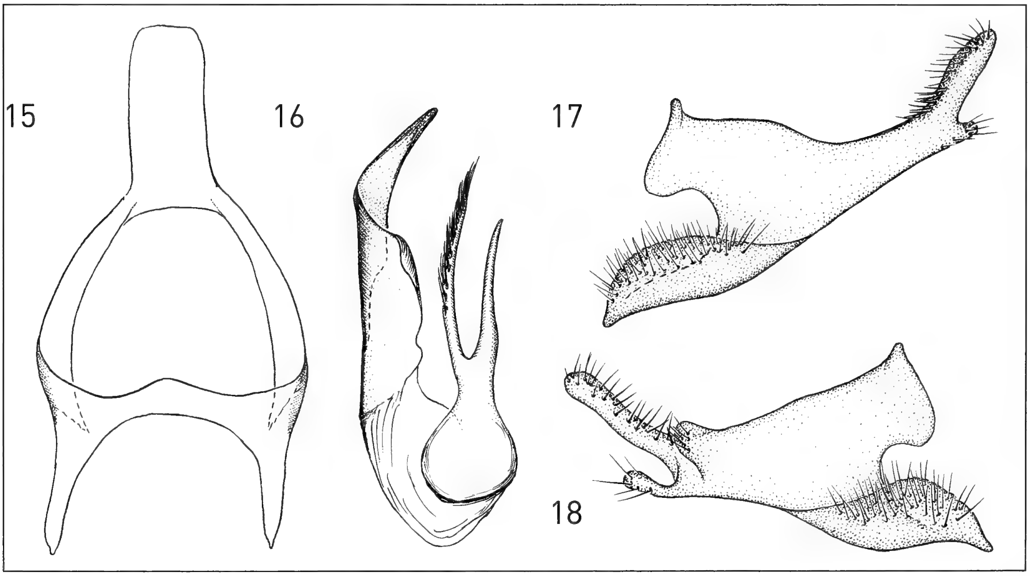
Female genitalia. Unknown.
Etymology. Named after the asymmetric valvae.

Klimeschia vibratoriella (Mann, 1862)

Material. 2♀, **Turkey**, Prov. Ismir, 30 km NW Bergama, 10.–12.v.1993, 500–700 m, leg. O. Karsholt; ZMUC. First record other than the type series (Turkey: “Brussa”).



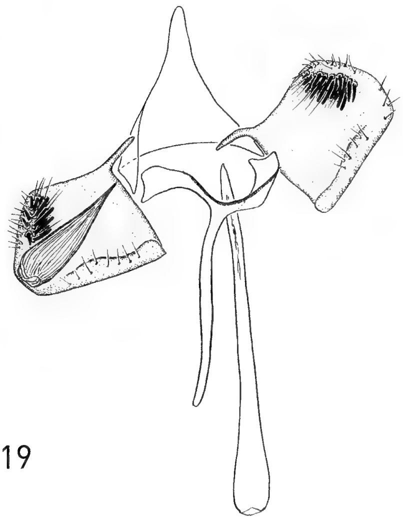
Figs 12–14. *Infurcitinea olympica* Petersen male genitalia. **12.** Genitalia, phallus with anellus removed. **13.** Phallus with anellus. **14.** Tip of valva (variability).



Figs 15–18. *Infurcitinea romanica* Căpuşe male genitalia. **15.** Uncus-tegumen-vinculum. **16.** Phallus with anellus. **17, 18.** Valvae.

Klimeschia afghanica Gaedike, 1974

Material. 1♂, **Iran**, Khorasan, Nodeh, 30-40 km ESE Bojnurd, 11.vii.1994, leg. R. Linnavuori; FMNH. 1♂, **Russia**, Tuva rep., 50°45'N, 94°29'E, 1250 m, E. Tannu-Ola mts, 16.vi.1995, leg. Jalava & Kullberg; FMNH; 1♂, Tuva rep., 50°44'N, 93°08'E, 1000 m, E. Tannu-Ola mts, 13.–16.vi.1995, leg. Jalava & Kullberg; FMNH. New country records.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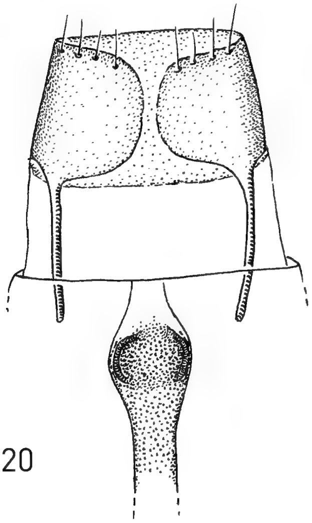
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Fig. 19. *Tinagma asymmetricum* sp. n., male genitalia. **Fig. 20.** *Infurcitinea iberica* sp. n., female genitalia.

EPERMENIIDAE

Phaulernis rebelliella Gaedike, 1966

Material. 2♂, **Croatia**, Kroatien, Bater, 800 m, 12.–24.vi.2004, leg. et coll. F. Theimer. New country record.

Epermenia (Calotripis) insecurella (Stainton, 1849)

Material. 1♂, **Greece**, Serres, Vrontous Mts. 5 km SE Kapnofito, 850 m, 16.vii.1998, leg. B. Skule & D. Nilsson; ZMUC; 1♂, Peloponisos, Ahia Helmos, 25.viii.1987, leg. P. Grotenfelt; FMNH; 3♂, Peloponisos, Florina Vatochorion, 7.viii.1987, leg. P. Grotenfelt; FMNH. 6♂, 1♀, **San Marino**, 31.viii.1980, leg. P. Grotenfelt; FMNH. New country records.

Epermenia (Calotripis) aequidentella (Hofmann, 1867)

Material. 1♂, 1♀, **San Marino**, 29.ix.1980, 9.vii.1981, leg. P. Grotenfelt; FMNH. New country record.

Epermenia (Calotripis) chaerophyllella (Goeze, 1783)

Material. 1♀, **Greece**, Crete, W. Argiroupoli, 200 m, 15 km SW Rhetymnon, 25.–29.vi.2000, leg. M. Fibiger et al.; ZMUC. First record for Crete.

Epermenia (Cataplectica) iniquella (Wocke, 1867)

Material. 1♀, **Slovenia**, Portoroñ, Señovlje, 6.ix.2000, leg. et coll. M. Lasan. New country record.

Acknowledgements

I would like to express my thanks to the following collectors and custodians for sending their material for my studies: Bengt Å. Bengtsson, Georg Derra, Stanislav Gomboc, Marcel Heller, Lauri Kaila (FMNH), Ole Karsholt (ZMUC), Mojmir Lasan, Marc Meyer (MHNL), Joel Minet (MNHN), Erik van Nieukerken (RMNH), Hartmut Roweck, Willibald Schmitz, Franz Theimer, Robert Trusch SMNK), Wolfgang Wittland, and Michael Zerafa. My special thank to Bernard Landry, Paul Sokoloff and Andrew Liston for linguistic corrections, to Christian Kutzscher for making color pictures, and to the referees for the important comments.

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Pelecystola fraudulentella (Zeller, 1852) discovered in Slovakia, a third locality record (Tineidae)

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Abstract. The occurrence of *Pelecystola fraudulentella* (Zeller, 1852) in Slovakia is recorded. This species was hitherto only known from two distant localities in Slovenia and southeastern Sweden. Photographs and sketches are given of the male and female adults and genitalia.

Introduction

In 2001 the first author received for determination from the second author drawings of male and female genitalia of two specimens collected in Slovakia. However, at this time it was impossible to identify them.

Only recently, following the discovery of the same species in Sweden (Lindeborg & Bengtsson 2009) was it possible to solve this problem. The illustrations of the genitalia published in this paper of the male lectotype of *Pelecystola fraudulentella* (Zeller, 1852) and the female specimen, collected in Sweden, show that the specimens from Slovakia belong to the same species. Information on this very remarkable record had also been published by Lindeborg (2008) and by Svensson (2008).

Pelecystola fraudulentella (Zeller, 1852)

Ivan Richter, a Slovak amateur entomologist, collected two specimens of *Pelecystola fraudulentella* (Zeller, 1852) in a locality near the village of Lehota pod Vtáčnikom, western Slovakia, on the 9th of June 2000. He informed us that these specimens (one male, one female) were caught on the wing at twilight, on a warm evening.

The locality is situated approximately two km from the village in the direction of Vtáčnik Mountain (Strážovské vrchy Mauntains) at an altitude of about 500 m. This is a canyon with steep rocky slopes, lower parts of which merge into a deciduous forest densely strewn with andesitic rocks. Moths were found close to a path running through the canyon on the north-facing slope (Fig. 1).

Beeches (*Fagus sylvatica* Linnaeus (Fagaceae)) dominate the forest, mixed with sycamore (*Acer pseudoplatanus* Linnaeus (Sapindaceae)) and sporadically with other broadleaved trees. At higher altitudes on this path the deciduous forest becomes a mixture of fir and beech. The projecting rocks in the forest are covered with moss and lichens.

This is now the third known locality in Europe for the species which, for more than 150 years, was known only from the type locality (Laibach [= Ljubljana]) in Slovenia. The site in which the specimens were collected in Slovakia is similar to that in Sweden.

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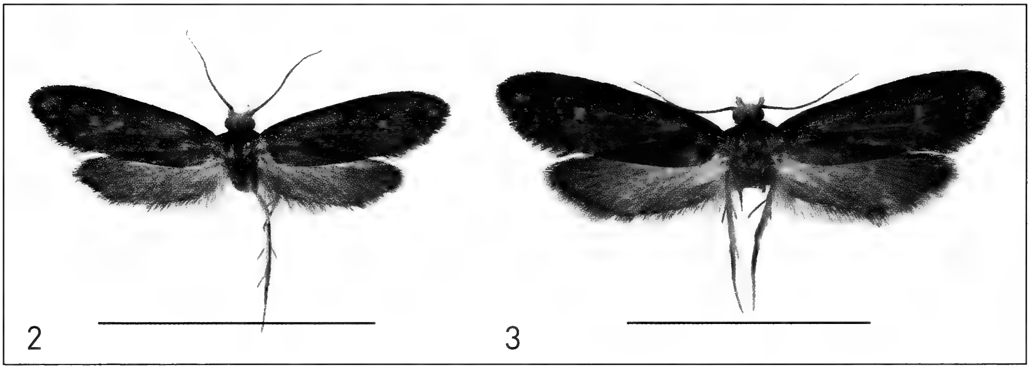
Fig. 1. Locality in which the Sovakian specimens of *P. fraudulentella* were collected.



Figs 2–3. *Pelecystola fraudulentella*. **2.** Male (wingspan: 15 mm) (scale: 10 mm). **3.** Female (wingspan: 20.5 mm) (scale: 10 mm).

Ivan Richter also tried to find adults of *Pelecystola fraudulentella* in the following two years, but was unsuccessful. The site, unfortunately, has been changed by man during the last several years and now the road leads through the canyon towards a newly opened quarry. Nevertheless, it is to be hoped that *Pelecystola fraudulentella* could be resident in similar localities elsewhere.

Fig. 4. Male head.

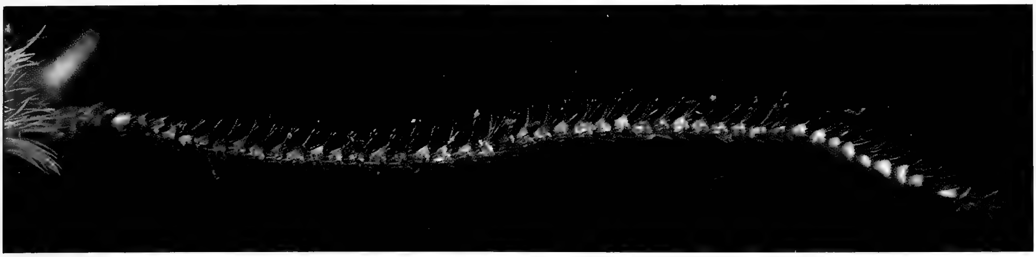


Fig. 5. Male antenna.

For the detailed description of the adult of this tineid, including the genitalia of both sexes, see Lindeborg & Bengtsson (2009). Here, we present photographs of the male (Fig. 2) and the female (Fig. 3) adults from Slovakia and, in more detail, the male head (Fig. 4) and male antenna (Fig. 5). Figures 6 and 7 show the male (from the lectotype slide) (6) and the female (7) genitalia. As the bursa copulatrix was lost in the slide of the Slovakian specimen, we illustrate the photo of the Swedish specimen, which was kindly sent to us by our colleague Bengt Å. Bengtsson.

Diagnostic and remarkable are the ciliae on the male antenna, which are 1.5 times longer than the diameter of the antenna, the pectinifera of the valva in the male genitalia, and the paired signum of the female. So far as known, there are no similarities in these features to any other Palaearctic tineid.

Lindeborg & Bengtsson (2009) discussed in great detail the assignment of *Pelecystola fraudulentella*. Up to now, according to Robinson (2007) the species has not been assigned to any subfamily. The genus may belong to a subfamily not yet defined and erected.

Seven other species of genus *Pelecystola* Meyrick, 1920 are known: four species from Africa (Gozmány & Vari 1973), one from the Nearctic (Davis & Davis 2009), one from the East Palaearctic subregion (*P. strigosa* (Moore, 1888)), and *P. hierophanta* (Meyrick, 1916) known from India (Lindeborg & Bengtsson 2009) and Japan (examined material).

Bionomy. The food-plant and the early stages are unknown. Adults have been collected only in June. Known localities indicate that it probably occurs in deciduous or mixed ancient forests. The larva may feed on fungi, rotten wood, bird's nests, etc., in the same way as larvae of many other species in the family.

Distribution. Currently the species is known from three widely separated localities in Slovenia (Ljubljana), Slovakia (Lehota pod Vtáčnikom env., Strážovské vrchy Mts.) and Sweden (NR Grytsjön, Bäckebo, Nybro) (Fig. 8). To avoid misunderstanding in the future, it should be noted that in the collections of the Zoological Museum of St. Peterburg an additional specimen is deposited under the name *fraudulentella* from "Semmering [Austria], 6. [18]48, leg. Mann" , slied Nr. 4044. The first author checked this slide, and the genitalia structure is completely different from that of *fraudulentella*.

Remarks. Why has *Pelecystola fraudulentella* been collected so infrequently up to now? We think there are several reasons: little collecting has been done in localities like ours, possibly the flight time of the adults is restricted, or the species may not

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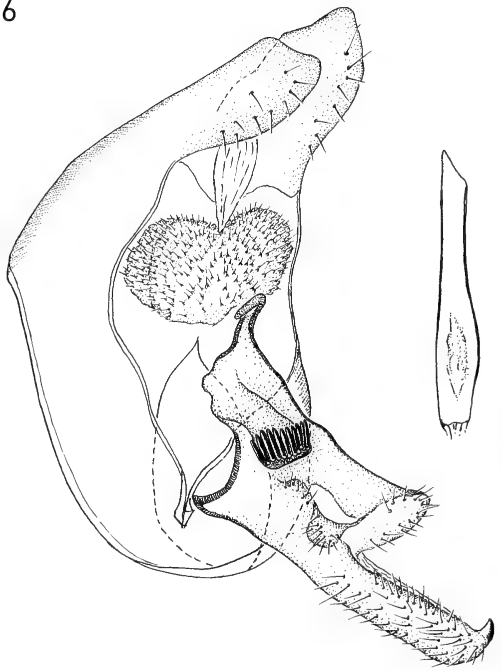

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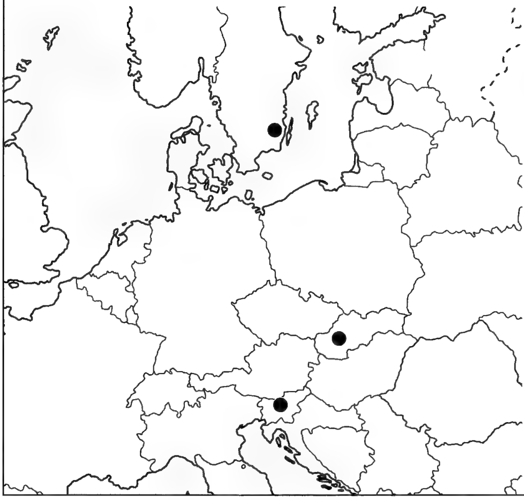

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Fig. 6. Male genitalia (after lectotype slide G.S. Robinson 12195, Brit. Mus. (N.H.) London). **Fig. 7.** Female genitalia (photo: Bengt Å. Bengtsson). **Fig. 8.** Distribution map of *P. fraudulentella*.

be attracted light. Furthermore, the immature stages of the species may be secretive and difficult to locate. We also fully agree with the other opinions of Lindeborg & Bengtsson (see: "Discussion" in their paper) about the possibilities for collecting this species. In the USA *Pelecystola nearctica* is regulary collected at light (Davis & Davis 2009).

Acknowledgements

Our thanks are due to Mr Ivan Richter (Prievidza) for providing specimens, information, and permission to publish his discovery, and to his brother Mr Ignác Richter (Prievidza) for taking photographs of the locality and other assistance. We appreciate the kindness of Mr Mats Lindeborg (Kalmar) and Bengt Å. Bengtsson (Färjestaden) for sending us reprints of their papers and for information on the Swedish find, and of Mr František Slamka (Bratislava) for producing colour photographs of the species and other help. Mr Andrew Liston (Müncheberg) kindly corrected the language. Bengt Å. Bengtsson gave us the permission to use his photograph of the female genitalia. A special thank to the reviewers for their important comments.

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Villa, R., M. Pellecchia & G. B. Pesce 2009 – Farfalle d'Italia. – Editrice Compositori, Bologna, 375 pp., 22 × 28 cm, soft cover, ISBN 978-88-7794-658-4. – 45.00 Euro (cover price; the same book, with the same ISBN number, but a different image on the cover, is presently sold by the publisher for 35 Euro).

This book is probably the first example of an updatable identification guide published on paper. The authors conceived it as a "sticker album", where a full page is dedicated to each of the 281 species of Italian Papilionoidea and Hesperioidea. On each of these pages, standardized spaces are reserved for the photos of adult male and female, egg, newly hatched larva, mature larva, and pupa of a given species. However, the authors left some of these spaces blank, either because they could not photograph the corresponding life stage (which does not necessarily mean that this stage is unknown to science), or because they did not not regard it as essential for identification, as in the case of the adult underside of some species. The reader may add further figures to the book as they become available, although the publication of new figures in the form of stickers is not yet planned. The standardized format of the "stickers" curiously led the authors to rotate all illustrations of nymphalid pupae, which therefore lie on their venter instead of hanging with their heads downwards. For each species, information on the flight period, foodplants, distribution in Italy and in the region Emilia Romagna, and a short description of the habitat are given. The identification of the adults is aided by 25 plates in which similar species are compared noting their diagnostic characters.

The systematic pages are preceded by a general part containing information on lepidopteran morphology, anatomy, life cycle, ethology, and ecology. Although some technical terms are improperly used, and in spite of some avoidable mistakes (adults with "two or more" ocelli; the "jugum" of an arctiid moth...), the quality of the text is acceptable for an identification guide, and most photographic illustrations are good or very good. However, the drawings were apparently not made by an entomologist, and the authors did not check them carefully enough to discover some monstrosities, like adult legs with additional segments, and fancy mouthparts on the head of a caterpillar.

"Farfalle d'Italia" is presented in the introduction as a possible aid for the identification of threatened species of Italian butterflies in the field, for the purpose of habitat management. However, the size and weight of this book are greatly inflated by the space left for further "stickers" and by the fact that comparisons between similar species are printed twice: once as "species A versus species B", and once as "species B versus species A". This may hinder its use as a fieldguide. Moreover, the authors do not mention the endangered or protected status of any of the species. Actually the major merit of this book is to provide the most complete printed colour atlas of the early stages of Italian butterflies, with very good quality photographs, although not accompanied by a discussion of the diagnostic characters. On the other hand, the introduction of Italian vernacular names for all species of butterflies occurring in Italy was in my opinion not desirable. Until now only very few butterflies had Italian vernacular names; therefore all Italian amateurs, children included, had to use scientific names. Villa et al. introduced vernacular names in the hope that this might attract more people to the study of butterflies. However, the scarcity of Italian vernacular names for butterflies probably depends on the scarcity of amateurs, and not vice versa.

FRANCESCA VEGLIANTE

The Dusky Large Blue – *Maculinea nausithous kijevensis* (Sheljuzhko, 1928) in the Transylvanian basin: New data on taxonomy and ecology

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Abstract. *Maculinea nausithous* (Bergsträsser, 1779) was recently discovered in two parts of the Transylvanian basin. External characters of these populations completely agree with the original description of *Maculinea nausithous kijevensis* (Sheljuzhko, 1928) and show some small but constant differences against the Central European nominotypic populations. Since the habitats and host ant selection of these populations are also different from the Central European populations, we consider *M. nausithous kijevensis* **stat. rev.** as valid subspecific taxon. Specimens with the same external characters were also collected in northeastern Romania, in Kazakhstan and in the western part of the Altai Mts. Therefore we believe that this subspecies has a wider Euro-Siberian distribution.

Introduction

The Dusky Large Blue, *Maculinea nausithous* (Bergsträsser, 1779)[1], has a Euro-Siberian distribution with a wide but sporadic range from Western and Central Europe to Kazakhstan, Southern Siberia and Mongolia (Lukhtanov & Lukhtanov 1994; Tuzov 1997; Wynhoff 1998; Munguira & Martín 1999). It is known from the North of the Balkan peninsula (Kolev 2002) and from northern Turkey (Hesselbarth et al. 1995) but unknown from the former Soviet Central Asia, Transbaikalia, Russian Far East, China, Korea and Japan (Sibatani et al. 1994; Tshikolovets 2003; Tshikolovets et al. 2002). This species has a disjunct distribution in the Carpathian basin. It is relatively widely distributed and locally frequent in the western and northern hilly and lowland regions of the basin (e.g. mostly in the areas bordering Austria, Slovenia and Hungary) but completely absent in the Pannonian lowland along and East of the river Danube.

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[1] According to the phylogenetic analysis of Pech et al. (2004) and Frić et al. (2007) the generic name *Phengaris* Doherty, 1891 should be used. However, in the ecological and conservation biological publications the generic name *Maculinea* Van Eecke, 1915 is widely accepted and used. Therefore, for simplicity we follow here this most frequently used and established generic name.

Until recent times it was also unknown from Transylvania. It was discovered by Goia and Rákosy in two different parts of the steppic area Câmpia Transilvaniei near Cluj-Napoca (Răscruci and Fânaţele Clujului). The first surveys supplied new data on the ecology and host ant use of these fairly isolated populations (Tartally et al. 2008a).

Taxonomical problems of Eastern European populations of *Maculinea nausithous*

A new subspecies of *M. nausithous* was described by Sheljuzhko (1928) as *Lycaena arcas kijevensis* with type locality "gouvernment Kijev" in Ukraine. Although the original description consists of some differential characters, this taxon has been mostly neglected or synonymised with the nominotypic subspecies (Lukhtanov & Lukhtanov 1994; Sibatani et al. 1994; Tuzov 1997; Tschikolovetz et al. 2002; Tshikolovetz 2003). Some authors, however, repeatedly considered that *M. nausithous* can consist of some "cryptic species". Molecular analyses have shown an "*unexpectedly deep diversification*" even on a local geographical scale in eastern Europe (Als et al. 2004; Fric et al. 2007).

According to the original description "the males [of *M. nausithous kijevensis*] have much darker blue colouration, with an essentially broader dark margin on all wings. Anterior margin of forewings reaches until the discus with a broad dark blue suffusion. The margin is very diffuse and the dark scales are, in many specimens, so extended that the discal spots can hardly be seen. The females do not differ from the type. The underside in both sexes is darker and the light rings around the ocelli are more obscure or even absent on the forewings." The original description is in German and reads as follows: „Viel mehr dunkelblau gefärbte Männchen mit bedeutend breiterem Saum aller Flügeln. Der ganze Vorderrand der Vf. etwa bis zum Diskus breit dunkelblau übergossen. Die Säume sehr diffus und bei manchen Stücken ist die schwarze Beschuppung so ausgedehnt, dass alle Keilfleckeauf allen Flügeln nur schwach bemerkbar sind. Die Weibchen weichen von dem Typus nicht ab. Auf der Unterseite beider Geschlechter etwas dunkler und die helle Umrandung der Ocellen ist eine Kleinigkeit weniger deutlich, besonders auf den VF-n, wo sie manchmal ganz fehlen kann."

The specimens from Dealulire Clujului and Dejului (Fânatele Clujului and Râscruci) also completely agree with the description of Sheljuzhko. These specimens are slightly smaller and darker on average and seem to be more acutely winged than typical *M. nausithous* from western Hungary, Slovenia and Germany. They have a darker and shiny reddish-purple-brownish colouration of the underside (Fig. 1). The tiny, often obsolescent ocellae are also different from the typical subspecies. In addition, these populations are also biologically (habitats and host ant use) clearly different from the Central European and western Hungarian populations (Tartally et al. 2008a). Similar specimens were also collected by C. Corduneanu in northeastern Romania (Jud. Suceava, Horodnic de Sus, valea Seaca), by B. Larsen in Kazakhstan (2003), N of the lake Balkhas and also by Z. Varga (coll. HNHM, Budapest) in the woody steppic habitats (near Samarka, at the river Tsharyn) in the western part of the Altai Mts.

This suggests that these differences are sufficient for the recognition of *M. nausithous kijevensis* as a distinct subspecies. We therefore consider *M. nausithous kijevensis* (Sheljuzhko, 1928) **stat. rev.** as a valid taxon which is morphologically, geographically and ecologically differentiated from the Central European nominotypic subspecies (Figs 1 – 2). It probably has a wide Euro-Siberian distribution.

We have to note that a preliminary allozyme analysis of the Transylvanian population has shown that this sample proved to be surprisingly variable compared with the western Hungarian populations, although these populations are strictly isolated from the main area of the species (Pecsenye et al. 2007 and unpublished data). This provides additional justification for the subspecies status.

Field observations: Habitats and behaviour of the "steppic" *Maculinea nausithous*

Both sites where *M. nausithous* was found in the Transylvanian basin are forb-rich meadow steppes and lowland hay meadows with sporadic small boggy depressions with *Molinia* and tall forb vegetation, with dense stands of *Sanguisorba officinalis* L.. Typical plant species of these moist habitats are as follows: *Molinia coerulea* (L.) Moench, *Clematis integrifolia* L., *Ranunculus acris* L., *Thalictrum aquilegifolium* L., *Gentiana pneumonanthe* L., *Peucedanum rochelianum* Heuff., *Serratula tinctoria* L., *Iris spuria* L., *Veratrum nigrum* L., etc. (Fig. 2).

This habitat type differs strikingly from the *nausithous*-habitats in Transdanubia, Slovenia and Austria as well as other Central European countries. They have, however, numerous common features with the humid, tall grass-tall forb steppic habitats in Southern Siberia, populated also by *M. nausithous* and *M. teleius* (Bergsträsser, 1779). The behaviour of the butterflies is highly adapted to these peculiar habitat conditions. The butterflies occur at the highest density in the moderately scrubby patches within and around the humid depressions. The females proved to be rather sedentary within vegetation patches with dense stands of the initial food plant, especially near to the scrubby patches. The males had either a patrolling behaviour around the *Sanguisorba* plants within the same patches or were rapidly flying between the isolated patches of habitat. This type of behaviour is essentially different from the behaviour of *M. teleius* and *M. alcon*, co-occurring in the same habitats.

Nests of the host ant, *Myrmica scabrinodis* Nylander, 1846, were found mostly near to the scrubs in semi-shaded places within the patches densely overgrown with *Molinia* and the food plant *Sanguisorba officinalis*. Very few of the ant nests contained larvae. From a total of 107 *My. scabrinodis* nests which were found at the two sites (58 at Fânaţele Clujului and 49 at Răscruci), only two nests from Răscruci were found to contain *M. nausithous*, in both cases only a single *M. nausithous* larva (Tartally et al. 2008a).

Larvae of *M. alcon* (Denis & Schiffermüller, 1775) and *M. teleius* were also found in *My. scabrinodis* nests which is not surprising since *My. scabrinodis* is a common host ant of these butterflies (e.g.: Elmes et al. 1998; Als et al. 2004; Fiedler 2006). One of the

Fig. 1. *Maculinea nausithous kijevensis* in habitat.

two nests in which *M. nausithous* was found also contained a *M. teleius* larva (Tartally et al. 2008a). Other *Myrmica* species (*My. hellenica* Finzi, 1926, *My. sabuleti* Meinert, 1861, *My. schencki* Viereck, 1903 and *My. specioides* Bondroit, 1918) have been recorded from the drier patches of these habitats (Markó 1998; Markó & Csősz 2001; Tartally et al. 2008b; B. Markó, pers. comm.), but only *My. scabrinodis* was found in the small boggy depressions where *M. nausithous* can lay eggs on *S. officinalis*.

Discussion and conclusions

The discovery of *M. nausithous* in Transylvania had been expected because of the general distribution of the species. These sites have an intermediate position between the numerous recorded sites in the western part of the Carpathian basin and the records East of the Carpathians in Bukovina. It is difficult to explain, however, the seemingly large hiatus between the central and eastern part of the Carpathian basin where many habitats of *Sanguisorba officinalis* are known with numerous records of *M. teleius*, but without *M. nausithous*. Interestingly, *M. nausithous* occurs only in western parts of Hungary where *My. rubra* (Linnaeus, 1758) is common on marshy meadows with *S. officinalis*, but this butterfly does not occur in central and eastern parts of Hungary where *My. rubra* is rare or absent from such sites (Tartally & Varga 2005a; 2008). Thus, the absence of the species is probably connected to the ecological requirements of its main host ant *My. rubra*. Although *My. rubra* occurs in the eastern part of the Carpathian Basin

Fig. 2. Habitat of *Maculinea nausithous kijevensis* at Râscruci near Cluj.

and also in Transylvania it is mostly associated with damp forested habitats. Thus, the hypothesis of Witek et al. (2008) on the possible host ant colony change can not be accepted as *My. rubra* is unknown from the sites investigated here where *M. nausithous* occurs, despite extensive surveys by local myrmecologists (B. Markó, pers. comm.). Thus, the key factor in the occurrence of *M. nausithous* might be the use of *My. scabrinodis* as a host ant. These records, of course, are not the first data on *M. nausithous* exploiting *My. scabrinodis*, since Munguira & Martín (1999) have already reported this ant as a host of *M. nausithous* in Spain and Witek et al. (2008) found it as an occasional host in Poland. However, apart from these records, this widespread *Myrmica* species has not been recorded as a host of *M. nausithous* on the other European sites studied (although *My. scabrinodis* is often common on those sites), where *My. rubra* is used almost exclusively (Thomas et al. 1989; Elmes et al. 1998; Stankiewicz & Sielezniew 2002; Tartally & Varga 2005a; Anton et al. 2007; Witeck et al. 2008). However, *My. scabrinodis* is widespread and frequent in most of the Hungarian *Sanguisorba officinalis* sites investigated (Tartally & Varga 2005a, b). Hence, it is an open question why the eastern Hungarian *S. officinalis* sites have not been colonised by the *M. nausithous* from Transylvania which uses *My. scabrinodis*. One reason could be that the high mountains of Muntii Apuseni inhibit spread to eastern Hungary, acting as a barrier to the isolated Transylvanian *M. nausithous* populations. Another possible explanation is that *M. teleius* and *M. alcon* populations are in competition with *M. nausithous* in eastern Hungary through their common use of *My. scabrinodis*.

Interestingly *M. nausithous* does not occur at Şardu, about 20 km W of Cluj, where a suitable site is known near to the Câmpia Transilvaniei region, with high densities of *S. officinalis* and *My. scabrinodis* (Tartally & Varga 2008; Tartally et al. 2008b). This site is, however, used by *M. teleius* and *M. alcon* (both butterflies exploit *My. scabrinodis* and *My. vandeli* Bondroit, 1920 as the host ant), and appears more similar to the central and western European *M. nausithous* sites (with bushy forest edges) than the sites investigated in the Câmpia Transilvaniei region. Surely, the finer ecological details of these occurrences await further investigation.

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The distribution, ecology and conservation status of the Spinose Skipper *Muschampia cribrellum* (Eversmann, 1841) at the western limit of its range in Europe (Hesperiidae)

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Abstract. Based both on published and original data, we provide an overview on the distribution, ecology and conservation status of *Muschampia cribrellum* (Eversmann, 1841) at the western limit of its range. We report the presence of the species in four countries (Romania, Bulgaria, Republic of Macedonia and Serbia) with a total of 28 confirmed sites out of which 11 are mentioned here for the first time. The presence of *M. cribrellum* in Hungary is questioned due to lack of relevant material. We discuss the past, current and potential distribution of *M. cribrellum* in each of the countries involved. Special attention is given to ecological and conservation aspects by discussing key factors (behaviour, phenology, habitat requirements and preimaginal stages) involved in the species distribution, dynamics and survival.

Résumé. Basé sur des données publiées et inédites, nous fournissons une synthèse concernant la distribution, l'écologie et l'état de conservation de *Muschampia cribrellum* (Eversmann, 1841) aux limites occidentales de sa répartition. Nous rapportons la présence de l'espèce de quatre pays (Roumanie, Bulgarie, République de Macédoine et Serbie) avec au total 28 localités confirmées dont 11 sont mentionnées ici pour la première fois. La présence de *M. cribrellum* en Hongrie est douteuse étant donné l'absence de matériel concret. Nous traitons la distribution historique, actuelle et potentielle de *M. cribrellum* dans les pays impliqués. Une attention particulière est accordée à l'écologie et à l'état de conservation, en discutant des facteurs clés (comportement, phénologie, exigences de l'habitat et états pré imaginaux) impliqués dans la répartition, la dynamique et la survie de l'espèce.

Zusammenfassung. Auf Grundlage bereits publizierter sowie originaler Daten wird ein Überblick über die Verbreitung, die Ökologie und den Schutzstatus von *Muschampia cribrellum* (Eversmann, 1841) für das westliche Verbreitungsareal gegeben. Wir bestätigen das Vorkommen der Art für vier Länder (Rumänien, Bulgarien, Mazedonien und Serbien) mit insgesamt 28 Vorkommen, wovon 11 zum ersten publiziert werden. Die Anwesenheit von *M. cribrellum* in Ungarn ist mangels relevanten Materials fraglich. Wir diskutieren die historische, rezente und zukünftige Verbreitung von *M. cribellum* für die in diese Studie einbezogenen Länder. Durch die vertiefte Diskussion über Schlüsselfaktoren (wie Verhalten, Phänologie, Habitatansprüche und Präimaginalstadien) werden besonders ökologische wie auch Naturschutzaspekte berücksichtigt, die entscheidend für die Verbreitung, Dynamik und das Überleben dieser Art sind.

Introduction

The Spinose Skipper *Muschampia cribrellum* (Eversmann, 1841) is one of the rarest and least known skippers in Europe west of the former Soviet Union. It was described from the "South Ural and the Volga Basin" at the easternmost limit of Europe. The species range extends over a large area roughly covering south-eastern and eastern Europe, then extending eastwards across southern Siberia, Amur region, Mongolia and northern China (Gorbunov 2001, Tshikolovets 2003, 2005, Tolman & Lewington 1997, 2008).

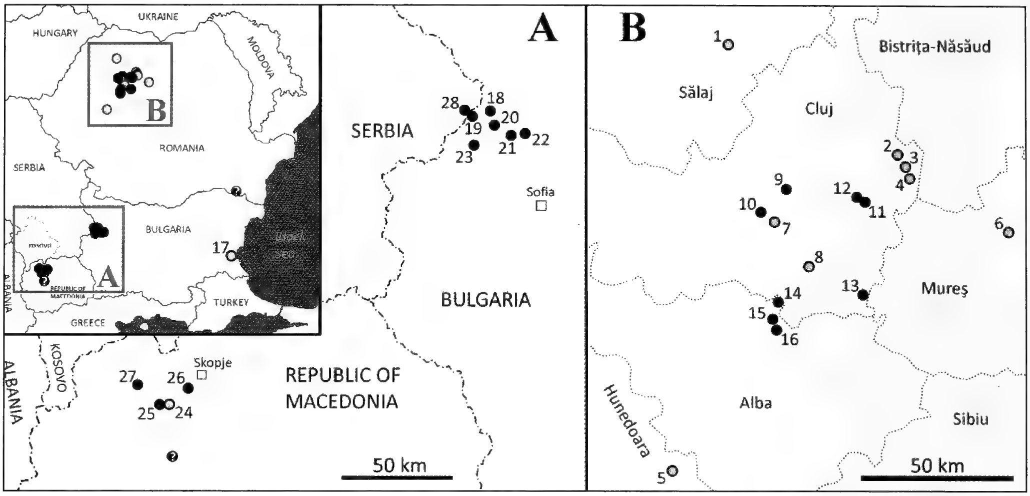

Fig. 1. Inset: general distribution of *M. cribrellum* at the western limit of its range in Europe. **A.** Recorded sites in the central Balkans. **B.** Recorded sites in Transylvania (Romania). The numbers refer to the localities from Tab. 1. Grey-filled circles – records prior to 1990; Black dots – records beginning with 1990; ? – Records requiring confirmation. Map by Z. Kolev.

However, considering the western limit of its distribution, the species is poorly known and localized, being reported from a handful of sites in only four countries: Romania (Rothschild 1912; Rákosy & Goia 1997; Rákosy 2000; Kovács et al. 2001, 2002; Rákosy et al. 2003; Goia & Dincă 2008; Székely 2008), the Republic of Macedonia (Lorković 1983; Jakšić 1988, 1998; Schaider & Jakšić 1989), Bulgaria (Kolev 2003; Abadjiev & Beshkov 2007) and Hungary (Higgins 1975; Tolman & Lewington 1997, 2008; Tolman 2001; Tshikolovets 2003, 2005; Lafranchis 2004; Nekrutenko & Tshikolovets 2005). New data provided in this paper reveal the presence of *M. cribrellum* in a fifth country, namely Serbia (Fig. 1). The presence of the species in Hungary is questioned given the lack of recent reliable data.

In addition to the scarcity of European records, only limited and scattered information is available on the habitat requirements of the species which is generally known to be associated with steppes, dry meadows on mountain slopes or screes (e.g. Korshunov & Gorbunov 1995; Rákosy & Goia 1997; Gorbunov 2001; Tshikolovets 2003, 2005). Detailed data on the biology of *M. cribrellum* is even scarcer and of questionable reliability (especially for Europe). Despite its fragmented and highly restricted range at the western limit of the distribution, the species is not considered threatened in Europe (van Swaay & Warren 1999) due to its predominantly Asian distribution and reported stable population sizes in Russia.

Given the facts presented above, the overall information on *M. cribrellum* at the western limit of its distribution is sporadic and often of unknown reliability. Therefore, our aim is to collate all available published and recent unpublished data on the distribution, ecology and conservation status of the Spinose Skipper in the area west of the former Soviet Union. This will hopefully stimulate further research on this very local and poorly known species and facilitate its legal protection in the countries concerned.

Fig. 2. The botanical reserve Fânaţele Clujului (Transylvania, Romania, ca. 500 m, 1.vi.2006) hosts almost 100 butterfly species among which *M. cribrellum*. Photo V. Dincă.

Distribution of *M. cribrellum* at the western range limit in Europe

West of the Black Sea, *M. cribrellum* has been reported from four countries: Romania, Bulgaria, Republic of Macedonia, and Hungary. The presence of the species in Serbia has not been mentioned previously and is reported here for the first time. Rákosy & Goia (1997) mentioned *M. cribrellum* from Greece too, but the paper does not provide additional data or relevant references and no other studies known to us support this statement. *M. cribrellum* was not listed among the Greek butterflies in the comprehensive work of Pamperis (1997) and, based on records from neighbouring countries, was only considered as potentially present in the northern and eastern borders of the country (Pamperis 2009).

Romania

The majority of the records of *M. cribrellum* at the western limit of its European distribution come from Romania. More precisely, all but one of the Romanian sites lie in Transylvania (Fig. 1B, Tab. 1). The species was first noted from Romania by Rothschild (1912) based on material collected by Karl Predota in 1911 from four localities in Cluj (Buza, Năsal, Feldioara) and Sălaj (Surduc) Counties. These records represented the first data proving the presence of *M. cribrellum* west of the former Soviet Union. Although there are no doubts regarding the accuracy of the identifications (the dorsal and ventral sides of one specimen are illustrated in Rothschild's paper), the species was never recorded again from any of these localities. Subsequently (1928–1931), the species was collected from the surroundings of Cluj-Napoca (Fânaţele Clujului, Dealul

Fig. 3. The xeric terraces with steppe-like vegetation from Suatu (Transylvania, Romania, ca. 380 m, 8.vii.2006) represent an optimal habitat for *M. cribrellum*. Photo V. Dincă.

Sf. Pavel and Valea Popii) (Cluj County) (Popescu-Gorj 1964; Căpuşe & Kovács 1987; Rákosy 1988), and also from Ardeu-cetate (Hunedoara County) (Popescu-Gorj 1964). Recent records confirmed the presence of *M. cribrellum* in the surroundings of Cluj-Napoca, mainly at Fânaţele Clujului (Szabó 1982; Rákosy & Goia 1997; Rákosy & Lászlóffy 1997; Goia & Dincă 2008) (Fig. 2) and on Dealul Sf. Pavel (Goia & Dincă 2008). A new population of *M. cribrellum* was discovered in 1978 at Toldal (Mureş County) near Reghin city (Moldoveanu et al. 1980; Szábo 1982). Based on material collected during 1975–1989, Rákosy & Viehmann (1991) recorded *M. cribrellum* as rare from Cheile Tureni (calcareous gorges in Cluj County). One of the recently still occupied sites was discovered in 1980 at Suatu (Cluj County) (Rákosy & Goia 1997; Rákosy 2000; Dincă & Vila 2008) (Fig. 3). Additionally, *M. cribrellum* was reported as relatively common at Viişoara (Kovács et al. 2001, 2002), and one specimen was found at Căianu Mic (Cremene et al. 2003) (both localities in Cluj County).

The most recent, previously unpublished records of *M. cribrellum* come from the eastern part of the Western Carpathians, namely the area of Buru (Cluj County) – Rimetea (Alba County) – Colţeşti (Alba County) (Figs 1B, 4). The new sites and the corresponding observations are provided below:

- near the main road north to Rimetea, ca. 1 km before the entrance in the village, at the end of May 2005: two specimens were observed mud-puddling (A. L. Viborg pers. obs.);
- Colţeşti (ca. 1.5 km east of the village) at the end of May 2005: five specimens (C. J. Luckens pers. obs., A. L. Viborg pers. obs.);

Fig. 4. Several flowery meadows on calcareous ground surrounding the village of Rimetea (Transylvania, Romania, 500–650 m, 18.vii.2006) are suitable habitats for *M. cribrellum*. Photo V. Dincă.

- steep rocky slope ca. 2 km south of Buru at the end of May 2005: three specimens; ditto, the end of May 2008: eight to ten specimens (A. L. Viborg & T. Friis-Larsen, pers. obs.);
- the western outskirts of Rimetea in a flowery glade with sparse low trees on May 31.v.2009: one female (N. Greatorex-Davis leg. et coll., Z. Kolev det.).

The only Romanian record of *M. cribrellum* from outside Transylvania is a male collected on 31.v.1986 from Canaraua Fetei (Constanţa County, southern Dobrogea) (Rákosy 2000). This record (Fig. 1) might require confirmation, as *M. cribrellum* was not mentioned as present in Dobrogea in the subsequently published Romanian Lepidoptera Catalogue (Rákosy et al. 2003) and in the recent book on the butterflies of Romania (Székely 2008).

Bulgaria

The first record of *M. cribrellum* from Bulgaria was based on two males collected in 1974 around the city of Burgas on the Black Sea coast (Fig. 1), but regrettably more precise locality data are lacking (Kolev 2003). Chronologically the next, hitherto unpublished record consists of three specimens in excellent condition which bear locality labels “West Bulgarien, Umg[ebung]. Dragoman” [West Bulgaria, vicinity of Dragoman town] on 24.vi.1987 (1 male), 29.vi.1987 (1 female) and 15.vi.1989 (1 male) and are deposited in the collection of G. Kuna. The original collector, J. Leidenfrost, is deceased and it is thus not possible to obtain first-hand informa-

Tab. 1. The sites from where *M. cribrellum* has been recorded west of the former Soviet Union. The numbers correspond to those used in Fig. 1.

No.	Locality	Province	Alt. (m)	Lat N	Long E	Country
1	Surduc	Sălaj	200–300	47° 15'	23° 20'	Romania
2	Năsal	Cluj	300–400	46° 56'	24° 06'	Romania
3	Buza	Cluj	350–450	46° 54'	24° 08'	Romania
4	Feldioara	Cluj	350–450	46° 52'	24° 09'	Romania
5	Ardeu (cetate)	Hunedoara	400–450	46° 00'	23° 08'	Romania
6	Toldal	Mureş	400–500	46° 42'	24° 35'	Romania
7	Cluj-Napoca (valea Popii)	Cluj	400–500	46° 44'	23° 34'	Romania
8	Cheile Tureni	Cluj	450–500	46° 36'	23° 42'	Romania
9	Cluj-Napoca (Fânaţele Clujului)	Cluj	500	46° 50'	23° 37'	Romania
10	Cluj-Napoca (dealul Sf. Pavel)	Cluj	450	46° 46'	23° 31'	Romania
11	Suatu	Cluj	350–450	46° 47'	23° 57'	Romania
12	Căianu Mic	Cluj	350–400	46° 48'	23° 56'	Romania
13	Viişoara	Cluj	330–430	46° 31'	23° 56'	Romania
14	2 km S of Buru	Cluj	400–450	46° 30'	23° 35'	Romania
15	W and N outskirts of Rimetea	Alba	500–650	46° 27'	23° 34'	Romania
16	1.5 km E of Colţeşti	Alba	600–650	46° 25'	23° 35'	Romania
?	Canaraua Fetei (Băneasa)	Constanţa	20–100	44° 03'	27° 39'	Romania
17	Burgas	Burgas	5–100	42° 31'	27° 26'	Bulgaria
18	Gubesh	Sofia	1000–1300	43° 05'	23° 02'	Bulgaria
19	Golesh	Sofia	900	43° 04'	22° 56'	Bulgaria
20	NE of Godetch	Sofia	750	43° 01'	23° 04'	Bulgaria
21	W of Zavidovtsi	Sofia	700–800	42° 59'	23° 09'	Bulgaria
22	Iskretz	Sofia	550–650	42° 59'	23° 14'	Bulgaria
23	Chepán massif	Sofia	800–1100	42° 56'	22° 56'	Bulgaria
24	Nova Breznica	–	900	41° 53'	21° 16'	Macedonia
25	4 km W of Nova Breznica	–	1000	41° 53'	21° 13'	Macedonia
26	Mt. Vodno	–	950	41° 57'	21° 23'	Macedonia
27	Grupčin (28 km W of Skopje)	–	500	41° 58'	21° 07'	Macedonia
?	Treska Valley (near Gorna Belica)	–	500–1100	41° 41'	21° 15'	Macedonia
28	12 km NE of Dimitrovgrad	–	980	43° 05'	22° 54'	Serbia

tion about the precise locality (G. Kuna, pers. comm. to Z. Kolev), but it is almost certainly the imposing calcareous massif Chepán (highest point 1210 m). This is a southern branch of the Stara Planina mountain chain which rises just north-east of Dragoman town and forms a natural focus point for any collecting activity there. On a visit to Chepán on 7.vi.2007, Z. Kolev together with Stoyan Beshkov did not encounter the species, though note was taken of the extensive steppe-like rocky slopes with an unusual abundance of *Potentilla*. During a subsequent visit to the same place on 10–11.vi.2007, S. Beshkov and Boyan Tsvetkov collected a single female of *M. cribrellum* among numerous specimens of *Pyrgus carthami* (Hübner, 1813)

Fig. 5. A fresh *M. cribrellum* male perching on vegetation at a mud-puddling site near Gubesh village (western Bulgaria, ca. 1000 m), 10.vi.2009. Photo Z. Kolev.

(S. Beshkov, pers. comm. to Z. Kolev). This female is the basis for the brief mention of *M. cribrellum* from Chepán by Abadjiev & Beshkov (2007: 196). On 13.vi.2008, Z. Kolev and Nikolay Shtinkov visited this massif with the express purpose of finding *M. cribrellum*. The search was unsuccessful despite covering a wider habitat gradient ranging from the aforementioned exposed, dry south-facing slopes at higher altitude (900–1100 m) to moister gullies with lush vegetation at lower altitude (800–900 m). Another attempt to locate *M. cribrellum* on the Chepán massif in June 2008 also failed (M. Lindberg, pers. comm. to Z. Kolev). However, through purposeful search in 2008 and 2009, Markus Lindberg (pers. comm. to Z. Kolev) has discovered several other localities of *M. cribrellum* elsewhere in the region of western Stara Planina. Z. Kolev and N. Shtinkov were also able to locate one of these populations in 2009 (Fig. 5). The new localities and the respective numbers of specimens are as follows (Tab. 1, Fig. 1A):

- canyon above Golesh village, 26.v.2008: 4 males (M. Lindberg obs.);
- slopes north of Gubesh village, 27.v.2008: ca. 15 males (M. Lindberg obs.); ditto, 9.vi.2009: 18 males, 2 females (M. Lindberg obs.); ditto, 10.vi.2009: 13 males (Z. Kolev & N. Shtinkov obs., 9 males leg. & coll. Z. Kolev);
- river valley at the north-eastern edge of Godetch town, 29.v.2008: 1 male (M. Lindberg obs.);
- limestone quarry near Iskrets town, 11.vi.2009: 1 male (M. Lindberg obs.);
- valley of Iskrets River, west of Zavidovtsi village, 28.v.2008: 1 male (M. Lindberg obs.).

Fig. 6. A fresh male of *M. cribrellum* observed on a stony road NE of Dimitrovgrad (Serbia, 980 m, 17.v.2007). Photo C. van Swaay.

Serbia

There are no published records of *M. cribrellum* for Serbia. One male was observed and photographed in south-eastern Serbia (Fig. 6), mud puddling on the road north-east of Dimitrovgrad just 2 km from the Bulgarian border (Fig. 1A). The observation was made on 17.v.2007 by a group of lepidopterists working on the project Prime Butterfly Areas in Serbia, namely Predrag Jakšić, Milan Đurić, Ivan Dodok, Kars Veling and Chris van Swaay (van Swaay, pers. comm. to R. Verovnik). This discovery is to be expected in view of the recent records from western Bulgaria (Abadjiev & Beshkov 2007; see above), which come from a karstic region of western Stara Planina that extends across the border well into Serbia.

Republic of Macedonia

The Spinose Skipper was first reported for the Republic of Macedonia by Lorković (1983) based on his revision of the material collected by Slavoljub Jakonov. More than 10 fresh males were collected on the eastern slopes of Mt. Suva Planina near Nova Breznica village on 8.vi.1980. During a visit to the only confirmed site for the Republic of Macedonia in 2008, two males were found on the karstic plateau 4 km west of the known site (Fig. 7). Additionally, at least 3 specimens were observed on the southern slopes of Mt. Vodno approximately 15 km north-east of the previously mentioned localities (Verovnik & Micevski 2009). Another hitherto unpublished record is a fresh

Fig. 7. The xeric terrain with steppe like vegetation on the ridge east of Kozjak lake (Republic of Macedonia, 1050 m, 8.vi.2008) where a fresh male of *M. cribrellum* was observed. Photo K. Veling.

male collected by Peter Russell on 1.v.1990 near Grupčin village (ca. 28 km west of Skopje) (P. Russel, pers. comm. to R. Verovnik).

The distribution map of the species in the atlas of Schaider & Jakšić (1989) indicates a locality in the upper part of the Treska valley, in the vicinity of Gorna Belica village. The provenance of that record is still unknown as those authors did not record the species themselves, nor did they provide a reference. However, the record is plausible in view of the continuous karstic terrain encompassing it and the valid records further to the north.

Hungary

Several authors mentioned *M. cribrellum* for eastern Hungary (Higgins 1975; Tolman & Lewington 1997, 2008; Tolman 2001; Tshikolovets 2003, 2005; Lafranchis 2004; Nekrutenko & Tshikolovets 2005; Pljushtch et al. 2005) but evidence for this is wanting. The species is absent from the guide to the butterflies of the eastern part of Central Europe (Slamka 2004) as well as from the online list of butterflies of Hungary maintained by the Hungarian Lepidopterological Society (Tamás & Mihály 2009). The published checklist of the fauna of Hungary (Varga et al. 2005) mentioned that the records of *M. cribrellum* from this country "are only from the early XXth century". We were informed by Zoltán Varga that these reports are most likely due to confusion with older records from western Romania, once part of the Austro-Hungarian Empire (Z. Varga, pers. comm. to Z. Kolev and V. Dincă, 28.v.2009). A similar statement was made by Rákosy & Goia (1997).

Conclusions on distribution

By critically processing the available data on the distribution of *M. cribrellum* at the western limit of its range, we conclude that the species presence is currently confirmed in four countries: Romania, Bulgaria, Macedonia and Serbia (Fig. 1). A total of 28 confirmed sites were identified, of which 16 lie in Romania, seven in Bulgaria, four in the Republic of Macedonia and one in Serbia (Tab. 1). Two more reported sites require reconfirmation, namely Canaraua Fetei (Dobrogea, Romania) and the surroundings of Gorna Belica (Treska Valley, Republic of Macedonia).

More than half (16, representing 57%) of the currently known sites for *M. cribrellum* west of the former Soviet Union lie in Transylvania (Romania). However, only half of these sites have published records of *M. cribrellum* after 1990 (Tab. 1, Fig. 1B) with three of them being reported here for the first time. This may not necessarily be a consequence of local extinctions, but lack of recent research activities in most of the areas involved. Many of the sites represent “islands” of habitats with influences of the Pannonian steppes well known for their particular flora and fauna (e.g. Suatu, Căianu, Viişoara, Fânaţele Clujului, Toldal) (Figs 2, 3), while others are characterized by the presence of a calcareous ground (e.g. Cheile Tureni, Rimetea, Colţeşti, Buru) (Fig. 4). Taking into account the record from south-eastern Romania (Canaraua Fetei), the habitat spectrum for *M. cribrellum* in this country may be even wider as Canaraua Fetei is a mixture of karst and Balkanic forest-steppe areas. Adding the very limited butterfly data available for many parts of Romania, it is difficult to evaluate the potential distribution of *M. cribrellum* in the country. However, all Romanian localities with old records of *M. cribrellum* could still hold populations of the species, so directed research is highly recommended. In addition, potential populations could be present in unaltered habitat patches with Pannonian steppe influences that still survive locally in central and western Transylvania. An example is the area between Cluj and Dej or Luduş and Târgu-Mureş (Rákosy & Goia 1997). The karstic area from the eastern part of the Western Carpathians (from where recent records are already available) is also promising. The calcareous area of Cheile Mada – Cheile Glodului near Ardeu (Hunedoara County) might provide new records of *M. cribrellum* given the fact that the species has been recorded from Ardeu almost a century ago. Several other calcareous areas similar to those from the Western Carpathians or from Ardeu are scattered in Transylvania and across the country, so there is high potential for the discovery of new populations. Moreover, if the record from south-eastern Romania (Canaraua Fetei) is accurate, then several sites in Dobrogea may have populations of *M. cribrellum* as the region as a whole has a pronounced steppe character and certain karst areas do occur (e.g. Cheile Dobrogei).

Currently, seven localities of *M. cribrellum* are known from Bulgaria. All but one of these lie in western Stara Planina, in what is the largest continuous region of open karst in the country. Based on present data it can be expected that the species is widespread all over this karst area in Bulgaria and Serbia. Thus, in Bulgaria its range may extend eastward up to and including the gorge of Iskar River, although it is not yet recorded despite considerable collecting there (see Beshkov 2000 for an overview of literature). In Serbia the potential range of *M. cribrellum* is at least twice as large, as the same hilly calcareous region extends from the Bulgarian border westward all the way to the town of Niš (Z. Kolev, pers. obs. 10.viii.2009). In addition, two other areas in the same general region appear promising for *M. cribrellum*, due to their calcareous character and general appearance based on satellite imagery. The first is Mt. Suva Planina, a dry and steep karst mountain 20 km south-east from Niš (not to be confused with the similarly dry mountain in the Republic of Macedonia, where *M. cribrellum* does occur!). The second is a 85 km-long chain of largely karstic hills which starts 15 km south of Zaječar town in eastern Serbia and extends along the northern foothills of Stara Planina all the way to Montana town in western Bulgaria. These hills are very similar in geomorphologic terms to the region in Western Stara Planina where *M. cribrellum* is apparently widespread, and their butterfly fauna, with the exception of Suva Planina, is very poorly known (Jakšić 2003). Research specifically aimed at *M. cribrellum* would be thus highly desirable in all of these regions including Suva Planina, considering how easily the species may be overlooked even in its optimal habitats.

In the Republic of Macedonia, judging from the precisely known records and satellite imagery, the potential area where *M. cribrellum* may occur extends in an arc from Raduša village near the border with Kosovo and Mount Vodno just south of Skopje westward to Gostivar town and thence south to Brod and Debrešte villages. Further research in this lepidopterologically very rich region, including a verification of the record from the vicinity of Gorna Belica in Schaider & Jakšić (1989), is desirable.

Behaviour and biology

Behaviour

The adults of *M. cribrellum* have a fast flight typical of a skipper, with the males often displaying territorial behaviour (V. Dincă pers. obs., Verovnik & Micevski 2009). The butterflies feed on various flowers, including *Potentilla* (Rosaceae), the reported larval host-plant (R. Verovnik pers. obs.). The males were also observed mud-puddling (Fig. 8). Among butterflies this activity is almost exclusively restricted to males (Boggs & Jackson 1991), and it has been shown that males of the Hesperiid *Thymelicus lineola* (Linnaeus, 1758) gather sodium dissolved in water at puddles and transfer it to females during mating. The proposed explanation for this phenomenon is that sodium is essential in egg production in quantities greater than the female can provide (Pivnick & McNeil 1987). Apparently, in *M. cribrellum* the need for sodium and possibly other dissolved nutrients can be exceptionally great, as witnessed by the observed local abundance of males at puddles versus their total absence from the adjacent probable breeding habitats (where both the females of the species and *Potentilla* are present) in western Bulgaria. For comparison, males of *Pyrgus carthami*, the most abundant skipper accompanying *M. cribrellum* in Western Bulgaria, are common both at puddles (Fig. 8) and on flowers

Fig. 8. Two *M. cribrellum* males (red arrows) mud-puddling together with a large group of *Pyrgus carthami* and single *P. sidae* and *P. alveus*, near Gubesh village (western Bulgaria, ca. 1000 m), 10.vi.2009. Photo Z. Kolev.

on the adjacent xeric slopes (Z. Kolev pers. obs.). This observation is in line with the observations of Pivnick & McNeil (1987), who found that while only males of *T. lineola* mud-puddled, they also comprised 75–80% of the surrounding population.

While the usual rarity of females of *M. cribrellum* presents a difficulty for the study of the exact habitat preferences and autecology, the strong attraction of the males to puddles should facilitate general faunistical research, as efforts to track down new populations can be concentrated in a relatively small area of the potentially suitable terrain.

Phenology. The available data indicate that in our focus region the butterfly is univoltine and its main flight period is in the second half of May and June. Some specimens, however, may already fly in the beginning of May (e.g. the fresh male collected in the Republic of Macedonia near Grupčin village on 1.v.1990) or as late as August. The two males from E Bulgaria (Burgas) are very fresh and their labels state the date of collecting as 10.viii.1974 (Kolev 2003). Whether this is an example of partial second generation or delayed emergence is unknown, but such late-flying specimens are also known from the main range of *M. cribrellum*. Korshunov & Gorbunov (1995) reported that the species is bivoltine (mid-May/August) in the Asian part of Russia while Korshunov (2002: 167) reported that the species flies from mid-May till mid-August.

Pre-imaginal biology

Hardly anything is known of this aspect of the life cycle of *M. cribrellum*. A claim widely repeated in literature is that the larvae feed on cinquefoils (*Potentilla* spp., Rosaceae)

Fig. 9. Habitat of *M. cribrellum* on the southern slope of Mt. Chepán (Bulgaria), ca. 1000 m, 13.vi.2008. Photo Z. Kolev.

(Higgins & Riley 1980; Chinery 1989; Korshunov & Gorbunov 1995; Gorbunov 2001; Korshunov 2002; Tshikolovets 2003; Nekrutenko & Tshikolovets 2005). Tolman & Lewington (1997, 2008) also reported *Potentilla* but added that this requires confirmation. We have to agree, since we have been unable to trace the provenance of this information or receive independent confirmation thereof. It must be kept in mind that all other *Muschampia* species for which the larval host-plant is reliably known, use *Phlomis* spp. (Lamiaceae) (Hesselbarth et al. 1995; Tolman & Lewington 1997, 2008; Tuzov et al. 1997; Wagner 2009). We only have circumstantial evidence in favour of the possible use of *Potentilla* as a larval host-plant, i.e. the occurrence of *M. cribrellum* on slopes with abundant *Potentilla* and no *Phlomis* both in our region (Z. Kolev & S. Beshkov pers. obs., R. Verovnik pers. obs.) and in Siberia for the subspecies *obscurior* Staudinger, 1892 (J. Kullberg pers. comm. to Z. Kolev). In addition, Szabó (1982) mentioned *Astragalus* sp. (Fabaceae) as a larval food-plant for Romanian *M. cribrellum*, but this assertion lacked further details or literature references, so that we strongly question its accuracy. Therefore, concerted research on the pre-imaginal biology of *M. cribrellum* is urgently needed.

Habitat requirements

In Romania, *M. cribrellum* occurs in relatively dry habitats with more or less pronounced (Pannonian) steppe character, such as hay meadows, grassland fallows and pastures (e.g. Suatu, Viişoara, Fânaţele Clujului, Căianu Mic, Toldal) (Figs 2, 3), as

Fig. 10. Another aspect of the southern slope of Mt. Chepán (Bulgaria), ca. 950 m, 13.vi.2008. Pine plantations on the slopes in the background are marked with red arrows. Photo Z. Kolev.

well as in more or less xeric calcareous flowery meadows (e.g. Buru, Cheile Tureni, Rimetea, Colţeşti) (Fig. 4). In particular the first group of habitats is maintained at a suitable succession stage mostly through human intervention by extensive grazing and mowing. *M. cribrellum* flies at altitudes that usually range between 300 and 650 m, but the (uncertain) record from Canaraua Fetei is below 100 m.

In West Bulgaria, Serbia and Republic of Macedonia, *M. cribrellum* predominantly occurs in open grassy steppe-like habitats with diverse flowering vegetation on rocky, roughly south-facing calcareous slopes (Figs 7, 9, 10). While some of these habitats, e.g. parts of Mt. Chepán (Fig. 9), may be naturally open due to their steep incline and arid karst character, it is no exaggeration to say that considerable areas have been made suitable for *M. cribrellum* by human activities such as regular extensive grazing or deforestation. The males may leave the breeding habitat for nearby mud-puddling sites, in one case 200 m away (Z. Kolev pers. obs.). In the Balkan Peninsula, the butterfly has been recorded mostly from ca. 500 m to 1300 m, which is markedly higher than the Romanian range. In fact, the species may occur even higher, as the altitudinal range of continuous suitable terrain in Western Stara Planina extends up to ca. 1500 m. Only one record from our region is from near sea-level: Burgas city on the Black Sea coast.

Conservation considerations

The Spinose Skipper is not considered threatened in Europe (van Swaay & Warren 1999) owing to reported stable population sizes and range in all countries with presence

Fig. 11. Habitat of *M. cribrellum* overgrown by *Pinus* plantations at Căianu Mic (Transylvania, Romania, 400 m, 6.v.2006). Photo V. Dincă.

of this species in Europe. These assessments were most probably done on the basis of the best expert judgement as no detailed studies on distribution changes or population sizes for *M. cribrellum* are known to the authors. Certainly, the current and known past range in Romania shows that the species may have declined in its range over the last decades. However, this trend is hard to evaluate as many of the original sites have not been visited recently and new sites are still being discovered. In Bulgaria the species may be locally extinct, e.g. in the vicinity of Burgas due to urbanisation, small-scale agriculture and other degradation such as overgrowing (Kolev 2003) of the man-made steppe-like habitats that have existed there (Stoyanoff 1926). However, in reality this region is extremely poorly known and further research there is necessary before it can be claimed that this or any other of the several rare steppe butterfly species that have been collected there in the early XXth century are now extinct (Kolev 2003). The karst region of western Stara Planina, the main stronghold of *M. cribrellum* in Bulgaria, contains extensive areas that are superficially suitable for *cribrellum*, which means that further populations of the species most probably exist there. Since the presence of *M. cribrellum* in the region was detected only in 1987, and most records are only from the last three years, there are no data for evaluating population trends. Little is known about the changes of distribution in eastern Ukraine and especially southern Russia which possibly holds the largest populations of this species in Europe. Nekrutenko & Tshikolovets (2005) mentioned that *M. cribrellum* is extremely local in Ukraine where it has a poorly known distribution and requires conservation measures. Pljushtch et al. (2005) mentioned only six (mostly old) records for Ukraine. A similar situation exists for European Russia from where only 11 widely separated records (some old or requiring confirmation) have been mentioned by Pljushtch et al. (2005).

The size of the populations of *M. cribrellum* known in Europe is difficult to assess without data inferred from monitoring activities. However, for a few sites that were visited for several years, it seems that the population size is modest. This is for example the case of the populations in the vicinity of Cluj (Transylvania) which seem to be very small as only five to ten adults per generation have usually been observed (Rákosy & Lászlóffy 1997; Goia & Dincă 2008). One exception may be the population from Suatu (Transylvania) (Fig. 3), where the species is relatively abundant on terraces of abandoned vineyards (Dincă pers. obs.). Low numbers also apply to most localities in western Bulgaria: although *M. cribrellum* can apparently be locally abundant there, in most places the numbers of specimens recorded during a single visit have remained well below ten. Besides, abundance of males localised at mud-puddling sites may misrepresent the actual abundance of the species in the larger area. The Bulgarian observations so far indicate that females of the species in the actual breeding habitat (even adjacent to mud-puddling sites with greater abundance of males) are apparently very rare. If we consider that the species occurs at low densities over the whole western limit of its distribution and within a relatively small area of occupancy, the total population size in Europe could easily be below the threshold value for a threat status according to the Red List criteria. Even by adding the currently known populations from Ukraine and European Russia, the situation does not improve significantly as for these regions there are surprisingly few reliable records available (Pljushtch et al. 2005). However, the vast steppe area of Ukraine and European Russia requires extensive rigorous studies which are likely to lead to the discovery of further populations of *M. cribrellum.*

What remains in terms of evaluation of the threat status is the extreme fragmentation of the range of the species in Europe and indirect evidence of endangerment based on the habitat requirements of the species. *Muschampia cribrellum* is a habitat specialist limited to steppe refuges and according to Schmitt & Rákosy (2007) its most preferred habitat type is young grassland fallows. As such habitats are maintained only through low-intensity agriculture in the majority of the known sites, either abandonment or intensification could be deleterious for the local populations of the species. Circumstantial evidence for such phenomena is known in Macedonia (Verovnik & Micevski 2009) and Romania (overgrowing by shrubs, *Robinia* or *Pinus* - see Fig. 11). In Bulgaria, the planting of dense pine stands on karstic slopes has locally affected *cribrellum* habitats in western Stara Planina. The most extensive of these plantations are around Godetch town and along the southern slope of Mount Chepán and adjacent hills around Dragoman town (Z. Kolev, pers. obs., Fig. 10), but their extent is limited relative to the total area of habitats potentially suitable for *M. cribrellum.* In the long run, the decline or cessation of traditional land use could be considered as the most important threat. Due to ongoing human population decline in rural areas and unfavourable European Union (EU) common agriculture practices this process has already started. With abandonment of traditional extensive grazing practices, large-scale losses of suitable habitats for *M. cribrellum* at the western edge of its distribution are inevitable.

Due to the very poorly known situation in eastern Ukraine and southern Russia no definitive threat status could be given to the species on European level, but the near threatened status (NT) should be used to indicate that declines are present or anticipated for this species. On EU level the status of vulnerable (VU) should be implemented due to very small area of occupancy, extreme fragmentation, apparently small total population size, and contiguous decline anticipated from habitat loss. The new discoveries should certainly not be treated as recent expansions, but more as a result of the lack of faunistical research in the region and scarcity of the species. The habitats of the Spinose Skipper are very rich in butterflies and host many rare or threatened species in Europe, e.g. in Romania *Muschampia tessellum* (Hübner, 1803), *Colias chrysotheme* (Esper, 1781), *Pseudophilotes bavius* (Eversmann, 1832), and *Plebejus sephirus* Frivaldsky, 1835), in Bulgaria *Plebejus sephirus*, *Polyommatus eroides* (Frivaldszky, 1835), *Coenonympha leander* (Esper, 1784) (Z. Kolev, pers. obs.), and in the Republic of Macedonia *Euchloe penia* (Freyer, 1851) (Verovnik & Micevski 2009). Therefore the designation of the threat status to EU populations of the Spinose Skipper would have a wider positive effect. At national level, *M. cribrellum* has been legally protected in Romania since 2005 (see also Rákosy 2006). Regrettably, the species was inexplicably excluded from the list of target species for the project Prime Butterfly Areas in Bulgaria, even though it was recorded in the course of the project and was mentioned in the final publication (Abadjiev & Beshkov 2007). This unfortunate misjudgement must be corrected as soon as possible, not only in view of the rarity and localization of *M. cribrellum* in Bulgaria, but also because it is a very suitable "umbrella species" for the protection of the prime steppe-like habitats in western Stara Planina.

Currently, autecological studies on the Spinose Skipper are badly needed as well as precise mapping of its distribution and evaluation of the potential threats. Only with such precise information can the guidelines for conservation and management plans for long term survival of the species at its western limit of distribution be made.

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Anania ochrofascialis (Christoph) comb. n. and *A. murcialis* (Ragonot) comb. n. – two vicarious species from the western Palaearctic region (Pyraloidea: Crambidae: Pyraustinae)

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Abstract. With this contribution, we continue to investigate the generic classification of European Pyraustinae based on synapomorphic characters. Further taxa are recognized which are related to *Anania* Hübner, 1823. The monotypic genus *Ametasia* Martin, 1986 **syn. n.** is synonymised with *Anania* and two species are transferred to this genus: *Anania ochrofascialis* (Christoph, 1882) **comb. n.**, the type-species of *Ametasia*, and *Anania murcialis* (Ragonot, 1895) **comb. n.** Both species were formerly provisionally placed in *Achyra* Guenée, 1849. The two species are closely related as they cannot be distinguished according to characters of copulatory organs. They are vicarious in the Mediterranean region of the western Palaearctic, with *A. murcialis* occurring in Spain and Morocco, and *A. ochrofacialis* in Ukraine, southern part of European Russia, Azerbaijan, south of Dead Sea, Egypt, and Kazakhstan.

Introduction

In 2005, Leraut suggested a new concept for *Anania* Hübner, 1823 based on synapomorphic characters of the male and female copulatory organs. That approach has been adopted for Chinese and Afrotropical taxa by Tränkner & Nuss (2009). Since then we have investigated further the European Pyraustinae, some of which are rarely represented in collections. Among these is the monotypic genus *Ametasia* described by Martin (1986) for *Metasia ochrofascialis* Christoph, 1882, based on copulatory organ characters which are distinct from those of the remaining species of *Metasia* Guenée, 1854. However, no hypothesis has been available for phylogenetic relationships of that taxon until today. Merely Speidel (1996) and Zolotuhin (2005) placed *ochrofascialis* provisionally in *Achyra* Guenée, 1849. However, both authors overlooked the fact that *ochrofascialis* is the type species of the monotypic genus *Ametasia*, and did not synonymise it with *Achyra*. A further species provisionally placed in *Achyra* is *A. murcialis* (Ragonot, 1895) from Spain (Karsholt 1996). In this paper we present the results of our investigation of these taxa, which clarify their generic position within the Pyraustinae and point to some interesting biogeographical patterns.

Methods

Copulatory organs were prepared and mounted according to the standards suggested by Robinson (1976). Images of the copulatory organs were taken using NIKON Eclipse 600 microscope with ZEISS AxioCam MRc5 digital camera. The terminology follows Marion (1954, 1959), Kristensen (2003), and Nuss & Speidel (2005).

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Abbreviations

AT	Andreas Tränkner
MTD	Senckenberg Museum für Tierkunde Dresden
prep.	preparation of genitalia
ZMHB	Museum für Naturkunde der Humboldt-Universität zu Berlin
ZMUC	Zoological Museum, University of Copenhagen

Results

The taxa investigated here share the apomorphic characters of *Anania*. These are a strong sclerotised elongated asymmetric sclerite in the phallic apodeme (Figs 3–4) and a digitiform sclerotisation in the female antrum (Figs 5–6) (see Leraut 2005; Tränkner & Nuss 2009). Therefore, we here transfer *Metasia ochrofascialis* Christoph, 1882 and *Botys murcialis* Ragonot, 1895 to *Anania* in the combination *Anania ochrofascialis* (Christoph, 1882) **comb. n.** and *Anania murcialis* (Ragonot, 1895) **comb. n.** Because *Metasia ochrofascialis* Christoph, 1882 is the type-species of *Ametasia* M. O. Martin, 1986: 71–72 (by original designation and monotypy) and because we are transferring this species to *Anania*, we hereby synonymise *Ametasia* M. O. Martin, 1986 **syn. n.** with *Anania*.

Anania ochrofascialis (Christoph, 1882), comb. n. Figs 1, 3, 5

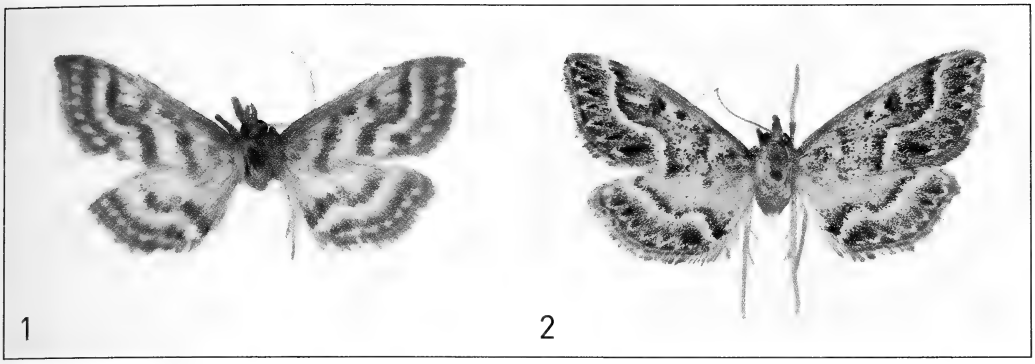
Metasia ochrofascialis Christoph, 1882: 121–122. – Type locality: Russia, Dagestan, Derbent (determined by lectotype designation by Munroe 1970: 1033, but misspelled as "ochrifascialis"; paralectotypes are from Azerbaijan, Ordubat and Russia, Elisabethpol).

Botys retowskyi Möschler, 1888: 128. – Type locality: Ukraine, Crimea, Feodosia. – Rebel 1902: 107 (syn.).

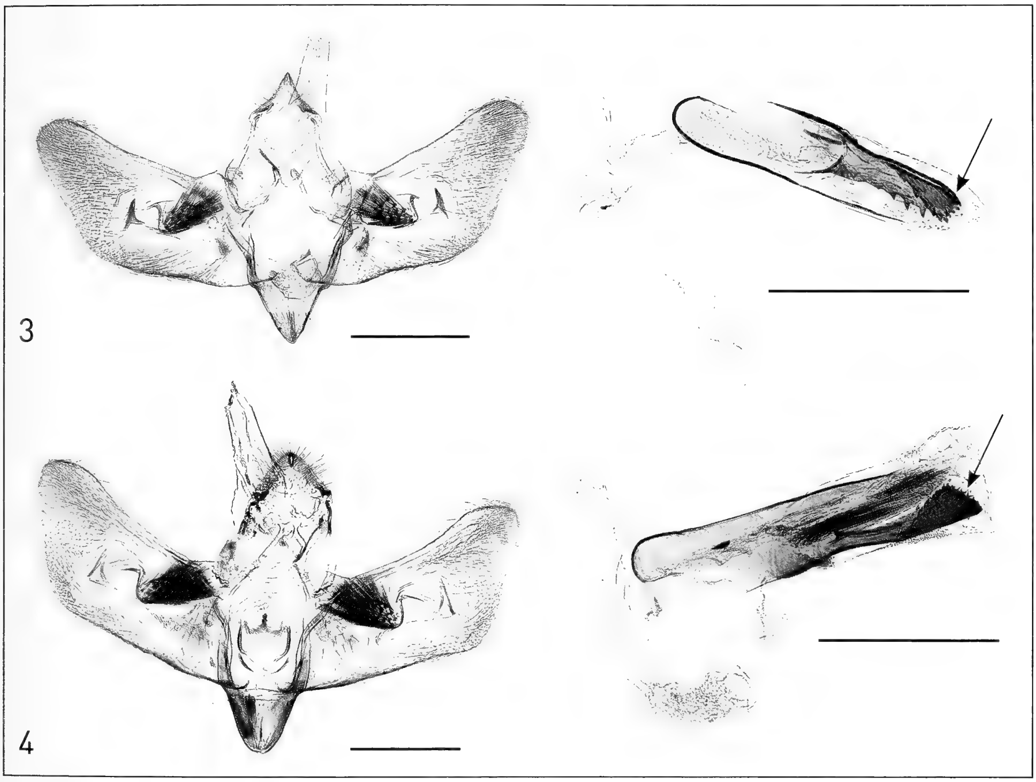
Hypotia bilinea Bethune-Baker, 1894: 46, pl. 1 fig. 15. – Type locality: Egypt, Alexandria. – Speidel 1996: 193, 326 (syn.).

Material. Holotype (by monotypy) of *Botys retowskyi* Möschler (Fig. 1): "Origin", "Type", "Holotype I *Botys* I *Retowskyi* I Möschler 1888 I des. V. Zolotuhin", "Krim I Ret. 81", Retowskyi I Möschl.", "coll. Möschl.", "ZMHU-Berlin I Pyr-Z 05", ZMHB. – 1♂, [country?], southern end of Dead Sea, 1.–27.iii.1933, leg. Amsel; 1♂, Azerbaijan, 60 km south of Baku, Gobustan, 9.vi.1999, leg. I. Pljuschtsch (prep. AT 161); 2♂, 2♀, Kazakhstan, Ili-River, 43°20'N 79°52'E, 500 m, softwood riparian forest on sand, 20.vi.2000, leg. M. Nuss (prep. AT 162, 168, 179); MTD.

Redescription (Fig. 1). Forewing length 7.0–9.0 mm (n = 7). Labial palpi porrect, beige laterally, white ventrally; maxillary palpi stilett-shaped, beige. Antennae of both sexes filiform, dorsally whitish scaled, ventrally with ciliate sensillae. Forewing apex acute; ground colour whitish with beige to pale brown pattern elements. Basal half of costa light brown. Antemedian line starting near costa at one-third of wing, running straight towards one-quarter of dorsum. Discoidal cell with ovate spot close to costal origin of antemedian line; distal discoidal stigma spot-like. Postmedian line starting from costa at three-quarter, running parallel to termen, curved sinusoid in middle of wing, ending at middle of dorsum. Subterminal area brown, with white spots between veins. Fringe at base pale yellow, followed by brown, distally beige and whitish cheq-



Figs 1–2. Adults of *Anania*. **1.** *A. ochrofascialis*, holotype of *Botys retowskyi* Möschler from Ukraine, Crimea (ZMHB). **2.** *A. murcialis* from Spain, Almeria (ZMUC).



Figs 3–4. Male copulatory organs of *Anania*. Arrows: asymmetric sclerite of phallic apodeme. **3.** *A. ochrofascialis* from Kazakhstan, prep. AT179 (MTD). **4.** *A. murcialis* from Spain, Almeria, prep. AT163 (ZMUC). Scale bars: 0.5 mm.

uered. Hindwing white, with median line sinusoid and subterminal area brown, with white spots between veins; fringe as in forewings.

Male terminalia (Fig. 3). Uncus broad, triangular, weakly sclerotised, laterally slightly concave, weakly setose, distally pointed. Valvae basally broad, with costa nearly straight, ventral margin conspicuously narrowing from middle of valva towards apex, the latter round. Vinculum dorso-laterally with membrane with loose-fitting brush of hair-like coremata with broadened tip (not shown in Fig. 3). Mesal wall of valva mediobasally with slightly elevated sclerotisation adorned with some straight bristles; sella and editum bearing many lamellae, directed dorsally; middle of valva with sclerotised spine directed dorsally. Phallus apodeme with conspicuously elongate sclerite reaching posterior end of phallus, posterior half of sclerite with serrated edge. Males investigated have no deciduous cornuti left in the phallus, but a female (Fig. 5) contains cornuti in the corpus bursae and appendix bursae.

Female terminalia (Fig. 5). Corpus bursae with rhomboid signum; appendix bursae attached laterally. Ductus bursae membranous, slightly curved, broadly enlarged anterior to antrum; colliculum not differentiated, ductus seminalis arising close to antrum. Antrum sac-like, enlarged, sclerotised, with free digitiform sclerotisation extending to posterior edge of antrum.

Differential diagnosis. Among all *Anania* species known to us, *A. ochrofascialis* is most similar to *A. murcialis*, redescribed below.

Distribution: Ukraine, southern part of European Russia, south of Dead Sea, Azerbaijan, Egypt, and Kazakhstan.

Remarks. We did not investigate the lectotype of *Anania ochrofascialis*, but it is figured by Zolotuhin (2005: text-fig. 9, colour-fig. 5). He also figured the holotype of *Botys retowskyi* (Zolotuhin 2005: colour-fig. 6) and confirmed its synonymy to *A. ochrofascialis*.

Anania murcialis (Ragonot, 1895), comb. n. Figs 2, 4, 6

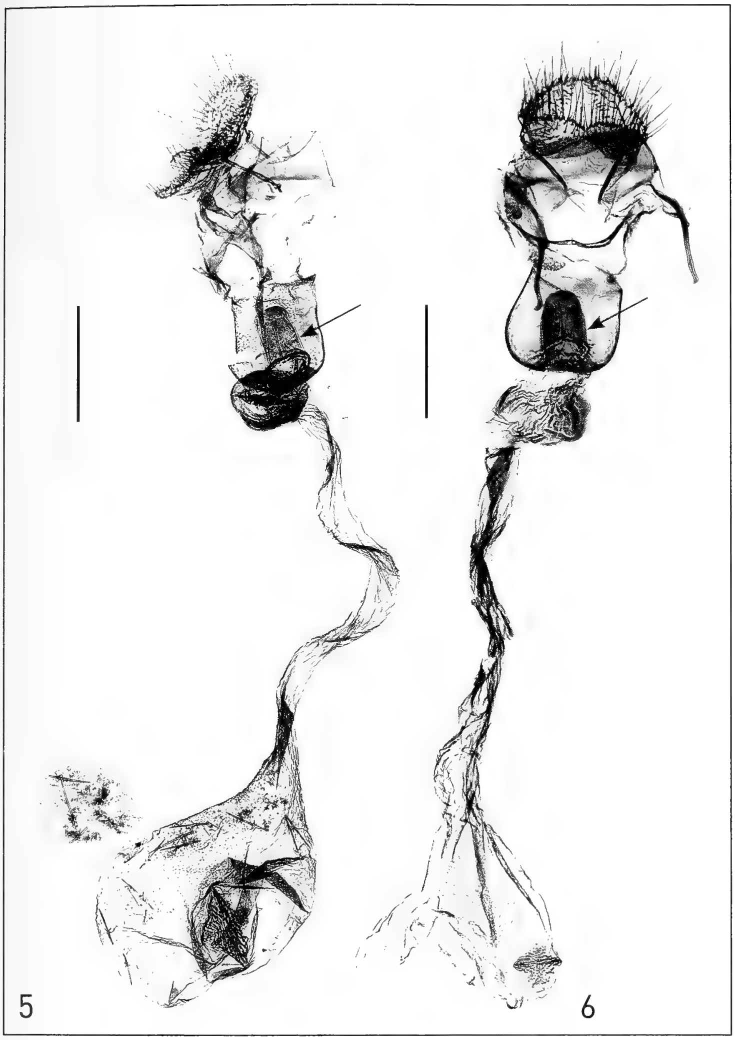
Botys (*Phlyctaenia*) *murcialis* Ragonot, 1895: 23. – Type locality: Spain, Province of Murcia, Algezares.

Material. 2♂, 2♀, Spain, Almeria, Mini Hollywood, 300 m, 15.v.1993, leg. B. Goater (prep. AT 163, 164), ZMUC.

Redescription. Forewing length: 9.0 – 10.0 mm (n = 4). Similar to *A. ochrofascialis* except labial palpi brown laterally; maxillary palpi brown. Antennae of both sexes dorsally brown scaled. Forewing with pale brown pattern elements conspicuously suffused by black scales; antemedian line starting near costa at one-quarter of wing; centre of discoidal cell with small black spot clearly distant to antemedian line; distal discoidal stigma a large brown spot, suffused black. Subterminal area with white, basally black-filled triangles between veins. Fringe with row of long scales, whitish at base, dark brown at tip, covered by second row of short, concolorous scales. Hindwing subterminal area with large white, black-filled ellipses between veins (Fig. 2).

Male terminalia (Fig. 4). Similar to *A. ochrofascialis* except uncus laterally straight. Valvae with costa slightly concave, ventral margin conspicuously narrowing from two thirds of valva towards apex. Phallus with numerous, straight deciduous cornuti.

Female terminalia (Fig. 6). Similar to *A. ochrofascialis* except ductus bursae straight.



Figs 5–6. Female copulatory organs of *Anania*. Arrows: Digitiform sclerotisation of antrum. **5.** *A. ochrofascialis* from Kazakhstan, prep. AT 162 (MTD). **6.** *A. murcialis* from Spain, Almeria, prep. AT 164 (ZMUC). Scale bars: 0.5 mm.

Differential diagnosis. In wing pattern elements *A. murcialis* is similar to *A. ochrofascialis*, but conspicuously suffused by black scales; the antemedian line starts more basal at costa and runs less oblique towards dorsum; the proximal spot in the discoidal cell is clearly distant to the antemedian line and the subterminal area is white with basally black-filled triangles between veins (instead of white spots). In genitalia, we did not find convincing differences between the two species. The possible differences that might be recognised in Figs 3–6 need to be investigated on a larger number of specimens.

Distribution: Only known from Spain and Morocco (Lucas 1942: 63; Rungs 1979: 172).

Remarks. *Botys murcialis* Ragonot, 1895 has been provisionally transferred to *Achyra* Guenée, 1849 by Karsholt (1996: 326), thus becoming a junior secondary homonym of the New World *Achyra murcialis* (Walker, 1859), originally described in *Ebulea*

Doubleday, 1849 and transferred to *Achyra* by Munroe (1976: 47). A replacement name has never been given for the secondary junior homonym '*Achyra murcialis* (Ragonot, 1895)'. However, since here we transfer *Botys murcialis* Ragonot, 1895 to *Anania* Hübner, 1823, the establishment of a replacement name is not necessary anymore.

Botys murcialis Ragonot, 1895 has been described based on two females. Unfortunately, the syntypes could not been traced at the Muséum National d'Histoire Naturelle in Paris (P. Leraut, pers. comm. to M. Nuss), where Ragonot's Microlepidoptera collection is deposited (Horn et al. 1990: 317). However, the identity of the species is verifiable unambiguously when compared to the original description.

Discussion

With *Anania ochrofascialis* and *A. murcialis*, the European fauna of *Anania* now comprises 15 species. Among them, *A. ochrofascialis* and *A. murcialis* might be regarded as close relatives due to their similar wing pattern elements and their nearly identical copulatory organs. In contrast to all other *Anania* species, these two species show a postmedian line that starts from the costa and runs parallel to the termen. Ragonot (1895), who did not mention *A. ochrofascialis*, compared *A. murcialis* as similar to *A. perlucidalis* in the colour and shape of the wings and treated both species in the subgenus *Phlyctaenia* Hübner, 1825 (now a synonym of *Anania*). However, wing pattern elements in common between *A. ochrofascialis*, *A. murcialis* and *A. perlucidalis*, e.g. presence of antemedian and postmedian lines, proximal and distal discoidal spots, are also shared by most other *Anania* species e.g. *A. verbascalis* (Denis & Schiffermüller, 1775), *A. oberthuri* (Turati, 1913), *A. crocealis* (Hübner, 1796), *A. lancealis* (Denis & Schiffermüller, 1775), as well as by non-*Anania* pyraustines, such as *Ostrinia nubilalis* (Hübner, 1796), *Paratalanta pandalis* (Hübner, 1825), or *Paracorsia repandalis* (Denis & Schiffermüller, 1775). Thus, these characters might be plesiomorphic. Also, the structures of the copulatory organs do not support a close relationship between *A. ochrofascialis* and *A. murcialis* on the one hand, and *A. perlucidalis* on the other. In *A. perlucidalis*, the sclerite of the phallic apodeme is deeply cleft whereas in *A. ochrofascialis* and *A. murcialis* it is not cleft, and thus similar to that of *A. funebris* (Ström, 1768) and *A. verbascalis*. Thus, the relationship of *A. ochrofascialis* and *A. murcialis* within *Anania* remains uncertain and the application of molecular techniques might be the prime tool for a phylogenetic reconstruction of *Anania* species.

According to the available data, *A. ochrofascialis* and *A. murcialis* might be vicarious species in the Mediterranean region of the western Palaearctic, with *A. murcialis* occurring in Spain and Morocco, and *A. ochrofacialis* in Ukraine, southern part of European Russia, Azerbaijan, south of Dead Sea, Egypt, and Kazakhstan. So far, we have been unable to trace specimens for the region situated between Morocco and Egypt, e.g. from Tunisia, where a number of entomologists have collected during the last decades. For a better understanding of the two species, the discovery of their life-history, especially of the larval host-plants, will be significant.

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A new subspecies of *Hyles siehei* (Püngeler) from the deserts of Central Asia (Sphingidae)

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Abstract. A new subspecies *Hyles siehei svetlana* **ssp. n.** is described from Central Asia (type locality: Western Kazakhstan, Aktobe Region, the Shagyray Plateau). It inhabits desert biotopes and differs from the nominotypical montane *H. siehei siehei* (Püngeler, 1903) by its smaller size and the presence of a larger postdiscal patch on the forewing. It is also quite distinct in the coloration and body pattern of the mature larvae, which feed on *Eremurus inderiensis* Stev. It is suggested that this desert subspecies originated about 2.5–1.7 million years ago as the result of global and prolonged isolation during repeated transgressions of the Caspian Sea. Data on the life history and morphology of the preimaginal stages are given. The species *H. siehei* is noted here from Kazakhstan, Uzbekistan and Turkmenistan for the first time. The holotype of the new taxon is deposited in the collection of the Zoological Institute of Russian Academy of Sciences, St. Petersburg, Russia.

Резюме. Из Средней Азии (типовая местность – Западный Казахстан, плато Шагырай) описывается новый подвид *Hyles siehei svetlana* **ssp. n.** Он населяет пустынные стации и отличается от номинативного горного *H. s. siehei* (Püngeler, 1903) меньшими размерами, наличием четкого дискального пятна на переднем крыле, а также принципиально иными окраской и рисунком взрослых гусениц, питающихся на пустынном *Eremurus inderiensis* Stev. Предполагается, что данный подвид сформировался при разрыве ареала исходного вида в результате трансгрессий Каспийского моря около 2,5–1,7 миллионов лет назад. Приведены подробные данные по биологии и морфологии его преимагинальных стадий. Вид *H. siehei* впервые отмечается, таким образом, для Казахстана, Узбекистана и Туркменистана. Голотип нового таксона хранится в коллекции Зоологического института Российской Академии Наук (г. Санкт-Петербург).

Introduction

In May 2006, some unknown larvae of a *Hyles* species (Figs 10, 11, 17) feeding on *Eremurus inderiensis* (Stev.) (Fig. 15) were collected by me at Shagyray Plateau, Aktobe Region of Kazakhstan. Their colouration precluded both *Hyles livornica* (Esper, 1780) which is common in this area and *Hyles centralasiae* (Staudinger, 1887) which is known from Turkmenistan, Uzbekistan and Central Kazakhstan. In addition at light we collected some moths very similar to *H. centralasiae* but differing in their smaller size and more olive ground colour of the fore wings. Unfortunately, adults were not successfully reared from those larvae. In 2007 and 2009 new expeditions were organised and similar larvae were collected about 300 km to the south of the previous location, also feeding on *Eremurus inderiensis*. In addition some moths similar to *H. centralasiae* were caught here at light. Five pupae were obtained from the collected larvae. The first imago emerged in July 2007, and the second one year later, in late August 2008, both moths being very similar to *H. centralasiae*.

Shchetkin (1952, 1960, 1975) repeatedly wrote about the biology of *H. centralasiae* (as *Celerio centralasiae*) in Central Asia. He noted the essential distinction between desert and mountain forms of the moths. In 1952 he pointed out that "moths of

C. centralasiae from desert and semi-desert regions (from Bet-Pak-Dala, Mujun-Kum, Repetek) are smaller than those individuals developing in the both foothills and higher altitude regions. Desert specimens have an average wingspan about 57 mm (from 55 to 60 mm), those from other regions average 65 mm (from 60 to 70 mm)". Desert and mountain taxa occur at different altitudes. The typical altitudes for the mountain taxon range between 500 and 2800 m a. s. l. (Shchetkin 1952, 1960, 1975; Danner et al. 1998; Derzhavets 1984; Jordan 1912; Pittaway 1997–2009). The altitudes at which we collected did not exceed 250 m a. s. l., and for coastal areas of the Aral Sea altitudes were minus 28 m. *Eremurus ambigens* Vved. and *E. olgae* Rgl. were specified as hostplants for mountain moths (Shchetkin 1952, 1975), and for the desert moths he states only that larvae feed on *Eremurus* species. It is clear that he had not seen the desert larvae of the hawk moth as he gave only for a description of the mountain form. The larvae found by us differ very strongly from that described, by Shchetkin. It should also be noted that *Eremurus inderiensis*, unlike other congeners, grows not in mountains or along mountain valleys, but only on the semifixed sand of desert and in semidesert biotopes (Fedchenko 1949).

Mitroshina (1989) describes the ecological features of hawk moths inhabiting deserts of Northern Turkmenistan (Southern Ustyurt, chink Burchliburun). The territories that we investigated are very similar, both geographically and climatically, to those described by Mitroshina. Unfortunately Mitroshina did not give a clear description of the larvae she observed. However the similar climatic conditions of the region, the flight period of the imago and the feeding of larvae on *Eremurus inderiensis* led us to suppose that she was dealing with the same species that we had observed.

Phenologically both taxa are quite distinct. As Shchetkin (1952, 1975), Danner et al. (1998), Derzhavets (1984), Jordan (1912) and Pittaway (1997–2008) remarked, the flight period for *H. centralasiae* falls in the first half of June and it is linked to the beginning of the flowering period for *Eremurus*. Larvae have to complete their feeding before the maturing of fruits of *Eremurus*, and their development therefore lasts on average 20–25 days. Similar situations were noted for *E. inderiensis* and the *Hyles* species trophically connected with it. Based on our data, the flight period of imago in deserts is the first weeks of May, which coincides with active vegetation growth and the beginning of flowering of *E. inderiensis*.

The life circle of *E. inderiensis* is much shorter in desert biotopes, and by late May all parts of the plant above ground level are completely dessicated. Development of larvae on this plant is accelerated, and from egg to a pupa lasts only about 9–11 days (pers. observ.).

It is reasonable to assume that *H. centralasiae* partially migrates in desert territories as during dry periods no hostplant can be found there. Thus it is possible to conclude that the differing life cycles produce a temporal isolation which preserves the desert pheno- and genotypes, separating these taxa from those in mountain regions.

Based on author's conclusion from the biological and morphological evidence, the taxon inhabiting the Western Kazakhstan differs from typical *H. centralasiae*. To test this assumption our material was subjected to the analysis of mitochondrial DNA. Results of this analysis (Hundsdörfer et al. 2009) confirmed the assumption that the samples differ from typical *H. centralasiae*, but surprisingly are close to *H. siehei* (Püngeler, 1903). Such a close relationship was unexpected, as these taxa differ strongly both morphologically (Figs 2, 4) and ecologically. The montane *H. siehei* prefers the sunny, moderately humid hills of Turkey (Danner et al. 1998; Pittaway, 1997–2009; Derzhavets 1984; Pelzer, 1982, 1991) (Fig. 19), and our taxon is a typical member of desert and semidesert fauna of the Central Asia. Thus, on the one hand ecological and morphological differences are enough to separate the taxon from the Western Kazakhstan to the rank of a species; on the other hand the analysis of mtDNA shows that the new taxon is very similar to *H. siehei*.

Basing on the facts given above I am of the opinion that the new taxon most likely has the rank of a new species, but at present there is insufficient unequivocal evidence to support this conclusion. I am therefore describing here the taxon from the Western Kazakhstan as a new subspecies of *H. siehei*.

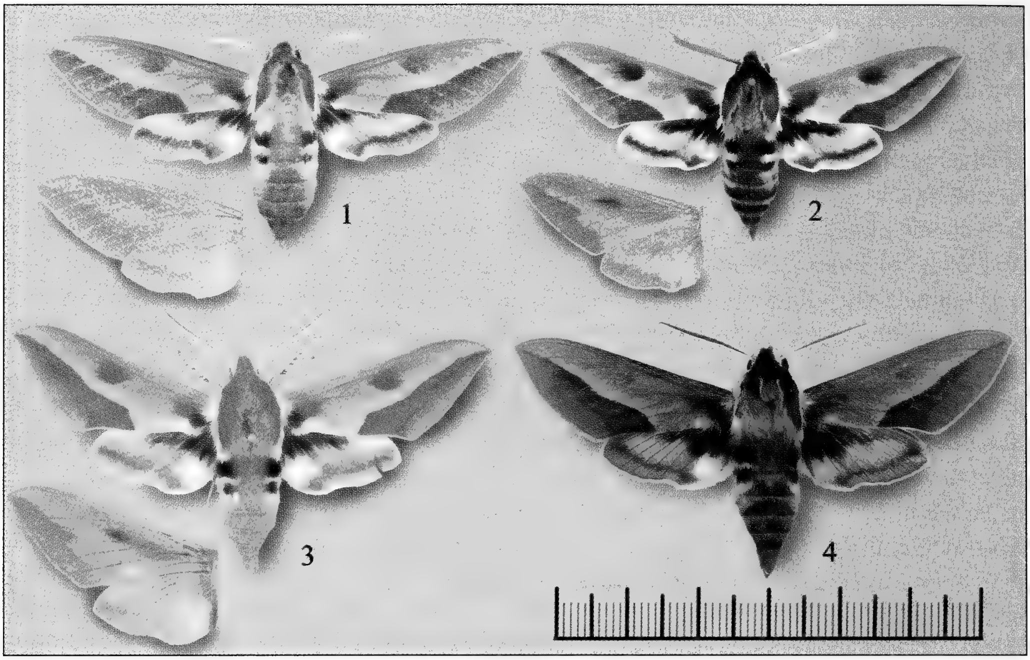
Abbreviations

BMNH	Natural History Museum, London, United Kingdom
LSSU	Laboratory of Animal Systematics and Faunistics, Samara State University, Samara, Russia
MWM	Entomological Museum Thomas J. Witt, Munich, Germany
WCA	Working collection of the author
ZISP	Zoological Institute of Russian Academy of Sciences, St. Petersburg, Russia

Hyles siehei svetlana ssp. n. (Figs 1–2, 5, 10–11, 16–18)

Material. Holotype ♂, '15.05.2006 Kazakhstan, I Aktobe Region, Plateau Shagyray, I N 46°52'35" EO 58°02'05" I leg. Trofimova T.A. & Shovkoon D.F.' <white rectangle, printed in black ink >, 'HOLOTYPUS. I P *Hyles siehei svetlana* I Shovkoon I design. Shovkoon D. F. 2009' <red rectangle, printed in black ink> (in coll. ZISP). – Paratypes: 6♂, 1♀ same data as holotype (1♂, 1♀ in coll. ZISP, 2♂ in coll. WCA, will be transferred in coll. BMNH, 1♂ in coll. WCA, will be transferred in coll. MWM, 2♂ in coll. LSSU); 1♂ 13.05.2006 Kazakhstan, Aqtobe Region, N 46°58'08" E 59°13'35", leg. Trofimova T.A. & Shovkoon D.F. (in coll. WCA); 3♂ 25.05.2006 Kazakhstan, Aqtobe Region, Plateau Shagyray. N 46°45'36" E 57°31'20", leg. Trofimova T.A. & Shovkoon D.F. (1♂ in coll. WCA, will be transferred in coll. BMNH, 2♂ in coll. LSSU); 1♂ 11.05.2004 Kazakhstan, Aqtobe Region, Plateau Shagyray. leg. Trofimova T.A. (in coll. LSSU); 1♂, 1♀ 27.05.2006 Kazakhstan, Qyzylorda Region, coast of Aral Sea N 46°20'09" E 59°43'21", leg. Trofimova T.A. & Shovkoon D.F. (in coll. WCA); 3♂ 16.05.2007 Kazakhstan, Mangistau Region, N 43°44'53" EO 53°38'14", leg. Trofimova T.A. & Shovkoon D.F. (1♂ in coll. WCA, will be transferred in coll. BMNH, 1♂ in coll. WCA, will be transferred in coll. MWM, 1♂ in coll. LSSU); 1♂ 16.05.2007 Kazakhstan, Mangistau Region, N 43°44'53" EO 53°38'14" – larva, 27.05.2007 – pupa, 18.07.2007 – imago (in coll. WCA); 1♂ 16.05.2007 Kazakhstan, Mangistau Region, N 43°44'53" E 53°38'14" – larva, 27.05.2007 – pupa, 29.08.2008 – imago (in coll. WCA). – Additional material. 1♂ sands Sary-Tau-Kum, 150 km NNE Alma Ata, on light, leg. Reznik 1.v.1981 (ZISP); 1♂ Kazakhstan, sands Sary-Tau-Kum in Lower Ili, near Aydayrly, leg. Seitova 11.05.1967 (ZISP); 1♂ Uzbekistan, Kyzyl-Kum desert leg. Falkovich 29.iv.1974 (ZISP); 1♂ Uzbekistan, Kyzyl-Kum desert, Ayakgujumdy, leg. Falkovich 18.iv.1986 (ZISP); 1 walking larva 29.05.2009 Kazakhstan, Mangistau Region, N 43°44'53" E 53°38'14" (WCA).

Etymology. The subspecies was named after my sister and Dr. Svetlana Kozlova, my dear friend, for her continuous valuable help in my scientific work.



Figs 1–4. Adults of *Hyles* spp. **1.** *H. siehei svetlana* ssp. n., ♀, paratype. **2.** *H. siehei svetlana* ssp. n., ♂, holotype from Kazakhstan, Aktobe Region, Plateau Shagyray (ZISP). **3.** *H. centralasiae*, ♂, Uzbekistan, Samarkand 20/22 IV, O. Herz 1892 (ZISP). **4.** *H. siehei siehei*, ♂, Turkey, Taurus (MWM).

Description. Imago: Wingspan: ♂ 55–60 mm (holotype 57 mm), ♀ 65 mm. Forewings with a large discal spot in the pale median stripe. Central gap in the oblique median stripe more reduced, or completely absent. The pink area of the hindwing can be intense or faint. Black or dark-olive post-discal band on the hindwing narrower and separated from the black basal area along the costa. Rarely with a distinct rosy hue on both wings and body. Antenna distally incrassate in both sexes and, in female, more clavate. Pilifer with long setae medially, and shorter ones laterally. Labial palpus smoothly scaled, concealing base of proboscis; scaling at apex of the first segment not arranged in a regular border on inner surface; second segment without apical tuft on inner side. Abdomen conically pointed, with strong dorsal spines usually arranged in two transversal rows. First segment of foretarsus short, with six strong spines.

Male genitalia (Fig. 5): Similar to all other species of *Hyles*. Uncus and gnathos beak-shaped, narrow. Valva broadly pear-shaped. Sacculus terminates in a thin simple, tapering process. Phallus tubular with apex bearing well-expressed dentate curved spur.

Ovum (Fig. 16): Small, 1.2 mm in diameter, almost spherical, pale green. Laid directly on flower buds or on a stalk of the hostplant nearby the ground.

Larva: The newly-hatched larva is 2.5 mm long, pale rosy with blackish brown head, legs, prothoracal shield and horn (the latest is short and vertical): the body bears rows of setae of the same colour. The head and thoracal segments are rose-tinted. In the second instar (Fig. 17) the primary body colour is pale rosy matching flowers of the host, with whitish dorso-lateral line bearing rudimentary eye-spots. There is a hint of an orange dorsal line. The third instar is similarly patterned and colored, primary colour can vary to greenish olive. The dorso-lateral line is more prominent, the eye-spots pure white, and a pinkish-white ventro-lateral line presented. The head, anal clasper and horn are black, dorsal line pale orange. In the fourth instar the primary body colour is greenish olive with scattered white, frequently darkly-ringed speckles. The head, legs, horn and prothoracal shield are black. Fully grown larva is 65–70 mm long (Figs 10, 11), greenish olive with scattered white, frequently dark-ringed speckles, with a bright yellow dorsal line. Each side with a dorso-lateral line having large, white or yellow, black-ringed eye-spots. Horn, head, legs and anal shield are black. Spiracles yellow, black-ringed.

Newly hatched larvae prefer feeding on the pollen-sacs and often sit on the flowers. As they grow, all parts of the flower are eaten, including the immature ovaries. Larvae of later instars feed openly on the tall, columnar inflorescence.

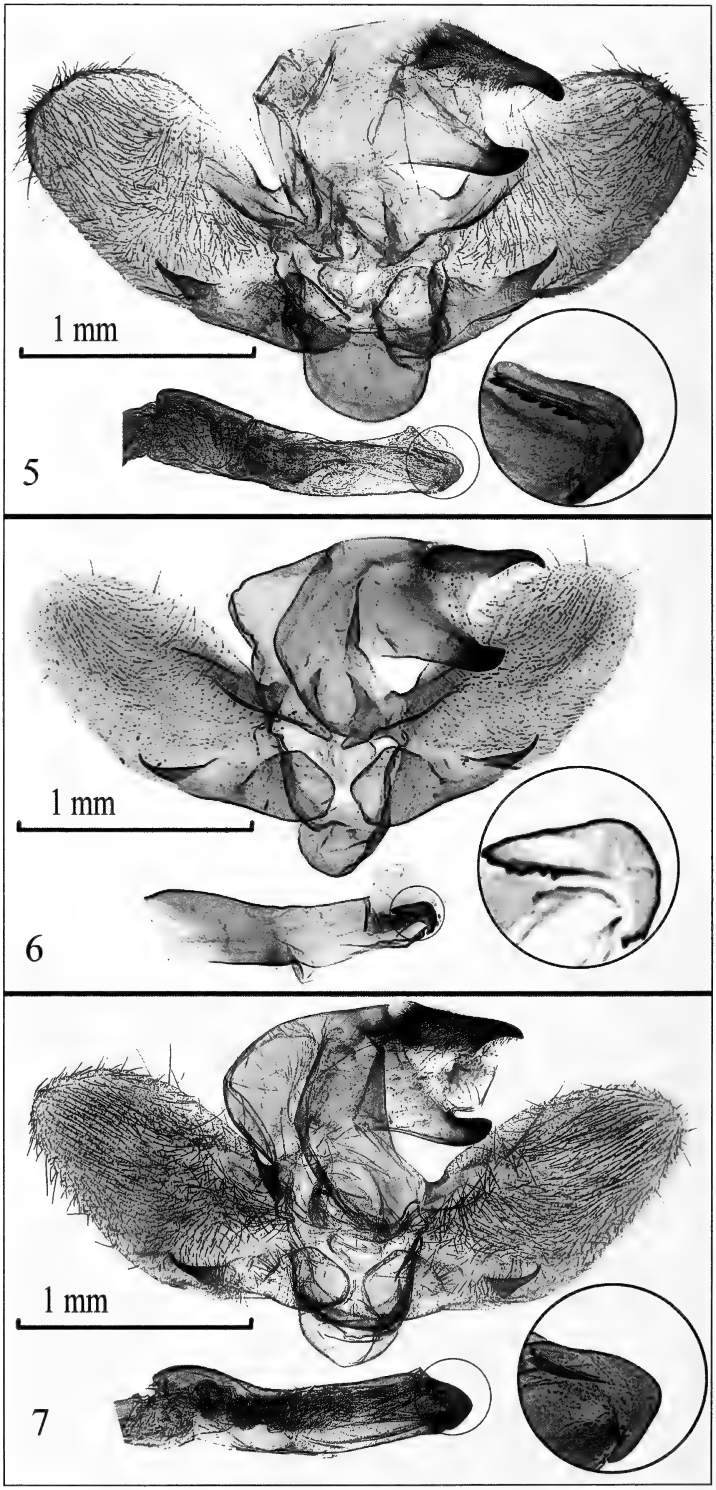
Pupa (Fig. 18): 37–42 mm. Pale greenish-brown with semitransparent cuticule, in a loosely spun, net-like cocoon among debris on the ground. Proboscis fused with body, not projecting anteriorly. Cremaster large, bent ventrally. Many pupae have a diapause of several years.

Diagnosis. From the nominate *H. s. siehei* (Fig. 4) moths of the new subspecies differ by (1) the smaller size, (2) the forewing has a clearly defined postdiscal patch and (3) lighter background oblique median stripe is always clearly defined and does not merge with a dark field at wing edge as is often seen in *H. siehei siehei*, and (4) the hindwing has a more clearly defined and wider black band than in *H. siehei siehei*.

From *H. centralasiae* (Fig. 3), moths of *H. s. svetlana* also differ in their smaller size (from 58 to 75 mm in *H. centralasiae*), though there is some overlap. The coloration of *H. s. svetlana* has a prevalence of olive tones and in *H. centralasiae* the colour is lighter, with a predominance of beige tones. Hindwing of *H. s. svetlana* has a more clearly defined, wide, black band. Underside of wings and abdomen in *H. s. svetlana* are rose (Fig. 1), in *H. centralasiae* cream coloured (Fig. 3), or, rarely, faintly rose.

The lectotype of *H. centralasiae* from Samarkand has a wingspan of only 58 mm (as measured from the illustration in Danner et al, 1998) and so falls within the range of the new taxon rather than montane *H. centralasiae*. However, the lectotype is also quite pale, rather beige, which would suggest that it is *centralasiae* sensu auctorum. Samarkand is located at 700 m above sea level, which correspond to the altitude at which *centralasiae* sensu auctorum occurs. But the question remains, whether the type locality of *H. centralasiae* is appropriate for the desert taxon or the montane taxon. There is a possibility that the desert taxon could be the true *centralasiae*, and then the name *transcaspica* Bang-Haas, 1936 (type locality: Achal tekke, Uzbekistan) would have to be reinstated for the montane taxon.

As the lectotype of *H. centralasiae* from Samarkand does not unequivocally answer this question, I studied the collection of ZISP where I found the moth illustrated in Fig. 3. This moth originates from the type locality of *H. centralasiae* and was reared from a larva. Remnants of larval and pupal exuviae are available for that specimen together with additional dried larvae. All larvae have the typical colouration and eye-spot pattern



Figs 5–7. Male genitalia of *Hyles* spp. **5.** *H. siehei svetlana* ssp. n. (ZISP), paratype. **6.** *H. siehei siehei*, Turkey (MWM). **7.** *H. centralasiae*, Uzbekistan, Samarkand (ZISP).

of the mountain taxon, which strongly suggests that the lectotype of *H. centralasiae* is congruent with *H. centralasiae* sensu auctorum and that the name *transcaspica* is a synonym.

Male genitalia are very variable and similar to those of other *Hyles* species, and do not seem to be suitable for diagnostic purposes. Differences in shape of the valva and uncus are constant. In *H. siehei svetlana* the valva is pear-shaped (Fig. 5), in *H. siehei siehei* (Fig. 6) and *H. centralasiae*. (Fig. 7) ovate. The uncus of *H. siehei svetlana* is smoother and less pointed, of *H. siehei siehei* coiled with beak-shaped apex, of *H. centralasiae* short and massive, sharply pointed at apex.

Differences in the larvae are more marked (Tab. 1).

Distribution (Fig. 19). *H. siehei svetlana* is strongly linked to the range of its hostplant. From our data, the moths inhabit desert and semi desert stations of the Western Kazakhstan where *E. inderiensis* grows – the Shagyray Plateau (Fig. 19, points 2–4), sands Bolshye Barsuki (point 5), part of the northern coast of Aral Sea (point 6) and Southern Ustyurt (point 1).

Besides that, material stored in the collection of ZISP and data from the literature indicates that the same subspecies is probably native to Northern Turkmenistan – part of Burchliburun (Mitroshina, 1989; point 10), the Kyzyl-Kum desert, Repetek (Shchetkin, 1952; point 12); in the Central Kazakhstan sands Sary-Tau-Kum in Lower Ili (Danner et al. 1998: pl. 35 fig. 7, moth with data: ♂, Kazakhstan, Kolshengel, 350 m, 13.v.1996, M. Danilevsky; point 8); 1♂ sands Sary-Tau-Kum, 150 km NNE Alma Ata, on light, leg. Reznik 1.v.1981 (ZISP), point 7; 1♂ Kazakhstan, sands Sary-Tau-Kum in Lower Ili, near Aydayrly, leg. Seitova 11.05.1967 (ZISP), point 9. In Uzbekistan – also the Kyzyl-Kum desert (Falkovich 1986; point 14); 1♂ Uzbekistan, Kyzyl-Kum desert leg. Falkovich 29.iv.1974 (ZISP) point 11; 1♂ Uzbekistan, Kyzyl-Kum desert, Ayakgujumdy, leg. Falkovich 18.iv.1986 (ZISP) point 13.

Nominotypical *H. siehei siehei* (Fig. 19, triangular marker) is distributed from the eastern Toros and Bolkar Mountains of southern Turkey (Danner et al. 1998), eastern Turkey, Armenia (Danner et al. 1998), northern Syria, northern Iraq and northern Iran. Thence probably south along the Zagros Mountains of Iran to Kerman Province, from where one specimen has been recorded (Pittaway 1997–2009).

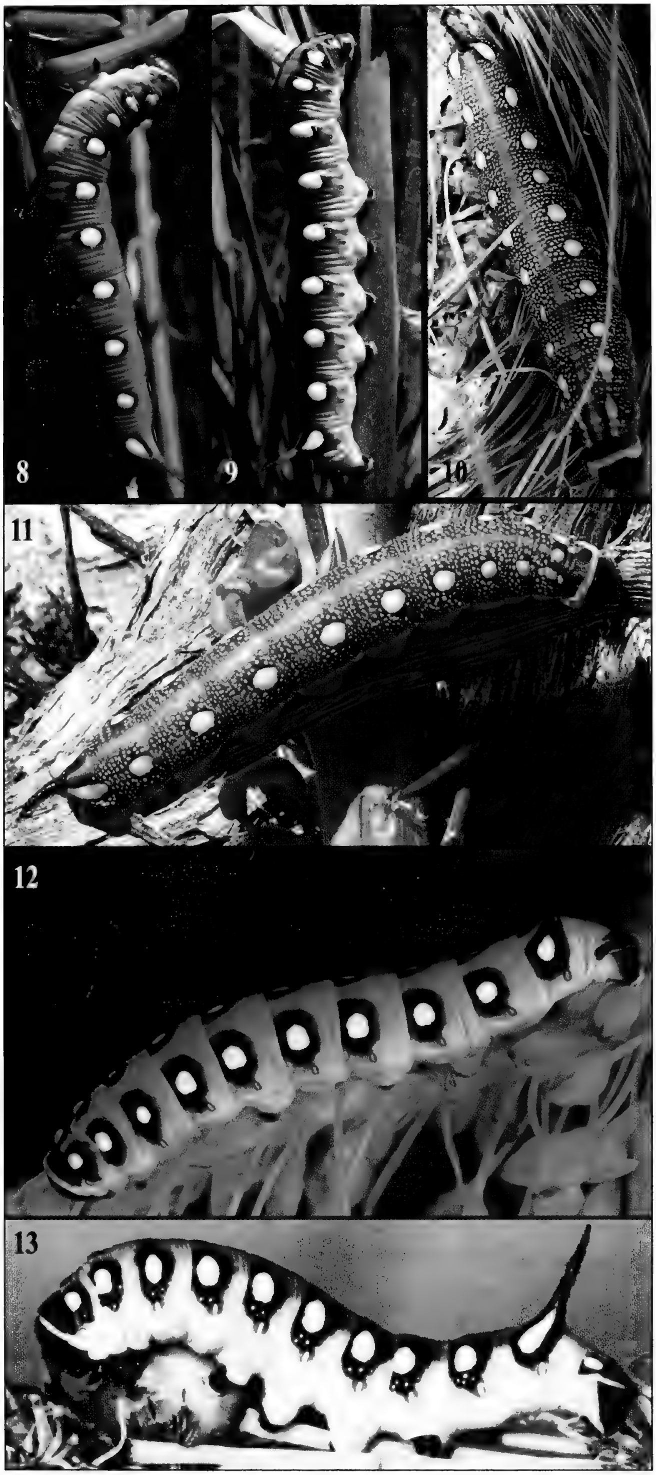
H. centralasiae (Fig. 19, square marker) is distributed from northeastern Iran (Danner et al. 1998), southern Turkmenistan (Derzhavets 1984), southern Uzbekistan (Bang-Haas 1936), southern Kazakhstan (Danner et al. 1998), Tajikistan (Grum-Grshimailo 1890; Bang-Haas 1936) Kyrgyzstan (Pittaway 1997–2009) to northern and eastern Afghanistan (Pittaway 1997–2009) and northern Xinjiang Province, China (Pittaway 1997–2009).

Unfortunately, some data attributed in the literature to *H. centralasiae* was not verified (Fig. 19, square marker with sign "?") and it is likely that these records should be attributed to the described subspecies. Amongst them – specimens from deserts of the Western and Central Turkmenistan (Shchetkin, 1952), and Central Kazakhstan – Middle and Lower Syr Darya (Danner et al. 1998).

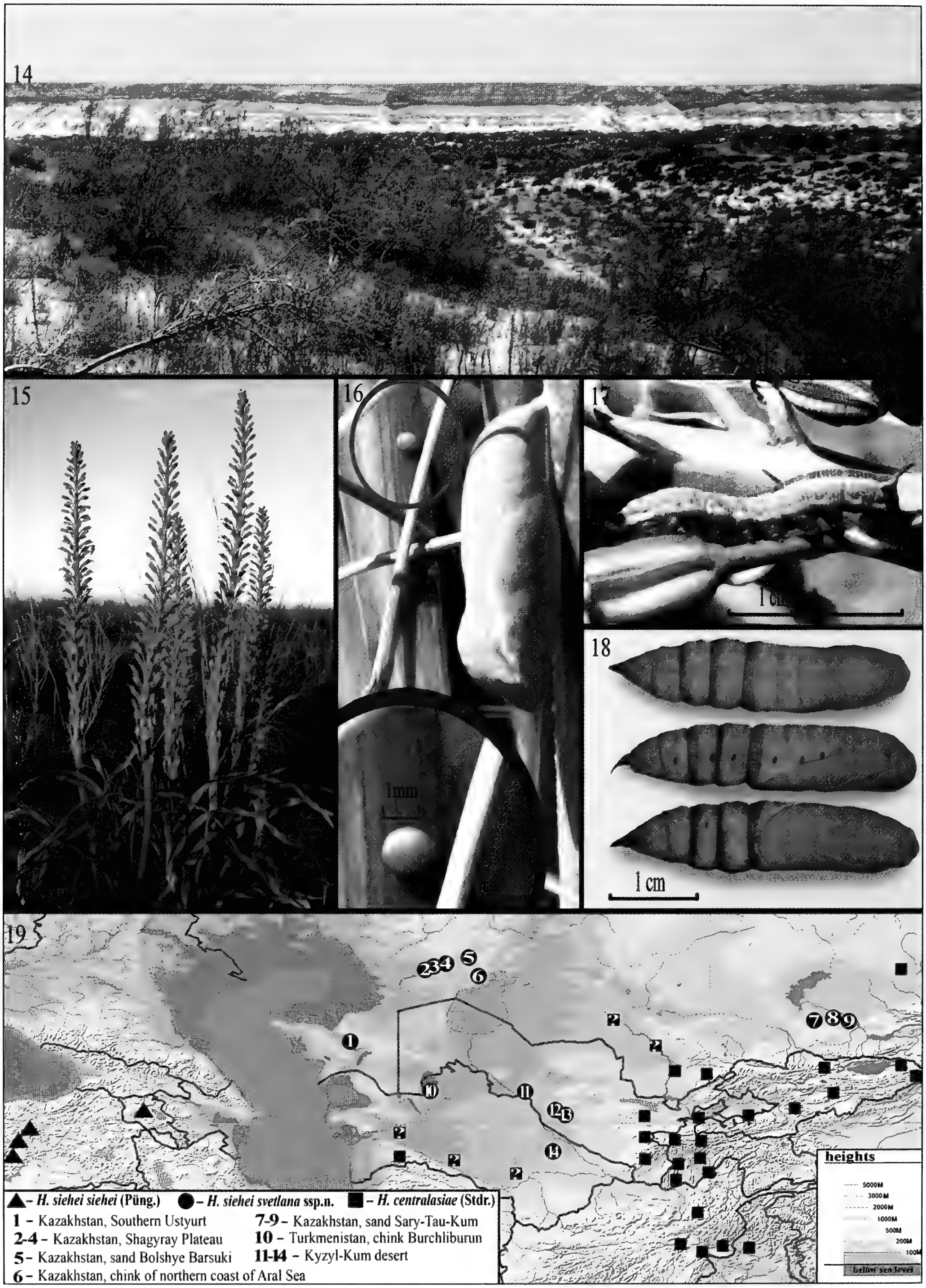
Type locality. The Shagyray Plateau (Figs 14, 19 – point 3) is a continuation of Ustyurt and Donyztau and winds in a northeast direction for 130 *km*. The width of a plateau

Tab. 1. Differential characters of final instar larva of Hyles siehei svetlana ssp. n., H. siehei siehei and H. centralasiae.

Character \ taxon	*H. centralasiae*	*H. siehei siehei*	*H. siehei svetlana* ssp. n.
Length of fully grown larvae, mm	75–90	70–80	65–70
Ground colour of mature larvae	pale grey, sometimes with a pale rose dorsal suffusion	pale brownish grey with rose dorsal suffusion	greenish olive with scattered white, frequently darkly-ringed speckles
Coloration of subspiracular field	strongly bright- to pinkish-cream or pinkish-white and passes to abdominal legs and all ventral surface.	strongly bright to cream-white or pale grayish and passes to abdominal legs and all ventral surface.	strongly bright to pinkish-white or pale grayish and passes to abdominal legs and all ventral surface.
Dorso-lateral line	with large, brilliant white, black-ringed eye-spots.	with very large brilliant white eye-spots and heavily ringed with black. In dark colored larvae, the eye-spots may be reduced or absent.	with large, little bit horizontally extended brilliant white or yellowish, black-ringed eye-spots.
Coloration of thoracic segments	At the majority of larvae spots of second and third segments double – merged of back and smaller forward. On first segment eye-spot is not present, but on their place two black spot, corresponding black-ringed of eye-spots.	At the majority of larvae on second and third segments, on one white eye-spots heavily ringed with black. On the first segment eye-spots stains are not present.	At all found larvae spots of second and third segments double – merged of back and smaller forward, merge full and spots are perceived as longitudinal short strips. On first segment eye-spots are not present, black-ringed is indiscernible merge with a dark background of a larva.
Dorsal line	not broken by any longitudinal strips. In many larvae black bordering of eye-spots of the next segments incorporate among themselves a blackish indistinct shade, and at the blacked out larvae on a back remains more or less narrow dorsal line of the basic pinkish tone.	clearly distinguishable and usually of pinkish colour.	clearly distinguishable and usually has the same coloring as eye-spots.
Horn	blood-red with a black tip, in dark larvae an be completely black	completely black	completely black, very rare orange with a black tip
Head, legs and anal shield	brown-red, in dark larvae can be completely black	black	black, very rare orange



Figs 8–13. Final instar larva of *Hyles* spp. **8.** *H. centralasiae*. **9.** *H. centralasiae*. **10.** Walking-phase of *H. siehei svetlana* ssp.n. **11.** *H. siehei svetlana* ssp.n. **12.** *H. siehei siehei* (from Danner et al. 1998). **13.** *H. siehei siehei* (from Pelzer, 1991).



Figs 14–19. On the lif-history of *Hyles siehei svetlana* ssp. n. **14.** The Shagyray Plateau in Kazakhstan, the type-locality of *H. s. svetlana*. **15.** *Eremurus inderiensis*, the hostplant of *H. s. svetlana*. **16.** Egg of *H. s. svetlana* (near pupa of *Hyponephele* sp.). **17.** Pupa of *H. s. svetlana*. **18.** Second instar larva of *H. s. svetlana*. **19.** Distribution map of *H. siehei svetlana* ssp. n., *H. siehei siehei*, and *H. centralasiae*.

does not exceed 30 *km* (average 15). East and southeast slopes are flat; the western has a more broken character – steep and penetrated by a system of deep ravines. Absolute altitudes here do not exceed 330 *m* a. s. l. but typically range between 100 and 150 m. The vegetation of this rugged terrain varies considerably with altitude. It is mostly composed of *Aristida karelini* Trin. et Rupr. Roshev., *Aeluropus littoralis* (Gouan) Parl., *Stipa lessingiana* Trin. et Rupr., *S. sareptana* A. Beck., *Bromus squarrosus* L. (all Poaceae), *Salsola chiwensis* M. Pop., *S. dendroides* Pall., *S. verrucosa* M. B., *S. rigida* Pall., *Atriplex patula* L., *Haloxylon aphyllum* (Minkw.) Iljin, *Halocnemum strobilaceum* (Pall.) Bieb., *Camphorosma monspeliaca* L. (all Chenopodiaceae), *Calligonum aphyllum* (Pall.) Guerke, *Atraphaxis spinosa* L. (all Polygonaceae), *Astragalus varius* S. G. Gmel., *Caragana frutex* (L.) C. Koch, *Alhagi pseudalhagi* (Bieb.) Fisch. (all Fabaceae), *Clematis glauca* Willd. (Ranunculaceae), *Euphorbia sclerocyathium* Korov. et M. Pop. (Euphorbiaceae), *Artemisia dracunculus* L., *A. austriaca* Jacq., *A. frigida* Willd. (all Asteraceae), *Ephedra equisetina* Bunge (Ephedraceae), *Tamarix gracilis* Willd. (Tamaricaceae), *Elaeagnus angustifol*

Discussion

This new subspecies from the deserts of Central Asia is a good example of the process of speciation when taxa that are already ecologically and biologically divided become geographically isolated. But in this case, the process of speciation probably started comparatively recently and changes are not yet reflected in the mitochondrial DNA.

The defining factors of speciation were most likely repeated isolations during the various transgressions of the Caspian Sea. At present it is known that there were at least five significant transgressions – Akchagylian (2.7–2.3 million years ago), Apsheronian (2 million years ago), Bakuvian (1.7 million years ago), the Early Khazarian (400 thousand years ago) and the Early Khvalynian (100 thousand years ago) (Aladin et al. 1998). The strongest isolating influence was most probably the Akchagylian and Apsheronian transgressions of the Caspian Sea (Fig. 20). The waters of Akchagyl Lake penetrated into the Aral depression forming islands corresponding to the modern Plateau Ustyurt. Extensive lowland stretches of Trans-Caspian, Azerbaijan, Dagestan and Volga were flooded. The Akchagyl Lake existed for a slightly less than 1 million years. The Apsheron reservoir emerged approximately 2 million years ago.

The lake was smaller than Akchagyl, but its waters also penetrated into the Aral basin and drained into the Black Sea. The Caspian lowland was completely flooded and the Kura lowland and Karakum were partially inundated. The Apsheron Lake existed for more than 1 million years.

Thus the flora and fauna of these territories (where our taxon is found) have been isolated from the Pamiro Alay of modern Uzbekistan and hills of modern Turkey twice for a long period of time (more than 0,5 million years).

It is likely these global and prolonged isolations facilitated the emergence of the desert taxon. The range of the new subspecies is separated geographically from the range of the nominated subspecies by water of the Caspian Sea supporting the contention that isolation and speciation are linked.

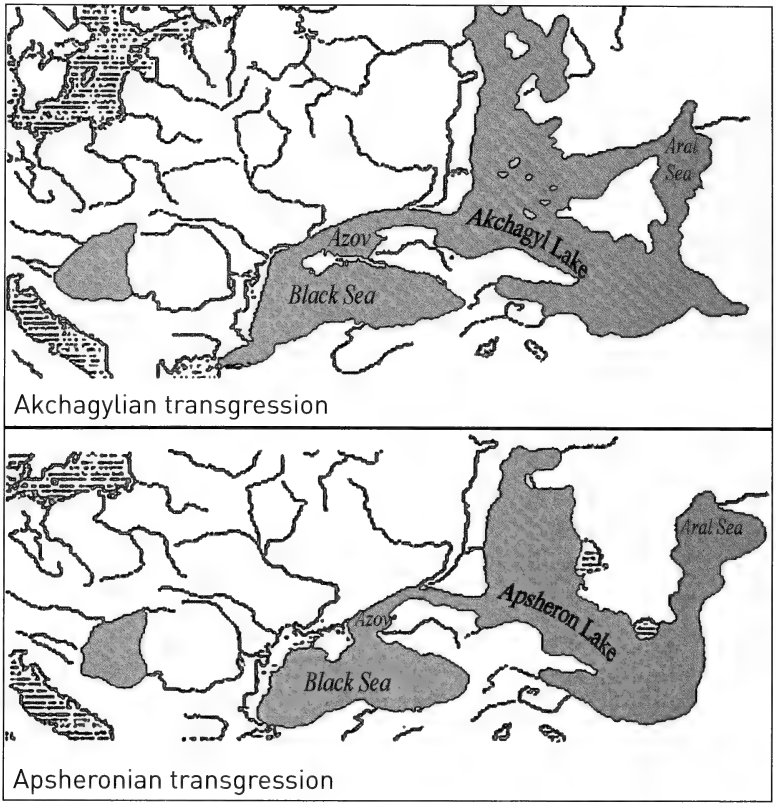


Fig. 20. Water bodies of the Akchagylian and Apsheronian transgressions of the Caspian Sea (from Aladin et al. 1998).

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Revision of some types of the genus *Bembecia* Hübner, 1819 in the Püngeler collection in the Museum for Natural History of the Humboldt University, Berlin (Sesiidae)

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Abstract. We here establish the identity of three clearwing moth species, *Bembecia viguraea* (Püngeler, 1912), *Bembecia auricaudata* (Bartel, 1912) **stat. rev.** and *Bembecia polyzona* (Püngeler, 1912), from Central Asia. All three species were revised by Căpuşe (1973) who selected lectotypes that were misinterpreted by subsequent authors. Two taxa, *Dipsosphecia wagneri* Püngeler, 1912 **syn. n.** and *Bembecia tsvetajevi* Gorbunov, 1992 **syn. n.**, were found to be synonyms of *Bembecia viguraea* (Püngeler, 1912) and *Bembecia polyzona* (Püngeler, 1912), respectively.

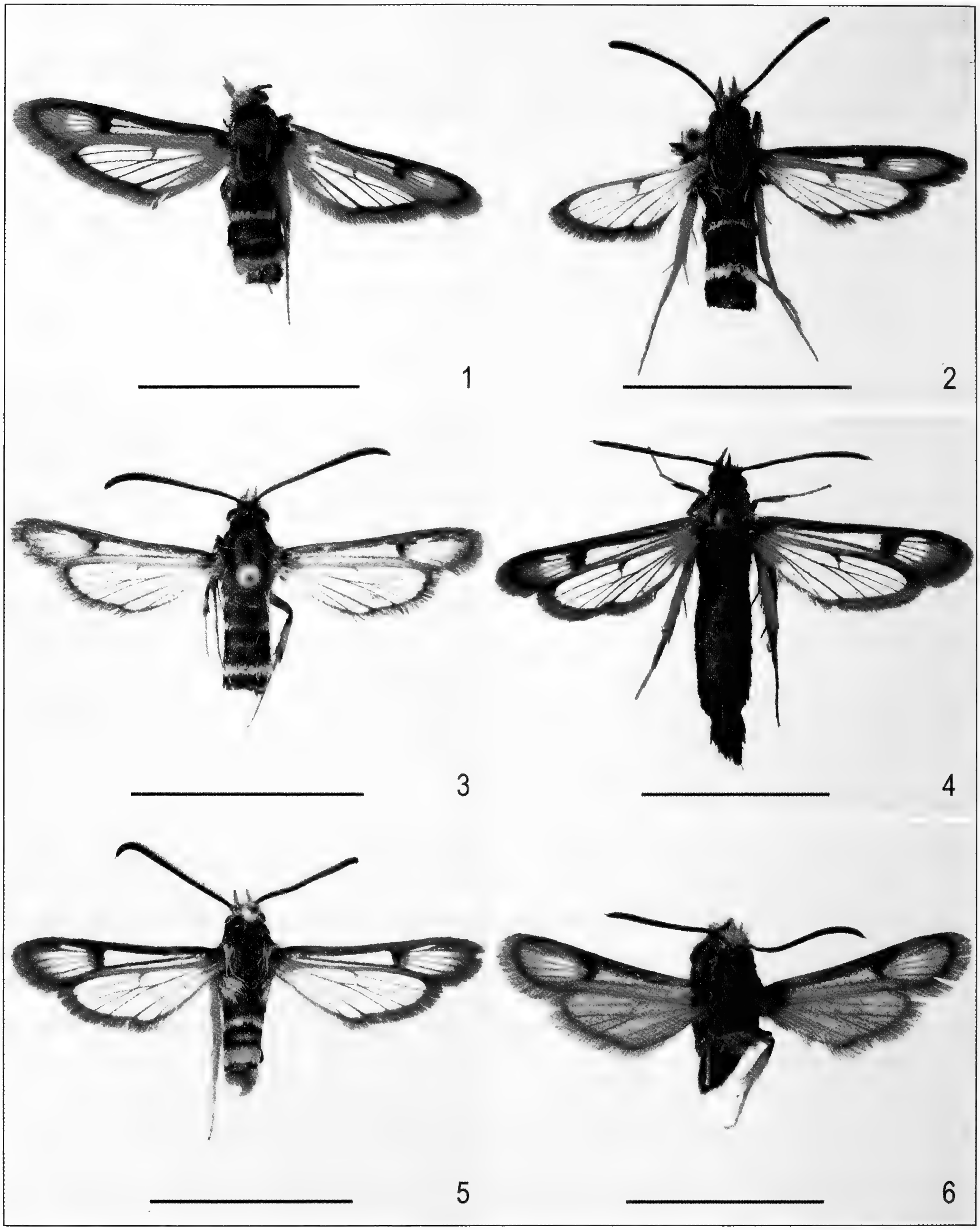
Zusammenfassung. Die Identität der drei Glasflüglerarten *Bembecia viguraea* (Püngeler, 1912), *Bembecia auricaudata* (Bartel, 1912) **stat. rev.** und *Bembecia polyzona* (Püngeler, 1912) aus Zentralasien wird geklärt. Căpuşe (1973) revidierte diese Arten und legte Lectotypen fest, die jedoch von nachfolgenden Autoren falsch interpretiert wurden. Die beiden Taxa *Dipsosphecia wagneri* Püngeler, 1912 **syn. n.** und *Bembecia tsvetajevi* Gorbunov, 1992 **syn. n.** werden hier als neue Synonyme von *Bembecia viguraea* (Püngeler, 1912) bzw. *Bembecia polyzona* (Püngeler, 1912) eingeführt.

Introduction

During the examination of the Püngeler collection in the Museum for Natural History of the Humboldt University, Berlin (MNHB) the authors realized discrepancies in the current understanding of the identity of a number of *Bembecia* Hübner, 1819 species (Sesiidae) from Central Asia and the type material of the taxa in question. These inconsistencies date back to a taxonomic revision by Căpuşe (1973) who dissected some of the type specimens, designated lectotypes and introduced new generic combinations for a number of sesiide taxa described from the Püngeler collection. Püngeler himself had selected 'types' and 'cotypes' from the type series, which, however, were not appropriately designated in the original descriptions (Püngeler 1912). Therefore, Căpuşe's lectotype designations were necessary and are considered valid here. As these designations did not agree with Püngeler's type selections, they were not consequently followed by other authors including Špatenka & Laštůvka (1989) and Špatenka et al. (1999) leading to misinterpretations of several taxa in current literature. We therefore wish to clarify the identity of the species in question and thereby establish stability in nomenclature.

Bembecia viguraea (Püngeler, 1912) Figs 1–2

Dipsosphecia viguraea Püngeler, 1912: 394. Căpuşe 1973: 139 (*Bembecia*). Lectotype ♀ (MNHB) (Fig. 1): Ost-Turkestan, Aksu, Rückbeil 1900 – Pr. gen. Nr. 3143 [sic!] (I.C.) des. Căpuşe 1973: 139. Labels:



Figs 1–6. Adults of *Bembecia* spp. **1.** *B. viguraea* (Püngeler, 1912), ♀, lectotype (MNHB). **2.** *B. viguraea* (Püngeler, 1912), ♂, lectotype of *Dipsosphecia wagneri* Püngeler, 1912 (MNHB). **3.** *B. auricaudata* (Bartel, 1912), ♂, holotype (MNHB). **4.** *B. auricaudata* (Bartel, 1912), ♀, paralectotype of *Dipsosphecia wagneri* Püngeler, 1912 (MNHB). **5.** *B. auricaudata* (Bartel, 1912), ♂, paralectotype of *Dipsosphecia polyzona* Püngeler, 1912 (MNHB). **6.** *B. polyzona* (Püngeler, 1912) ♀, lectotype (MNHB).

"Ost-Turkestan, Aksu, Rückbeil 1900 (recto); 2/1902, v. R. Tancré (verso)" – "Cotype, *virgurea*, Püng. ♀" – "Lectotypus ♀, *Bembecia viguraea* (Püng.)" – "Praep. Genit. Nr. 3145 ♀, I. Căpuşe".

Dipsosphecia wagneri Püngeler, 1912: 395 **syn. nov.** Lectotype ♂: 1/18 – Pr. gen. Nr. 3103 (I.C.) des. Căpuşe 1973: 143 (MNHB). Labels: "1/18" – "Cotype, *Wagneri*, Püng. ♂" – "Lectotypus ♂, *Bembecia wagneri* (Püng.)".

In the original description, Püngeler (1912) listed four specimens (2♂, 2♀) for *Dipsosphecia viguraea* all of which are preserved in the collection of the MNHB. Căpuşe designated a female specimen (Fig. 1) as lectotype which agrees with the current understanding of this taxon. The female originally labelled 'type' became a paralectotype due to the selection of Căpuşe.

In his description of *Dipsosphecia wagneri*, Püngeler (1912) listed four specimens, 1♂ and 3♀. Căpuşe selected male specimen as lectotype (Fig. 2), which is conspecific with *Bembecia viguraea*. Thus, *D. wagneri* becomes a junior subjective synonym of *B. viguraea*. The female originally labelled 'type' (Fig. 4) is now a paralectotype due to Căpuşe's designation. This specimen and the two other paralectotypes of *Dipsosphecia wagneri* are, however, conspecific with *Bembecia wagneri sensu auctorum* (Gorbunov 1994, Špatenka et al. 1997, Špatenka et al. 1999, Špatenka & Kallies 2006). For the latter species, the name *Dipsosphecia auricaudata* Bartel, 1912 is available. Thus, *Dipsosphecia auricaudata* Bartel, 1912 stat. rev., which had been synonymized with *Bembecia viguraea* by Špatenka et al. (1993), is here considered a valid taxon, which replaces *Bembecia wagneri sensu auctorum* (see below).

Bembecia auricaudata (Bartel, 1912) stat. rev. Figs 3–5

Dipsosphecia auricaudata Bartel, 1912: 393. Căpuşe 1973: 145 (*Bembecia*). Holotype (by monotypy) ♂ (Fig. 3): Ili-Gebiet (MNHB). Labels: "Asia centr., Turkestan, Ili-Gebiet, Coll. Wagner" – "Type, *auricaudata*, Bart. ♂" – "Praep. Genit. Nr. 3102 ♂, I. Căpuşe".

= *Bembecia wagneri sensu auctorum (nec* Püngeler 1912).

This species was described from a single male, which is the holotype (Fig. 3) of the species. This specimen is conspecific with *Bembecia wagneri sensu auctorum* (Gorbunov 1994, Špatenka et al. 1997, Špatenka et al. 1999, Špatenka & Kallies 2006). *Dipsosphecia auricaudata* Bartel, 1912 was erroneously synonymized with *Bembecia viguraea* by Špatenka et al. (1993).

Bembecia polyzona (Püngeler, 1912) Fig. 6

Dipsosphecia polyzona Püngeler, 1912: 394. Căpuşe 1973: 144 (*Bembecia*). Lectotype ♀ (MNHB) (Fig. 6): Transcaspia (Merw.), 1908 – Pr. gen. Nr. 3143 (I.C.) des. Căpuşe 1973: 144. Labels: "Transcaspia (Merw.), 1908" – "Cotype *polyzona* Püng. ♀" "Hololectotypus ♀ *Bembecia polyzona* (Püng.)".

= *Bembecia tsvetajevi* Gorbunov, 1992: 249 **syn. nov.** Holotype ♂: Middle Asia, Turkmenia, Ashkabad, 15.VIII.1928, leg. P. Donov (ZMUM).

In the description of *Dipsosphecia polyzona*, Püngeler (1912) listed four specimens, 2♂ and 2♀. The female specimen from Merw (Turkmenistan) which Căpuşe (1973) selected as lectotype (Fig. 6), is conspecific with *Bembecia tsvetajevi* Gorbunov, 1992, which thus becomes a junior subjective synonym of *B. polyzona*. A male syntype of *B. polyzona* in Püngeler's collection, originally labelled as 'type' (Fig. 5), became a paralectotype due to the actions of Căpuşe. This specimen and a second male of the type series, housed in the Natural History Museum, Vienna, Austria, are typical *Bembecia auricaudata*. The other female listed by Püngeler (1912) could not be located.

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A revision of the infraspecific structure of *Erebia euryale* (Esper, 1805) (Nymphalidae: Satyrinae)

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Abstract. A systematic analysis of the geographic variation of both valve shape and wing pattern reveals that the subspecies of *Erebia euryale* can be clustered into three groups, characterised by their valve shape. The *adyte*-group comprises the Alpine ssp. *adyte* and the Apenninian *brutiorum*, the *euryale*-group includes the Alpine subspecies *isarica* and *ocellaris*, and all remaining extra-Alpine occurrences. The third group (*kunzi*-group), not recognised hitherto, is confined to a restricted, entirely Italian, part of the southern Alps. It comprises two subspecies: ssp. *pseudoadyte* (**ssp. n.**), hardly distinguishable from ssp. *adyte* by its wing pattern, and ssp. *kunzi*, strongly melanistic and even exceeding ssp. *ocellaris* in this respect. The ssp. *pseudoadyte* territory is surrounded by the valleys of the rivers Adda, Rio Trafoi and Adige, and ssp. *kunzi* inhabits the eastern Venetian pre-Alps, the Feltre Alps and the Pale di San Martino. The intervening region (the western Venetian pre-Alps, the Cima d'Asta group and the Lagorai chain) is inhabited by intermediate populations. It is argued that these are probably not hybrid populations, but represent a third morphological unit within the *kunzi* group. A contact area of the *adyte* group and the *kunzi* group exists between Trafoi and Sulden, whereas the *kunzi* group and the *euryale* group almost meet at Passo Rolle. Indications of gene flow between groups were found only near Trafoi.

Zusammenfassung. Aus einer systematischen Analyse der geographischen Variation von sowohl Valvenform als auch Flügelzeichnung geht hervor, dass die Unterarten von *Erebia euryale* sich in drei Gruppen, die sich genitaliter voneinander unterscheiden, einordnen lassen. Zur *adyte*-Gruppe gehören die Unterarten *adyte* (in den Alpen) und *brutiorum* (Apennin). Die *euryale*-Gruppe umfasst die alpinen Unterarten *isarica* und *ocellaris* und alle weiteren außeralpinen Vorkommen der Art. Die dritte, bisher nicht erkannte Gruppe (die *kunzi*-Gruppe) umfasst zwei Unterarten: die ssp. *pseudoadyte* (**ssp. n.**), die sich in der Flügelzeichnung kaum von ssp. *adyte* unterscheidet, und ssp. *kunzi*, deren Melanisationsgrad sogar den der ssp. *ocellaris* übertrifft. Ihr Areal beschränkt sich auf einen Teil der italienischen Südalpen. Die ssp. *pseudoadyte* ist heimisch im Gebiet, das von den Tälern von Adda, Rio Trafoi und Etsch umschlossen wird, während die ssp. *kunzi* die östlichen Venezianer Voralpen, die Feltre Alpen und die Pale di San Martino bewohnt. Das dazwischen liegende Gebiet (westliche Venezianer Voralpen, Cima d'Asta-Gruppe und Lagorai Kette) wird von intermediären Populationen besiedelt. Es gibt Argumente dafür, dass letztere keine Hybridpopulationen darstellen, sondern als eine dritte morphologische Einheit innerhalb der *kunzi*-Gruppe zu betrachten sind. Eine Kontaktstelle der *adyte*-Gruppe und der *kunzi*-Gruppe findet sich zwischen Trafoi und Sulden, während die Areale der *kunzi*-Gruppe und der *euryale*-Gruppe sich am Rollepass berühren. Hinweise für Genfluss zwischen zwei Gruppen wurden nur bei Trafoi gefunden.

Riassunto. Un'analisi sistematica della variazione geografica nella forma della valva e del disegno alare rivela che le sottospecie d'*Erebia euryale* si raggruppano in tre gruppi, caratterizzati dalla forma della valva. Il gruppo *adyte* comprende le ssp. *adyte* (nelle Alpi) e *brutiorum* (negli Appennini). Il gruppo *euryale* include le sottospecie alpine *isarica* e *ocellaris* e tutte le altre sottospecie extraalpine. Il terzo gruppo (il gruppo *kunzi*) è indigeno di una ristretta parte – unicamente italiana – del versante Sud delle Alpi. Questo gruppo comprende due sottospecie: la ssp. *pseudoadyte* (**ssp. n.**), a malapena distinguibile da *adyte* per il disegno alare, e la ssp. *kunzi*, estremamente melanizzata, tanto da superare la ssp. *ocellaris* in questo aspetto. Il territorio della ssp *pseudoadyte* è delimitato dalla Valtellina, Val di Trafoi, Val Venosta e Val d'Adige, mentre la ssp. *kunzi* abita le Prealpi Venete orientali, le Vette Feltrine e la Pala di San Martino. Le Prealpi Venete occidentali, la Cima d'Asta e la catena del Lagorai sono abitate da popolazioni intermedie. È argomentato come queste ultime probabilmente non siano di origine ibrida, ma vadano considerate una terza entità morfologica nel gruppo *kunzi*. Un sito di contatto dei gruppi *adyte* e *kunzi* esiste tra Trafoi e Solda, mentre gli areali dei gruppi *kunzi* e *euryale* si toccano al Passo Rolle. Segni di scambio di geni sono trovati solo presso Trafoi

Introduction

Erebia euryale (Esper, 1805) is one of the most common and most widespread European *Erebia* species. It has a western Palaearctic, arctic-alpine disjunct distribution. The arctic subarea ranges from eastern Finland to the Urals (Lukhtanov & Lukhtanov, 1994; Tatarinov & Dolgin 1997), the alpine (oreal) subarea covers almost all European mountain systems (Warren 1936). This fragmented distribution pattern has led to the description of a large number of subspecies. These are traditionally clustered into three groups (Fig. 1): the *euryale* group, the *adyte* group and the *ocellaris* group (von Goltz 1933; Verity 1953; Arnscheid & Roos 1977, Sonderegger 2005).

In the Alps, the *adyte* group is represented by ssp. *adyte* (Hübner, 1822), the *euryale* group by ssp. *isarica* Heyne, 1895, and the *ocellaris* group by ssp. *ocellaris* Staudinger, 1861. Where two groups come into contact, they behave differently. The subspecies *adyte* and *isarica* remain separated in most contact sites. Intermediate individuals have been found (Rezbanyai-Reser 1991; Sonderegger 2005), but gene flow is strongly limited (Geiger & Rezbanyai 1982). Between the ssp. *ocellaris* and *isarica*, on the other hand, extensive hybrid zones have been described (von Goltz 1933; Arnscheid & Roos 1977). They seem to intermingle and interbreed wherever they meet. Contact sites of ssp. *adyte* and ssp. *ocellaris* have never been reported. Recently it has been demonstrated that the three morphologic groups, at least in the Alps, do not represent three genetic lineages: genetically, ssp. *ocellaris* fits perfectly into the east-Alpine *isarica* populations (Schmitt & Haubrich 2008). Two more subspecies have been described in the Alps. Their descriptions, though, are based on a single population, and their geographic boundaries have never been properly defined: ssp. *etobyma* Fruhstorfer, 1909 and ssp. *kunzi* Heinkele, 2007.

The differences between subspecies and between groups of subspecies are entirely based on wing pattern. Genital characters, which are not subjected to ecologic adaptation and thus are less variable, yield more stable taxonomic criteria than wing pattern does. Differences in male genital anatomy between the Alpine subspecies of *E. euryale* have been described (Arnscheid & Roos 1977, Sonderegger 2005), but their geographic variation has never been studied systematically. Genital morphology thus plays no role in the infraspecific taxonomy of *E. euryale*. This paper presents the results of a morphologic analysis of a large number of populations, covering the whole geographic range of the species, and involving both wing pattern and male genital characters. The results yield the basis for a revision of the infraspecific structure of *E. euryale*.

Material and methods

Wing pattern was studied in 2695 males and 858 females from 86 locations, 15 of which outside the Alps (Fig. 2), with an emphasis on the contact regions *adyte*/*ocellaris* and *isarica*/*ocellaris* in the south-eastern Alps (Tab. 1). In samples 87–114, added later, wing pattern was used for determination of the morphologic group only, without being quantified. Genital characters were studied in 772 males from 72 populations, as a rule of 10 males per sample. The choise of the measured parameters, both for

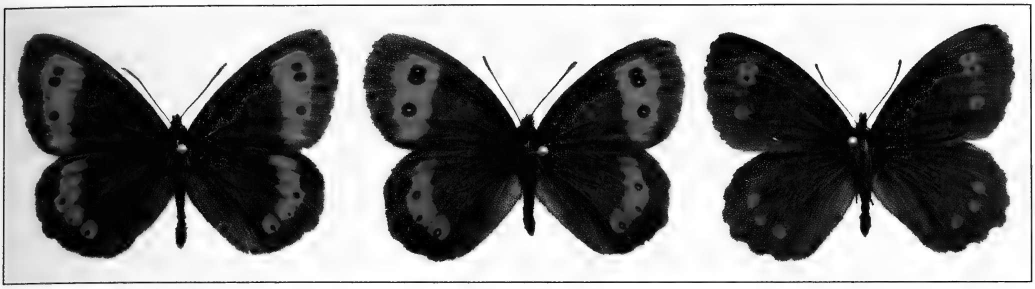

Fig. 1. The traditional tripartition: typical representatives of the *euryale* group, the *adyte* group and the *ocellaris* group (from left to right).

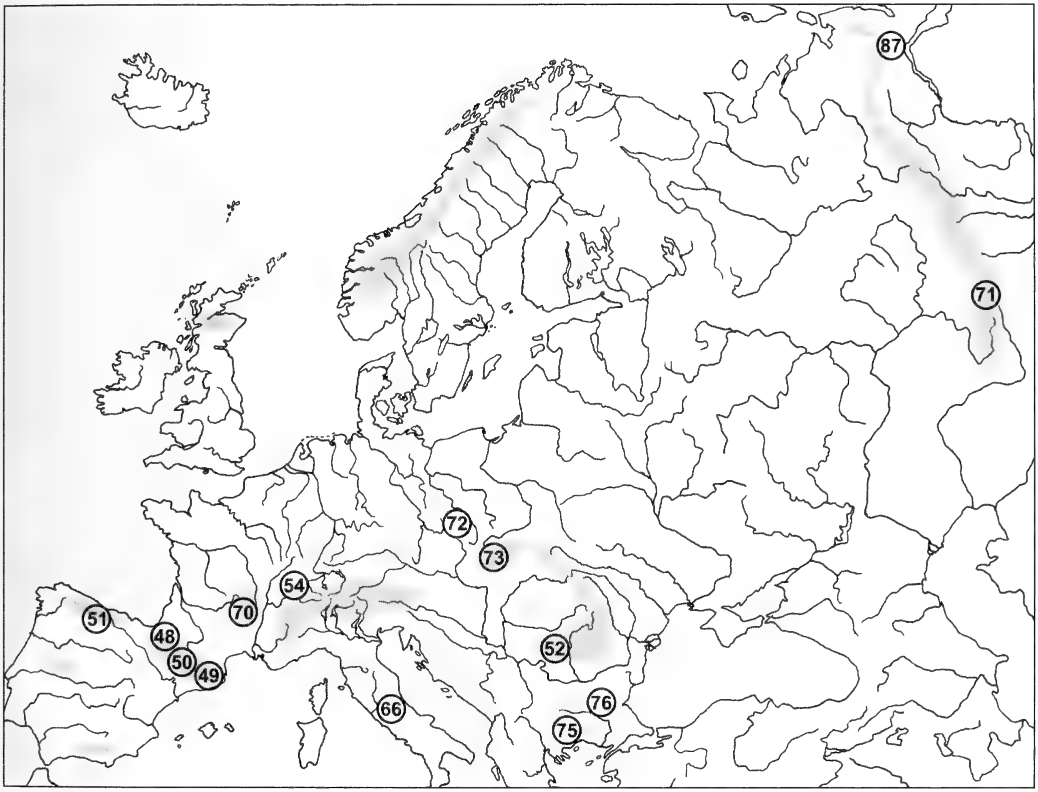

Fig. 2. The extra-Alpine sample sites. Sample numbers refer to Tab. 1. Grey area: mountain systems.

wing pattern and for valve shape, was based on current knowledge of the differences between the groups (Appendix 1). Diagnostic features, characteristic of individual subspecies within these groups, were disregarded.

Wing pattern. Nine wing pattern elements were quantified and scored (quantification criteria in appendix 2).

(i) Development of the postdiscal band on forewing upperside, forewing underside and hindwing upperside (males and females).

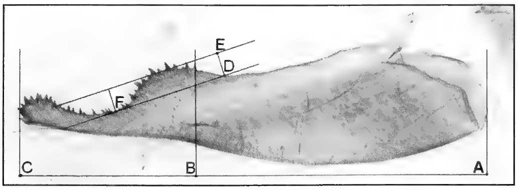

Fig. 3. Valve of *E. euryale*. Illustration of measured values. Shoulder Index = DE/DF. Position of first tooth = AB/AC.

(ii) Development of ocelli (absent, black or pupilled) on forewing upperside, forewing underside and hindwing upperside (males and females).
(iii) Development of the ocelli on the hindwing underside (absent, without or with brown ring) (males only).
(iv) Development of the white postdiscal streak on hindwing underside (males only).
(v) Colour of the postdiscal band on the hindwing underside (females only).

Valve shape. Abdominal tips were macerated in KOH 10% at 100 °C for 15 min, dissected, then dehydrated in ethanol 96% for 5 min and embedded in euparal. Three parameters were calculated from measured values:
(i) Shoulder Index: the height/width ratio of the dorsal shoulder (DE/DF in Fig. 3).
(ii) First Tooth: the relative position of the most proximal tooth (AB/AC in Fig. 3).
(iii) Tooth Length: the length of the longest tooth on the shoulder, measured on its distal slope, as a percentage of the valve length.

For (i) and (ii) a measuring microscope was used (magnification × 30, reading accuracy 10 microns), for (iii) calibrated microphotographs were measured on screen (final magnification x 1000).

Statistics. For cluster analysis variables were standardized (mean=0 and sd=1), squared Euclidian distances were measured, and four algorithms were applied: Ward-method, Average Linkage within groups, Average Linkage between groups and Nearest Neighbour. Equality of distributions (2 samples) was tested with Student's t-test (for $N>30$ and normal distribution), otherwise with Mann-Whitney U test; distributions of more than 2 samples were tested by one-way ANOVA for Gaussian populations with equal variances, otherwise by Kruskal-Wallis H test. Homogeneity of variances was tested with Levene's test, normal distribution with Kolmogorov-Smirnov test or (if $N<50$) Shapiro-Wilks test. All statistical tests were performed with the SPSS 12.0 package. Structuring of the Alps and nomenclature of the mountain groups are according to Marazzi (2005).

Abbreviations

Fw = forewing; Hw = hindwing; Up = upperside; Un = underside; B = postdiscal band; Oc = ocelli; ZMAN = Zoological Museum Amsterdam (NL); LMD = Löbbecke Museum Düsseldorf; CFC = Collection Frans Cupedo, Geulle (NL).

Material deposition

The material is deposited in LMD (sample 61), ZMAN (samples 36 p.p., 52 p.p., 74, 75, 76 p.p., 86) and CFC (remaining samples).

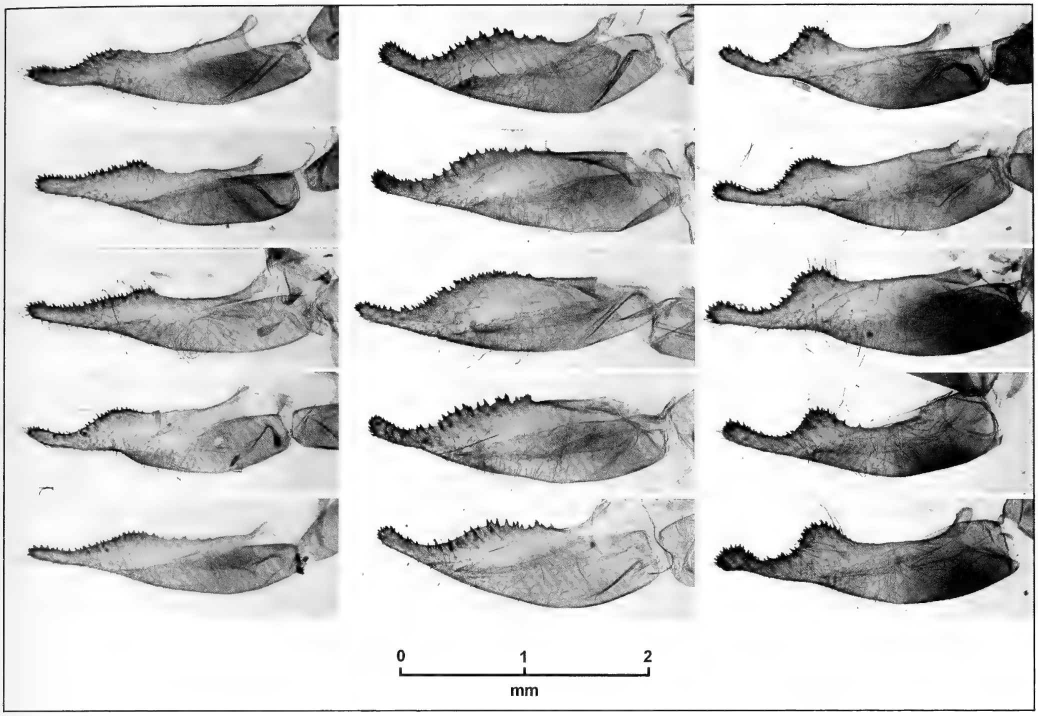

Fig. 4. *Erebia euryale*, valve type 1 (left), type 2 (middle) and type 3 (right).

Results

1 Male genital characters

Population level. A hierarchic cluster analysis based on population means for Shoulder Index, First Tooth and Tooth Length resulted in three clusters, whatever algorithm was used (not figured). These clusters are provisionally named group 1, 2 and 3. Their valve shapes are shown in Fig. 4. The valve of group 1 is slender, the spines are fine and separate, the valve has a large spine-free proximal part. Valve type 2 is broad, the dorsal ridge is convex and bears irregularly placed spines of unequal size, 2 or 3 of them often being fused. The spine-free part is decidedly shorter than in type 1. Type 3 is slender, with a knob shaped apex. Spine length is intermediate between both foregoing types. Its most characteristic features are (i) the prominent, hump-shaped shoulder and (ii) the spine-free proximal part of the valve, which is longer than in both other types. Differences between the three groups are highly significant ($p<0.001$ for each character by Kruskal-Wallis and Bonferroni corrected Mann-Whitney's U test). The boxplots (Fig. 5) visualise that each population is unambiguously attributable to one of the three groups on the basis of the measured parameters. Each algorithm except Nearest Neighbour showed group 1 and 3 more related to each other than to group 2.

Individual level. On the individual level, each parameter shows considerable spread, resulting in overlap between groups. An individual cannot be identified if all three

Tab 1. List of sample sites and sample sizes, the population means and standard deviations of valve characters. N(M) = sample size for male wing characters; N(F) = sample size for female wing characters; N(G) = sample size for genital characters. Population means: FT = First Tooth; SI = Shoulder Index; TL = Tooth Length. sd = standard deviation.

Nr	Sample	Massif	Locality	N(M)	N(F)	N(G)	FT	sd	SI	sd	TL	sd
1	Kaiser	Kaiser Mountains	Wilder Kaiser	22	0	0						
2	Karwendel	Karwendel Mountains	Seefeld	50	4	10	43.45	4.56	12.27	3.07	2.23	0.39
3	Kitzbüheler A	Kitzbühel Alps	Wildschönau	18	6	0						
4	Steinernes M	Berchtesgaden Alps	Dießbachtal	30	8	10	43.79	3.91	13.55	3.43	2.02	0.44
5	Stubaier A	Stubai Alps	Pinnistal	25	12	10	46.63	4.12	12.25	4.37	2.51	0.37
6	Zillertal A	Zillertal Alps	Mayrhofen	11	0	0						
7	H Tauern (N)	High Tauern	Rauris	18	0	10	43.57	3.20	11.59	3.06	2.06	0.31
8	N Tauern	Seckauer Tauern	Knittelfeld	14	7	10	42.72	3.46	11.29	2.35	2.37	0.47
9	Gurktal A	Gurktaler Alps	Turracher Höhe	36	7	10	43.58	5.70	12.77	3.29	2.31	0.30
10	Goldeck	Gailtal Alps	Goldeck	10	2	0						
11	Julian A (C)	Julian Alps	Triglav	36	9	10	42.38	3.54	10.14	1.97	1.99	0.48
12	Julian A (W)	Julian Alps	Sella Nevea	17	1	0						
13	Fleisstal	High Tauern	Grosses Fleisstal	50	6	0						
14	Ötztal A (S)	Ötztal Alps	Vermoispitze	26	13	10	45.47	5.42	9.81	2.89	2.32	0.54
15	P Rolle (W)	Pale di San Martino	Paneveggio	48	12	30	44.60	4.80	11.72	3.10	2.24	0.45
16	Sappada	Carnic Alps	Col Siera	21	0	0						
17	Cavallo	Belluno pre-Alps	Monte Cavallo	50	24	10	56.37	4.84	25.33	3.77	1.94	0.39
18	Tuxer A	Tuxer pre-Alps	Zillertal west side	23	3	0						
19	Geisler G	Geisler Group	Wolkenstein	50	15	10	45.35	3.81	9.77	2.71	2.18	0.31
20	Aurine G	Zillertal Alps	Altmühltal	50	10	0						
21	Defereggen G	Defereggen Alps	Thurntaler	50	7	0						
22	Hochschober	Schober Group	Debanttal	50	18	0						
23	Kreuzeck	Kreuzeck Group	Scharnik	50	18	0						
24	Feltre	Feltre Alps	Vette di Feltre	50	3	10	59.51	3.43	22.55	2.60	1.56	0.41
25	P. Rolle (E)	Lagorai	East of Passo Rolle	50	50	30	56.69	4.32	25.55	5.85	1.84	0.37
26	P Mauria	Carnic pre-Alps	Passo Mauria	30	50	10	45.79	4.40	12.72	3.37	2.19	0.28
27	Lienzer Dol	Gailtal Alps	Lienzer Dolomites	50	8	0						
28	Carega	Piccole Dolomiti	Passo Campogrosso	50	31	10	57.17	5.02	20.69	3.59	1.79	0.31
29	Lavarone	Altipiani Group	Lavarone	50	3	10	56.05	6.18	23.22	5.86	1.99	0.29
30	P Malghen	Lagorai	Passo Malghen	25	32	10	57.46	4.93	22.87	4.40	1.64	0.21
31	Pasubio	Piccole Dolomiti	Monte Pasubio	12	1	0						
32	Sesto	Sesto Dolomites	Sesto	50	4	10	45.16	3.03	12.24	4.31	2.34	0.28
33	Plöckenpas	Carnic Alps	Plöckenpass	38	7	10	42.97	2.01	13.16	3.18	1.93	0.43
34	Val Malga	Adamello Group	Val Malga	24	6	10	60.21	4.81	23.59	4.84	1.83	0.40
35	Croce Domini	Brescia pre-Alps	Passo Croce Domini	21	6	10	59.96	2.21	25.14	4.99	1.80	0.18
36	M Baldo	Garda pre-Alps	Monte Baldo	50	20	10	60.98	2.00	20.19	3.72	1.58	0.26
37	M Tremalzo	Garda pre-Alps	Monte Tremalzo	43	6	10	60.45	3.46	23.52	3.16	1.54	0.30
38	Val Concei	Garda pre-Alps	Val Concei	27	3	10	61.22	4.39	21.81	1.80	1.63	0.39
39	Trafoi-1	W Vinschgau Alps	Trafoi	22	0	10	49.65	6.33	15.54	2.11	1.42	0.18
40	Martelltal	Ortler Alps	Martelltal	48	17	10	60.60	5.77	20.43	5.11	1.77	0.34
41	M Legnone	Western Orobie Alps	Monte Legnone	27	12	10	59.03	3.69	20.80	5.49	1.85	0.32
42	Pzo Redorta	Central Orobie Alps	Pizzo Redorta	14	2	0						
43	Presolana	Bergamasque pre-Alps	Presolana Group	32	14	10	60.47	4.10	20.79	4.40	1.97	0.32
44	Lautaret	Dauphiné Alps	Col du lautaret	36	0	10	46.24	5.45	13.14	2.47	1.44	0.21
45	Oulx	Montgenèvre Alps	Oulx	34	13	10	50.70	6.82	15.13	2.59	1.42	0.38
46	Valdieri	Eastern Maritime Alps	Valle Gesso	44	50	10	51.52	5.20	13.68	2.47	1.47	0.25
47	Cottian A	Monviso Alps	Les Orres	33	34	10	45.51	5.27	11.26	3.19	1.46	0.19
48	Pyrenees (W)	Western Pyrenees	Col Marie Blanque	19	0	10	42.03	7.36	11.84	3.21	2.11	0.30
49	Pyrenees (E)	Eastern Pyrenees	Mont Canigou	62	0	10	44.57	4.14	9.93	2.53	2.05	0.33
50	Pyrenees (C)	Central Pyrenees	Val d'Aran	35	0	0						
51	Cantabria	Sierra Cantabrica	Puerto san Glorio	28	0	10	42.84	4.16	10.91	2.87	1.88	0.40
52	Retezat	Southern Carpathians	Muntii Retezat	33	5	15	42.60	2.53	8.29	2.38	2.28	0.38
53	Grindelwald (S)	Bernese Alps s.s.	Kleiner Scheidegg	18	0	0						
54	Jura	Jura	La Dôle	18	12	10	42.63	4.85	10.05	2.39	2.03	0.34

Tab 1. Continuation.

Nr	Sample	Massif	Locality	N(M)	N(F)	N(G)	FT	sd	SI	sd	TL	sd
58	Val di Vizze	Zillertal Alps	Val di Vizze	27	9	0						
59	Ridnaun	Stubai Alps	Ridnauntal	24	2	0						
60	Tessin	Ticino Alps	Campo Tencia	50	33	0						
61	Mendelpass	Nonsberger Alps	Mendelpass	8	12	8	62.22	2.04	24.61	6.32	1.78	0.38
62	Val Tinée	Western Maritime Alps	Val Tinée	34	16	0						
63	M Tamaro	Como pre-Alps	Monte Tamaro	26	14	10	52.95	6.89	12.67	2.96	1.35	0.22
64	Drôme	Diois pre-Alps	Several localities	29	6	10	46.00	4.35	10.69	3.39	1.27	0.30
65	Pralognan	Vanoise Alps	Pralognan	13	7	10	49.25	7.29	14.44	2.68	1.40	0.31
66	Gran Sasso	Gran Sasso	Gran Sasso	47	11	10	44.15	4.90	13.81	1.73	1.37	0.30
67	Brenta	Brenta Group	Brenta	10	15	10	60.17	2.98	21.83	4.48	1.77	0.34
68	Paganella	Brenta Group	Paganella	16	2	10	61.05	2.98	21.99	2.93	1.77	0.35
69	Pradilago	Presanella Group	Pradilago	24	38	10	58.51	4.86	20.74	3.81	1.90	0.24
70	Massif Central	Massif Central	Mont Meygal	44	7	10	43.35	4.64	12.57	3.00	2.61	0.81
71	Urals	Urals	Mont Iremel	25	6	10	40.82	3.87	11.26	6.25	2.23	0.67
72	Praded	Sudety Mountains	Praded	38	8	10	42.84	3.25	7.78	3.37	2.21	0.29
73	H Tatra	High Tatra	Pod Banske	26	2	10	41.85	3.16	10.73	2.38	2.29	0.17
74	Bohinj	Julian Alps	Bohinj	20	0	0						
75	Falakron	Falakron Mountains	Drama	21	0	12	40.79	3.37	9.91	3.19	2.28	0.52
76	Rila	Rila Mountains	Bulgaria	22	3	11	41.66	3.54	10.83	3.83	2.60	0.36
77	Cimonega	Feltre Alps	Cimonega	46	11	10	56.76	5.19	25.32	6.27	1.62	0.33
78	Visentin	Belluno pre-Alps	Col Visentin	46	6	10	60.47	2.08	24.46	2.37	1.83	0.22
79	Frassenè	Pale di San Martino	Monte Agner	12	1	10	58.69	5.57	28.05	6.92	1.77	0.39
80	M Serva	Zoldo Dolomites	Monte Serva	17	7	10	44.63	4.40	10.72	3.08	2.02	0.37
81	V Zemola	Carnic pre-Alps	Val Zemola	14	8	10	42.04	3.55	10.18	2.61	2.28	0.45
82	S Martino	Pale di San Martino	Sentiero dei Cacciatori	50	26	30	57.87	4.45	24.24	4.46	1.84	0.34
83	Depaoli	Pale di San Martino	Sentiero Depaoli	50	16	10	58.66	2.90	26.21	4.60	1.73	0.36
84	Trafoi-2	W Vinschgau Alps	Madatsch Gletscher	25	0	30	50.95	8.06	14.31	2.80	1.51	0.23
85	Sulden	Ortler Alps	Sulden Legerwand	7	0	7	63.91	2.90	22.89	6.32	1.60	0.43
86	Polar Ural	Polar Ural	Harp settlement	15	5	10	46.19	2.52	10.98	2.88	1.95	0.25
87	V Cavargna	Como pre-Alps	M Stabiello	4	0	0						
88	Serfaus	Samnaun Group	Serfaus	7	2	0						
89	Fimbertal	Samnaun Group	Fimbertal	2	0	0						
90	Kaunertal	Ötztal Alps	Kaunertal	8	0	0						
91	Jaufenpass	Sarntal Alps	Jaufenpass road	2	2	0						
92	Kurzras	Ötztal Alps	Schnalstal	11	1	0						
93	M Stivo	Garda pre-Alps	M Stivo	5	1	0						
94	Cima d'Asta	Cima d'Asta	Val Regana	5	0	0						
95	Lagorai	Lagorai	Cermis	7	50	0						
96	Segantini	Pale di San Martino	Baita Segantini	5	0	3	41.43	2.47	13.09	1.61	2.42	0.86
97	Valles	Passo Valles	Catena di Bocche	4	0	0						
98	S Pellegrino	Marmolada Group	Passo S pellegrino	10	9	5	46.67	2.39	11.69	3.84	2.35	0.44
99	Gares	Pale di San Martino	Val di Gares	16	9	14	59.07	6.12	23.25	4.35	1.91	0.61
100	Zoldo	Zoldo Dolomites	Val di Zoldo	2	0	4	42.26	3.36	8.65	4.39	2.50	0.75
101	Pordoi	Marmolada Group	Passo Pordoi	15	0	3	46.12	3.88	9.83	2.50	2.56	0.52
102	Plattkofel	Sasso Lungo Group	Plattkofel	7	2	0						
103	Rosengarten	Catinaccio	Val delle Feide	17	22	0						
104	M Grappa	Belluno pre-Alps	Monte Grappa	13	0	13	57.44	4.28	23.71	3.35	1.71	0.47
105	Zell am See	Zillertal Alps	Schmittenhöhe	8	0	0						
106	Bagozza	Bergamasque pre-Alps	Bagozza Group	6	1	0						
107	Melag	Ötztal Alps	Langtaufererta1	20	15	0						
108	Gößgraben	High Tauern	Ankogel Group	51	0	0						
109	Goldberg	Gailtal Alps	Goldbergsattel	12	5	0						
110	Gemona	Julian pre-Alps	Malga Cuarnan	20	14	0						
111	Mallnitz	High Tauern	Ankogel Group	5	3	0						
112	Falcade A	Marmolada Group	Falcade Alto	6	8	0						
113	Pejo	Ortler Alps	Val di Pejo	3	2	3	58.40	4.22	16.76	3.12	2.11	0.21
114	M Stabiello	Como pre-Alps	Val Cavargna	4	0	4	54.56	5.08	13.35	2.67	1.37	0.10

parameters lie in the overlap zone of two groups. The portion of such total transitions, in the Alpine populations, ranges from 12% (groups 2 and 3) to 29% (groups 1 and 3). To test whether this is due to inadequacy of the parameters or to lack of morphological signal, the right valves of all total transitions were photographed, randomised and identified by visual examination. Misidentifications, including doubts, range from 1.8% (groups 1 and 2) to 4.1% (groups 1 and 3). This demonstrates that valve shape (Fig. 4) offers reliable microscopic identification criteria, but that the parameters (derived from the poor pre-existing knowledge) insufficiently cover the differences between the groups on the individual level. They are appropriate, though, for identification of even a small sample (N=10).

2 Wing pattern

None of the three groups, based on valve shape, coincides with any of the traditional wing morphologic groups. Valve type 1 is found in all populations of the *adyte* group, except those that live east of the Valtellina – Val di Trafoi line. Valve type 2 is associated with all (Alpine and extra-Alpine) populations of both the *euryale* group and the *ocellaris* group, except those in the Pala Group, the Feltre Dolomites and the Venetian pre-Alps. Valve type 3 is found in the remaining populations, i.e. in (i) a group of populations that were hitherto attributed to *adyte*, (ii) a group of populations hitherto considered *ocellaris*, and (iii) a group of morphologically intermediate populations. Grouping based on valve shape and grouping based on wing pattern thus do not match. From now on, valve morphology will be the leading criterion.

The geographic range of group 1 includes the type locality of ssp. *adyte*, and the range of group 2 includes the type locality of ssp. *euryale.* Consequently, groups 1 and 2 retain the names *adyte* group and *euryale* group. The type locality of ssp. *ocellaris* lies within the group 2 area, hence *ocellaris* is the valid name of the melanistic Alpine populations of the *euryale* group.

Both the *euryale* group and group 3 thus consist of melanistic and non melanistic populations. In both cases, intermediate populations do exist. These need to be recognised and separated before the wing pattern of the three groups and their (melanistic and non-melanistic) subgroups can be described.

Intermediate populations in the *euryale* group. In table 2A all Alpine populations of the *euryale* group (i.e. ssp. *isarica*, ssp. *ocellaris* and the intermediate populations) were ranked according to decreasing band development. For comparison the melanistic populations of group 3, hitherto considered *ocellaris*, were included. Tab. 2 breaks up into four sections, corresponding to four geographically coherent groups of populations. (i) Numbers 1–11 are pure *isarica* populations. (ii) Numbers 12–21 are intermediate between *ocellaris* and *isarica*. (iii) Numbers 22–31 are typical *ocellaris* populations. (iv) The last five populations belong to group 3. There are no intermediate populations here: the values drop abruptly after population 31.

Geographic range. The intermediate *isarica*/*ocellaris* populations are found in a continuous belt along the southern slopes of the southern Ötztal Alps, the Zillertal Alps and the High Tauern (Fig. 6A). Its western limit is the Weisskugel-Hochalt chain (samples 14 and 92), its eastern limit is the Ankogel-Reißeck chain (sample 111). West of the former (Matschertal) and east of the latter (sample 108) flies pure *isarica*. From there it bends south, through the central Gailtal Alps (sample 109) into the western Julian Alps (samples 11, 12 and 110). One intermediate population is found north of the High Tauern chain (sample 6). The transitional belt thus separates the *isarica* range and the *ocellaris* range across its entire length, which is typical of a hybrid zone.

A second hybrid zone in the *euryale* group is found in the Pyrenees (Table 2B). The melanistic ssp. *antevortes* (sample 48) lives in the north-western Pyrenees. The Spanish side and the eastern Pyrenees are inhabited by the non-melanistic ssp. *pyraenaeicola* (sample 49). Hybrid populations are found in between (sample 50), but sampling density was insufficient to delimit the respective distribution areas. Ssp. *cantabricola* (Cantabrian Mountains, sample 51) is morphologically close to ssp. *pyraenaeicola.*

Intermediate populations in group 3. In table 3, all populations of this group were ranked according to (i) decreasing band development and (ii) decreasing value for ocelli development. For both characters, the 13 highest ranking populations are those with an *adyte* habitus. These are provisionally designated as group 3a. The five lowest ranking populations, in both cases, are the melanistic ones (from now on designated as group 3b). Populations 14–20 are transitional in both characters: they show a tendency towards loss of the white pupil in the forewing and hindwing ocelli, and to reduction of the postdiscal bands (Fig. 7).

Geographic range. The geographic borderline between group 3a and the transitional zone is sharp, and coincides with the Adige valley south of the confluence with the Avisio (Fig. 6A). The eastern borderline of the tran-

Tab 2. The Alpine and Pyrenean/Cantabrian populations of the *euryale* group, arranged according to decreasing development of the postdiscal band (sum of the mean scores for forewing upperside, forewing underside and hindwing upperside). Melanistic populations of group 3 are included in the Alpine series for comparison (in italics).

Rank	Locality	Sample	Band
	A. Alps		
1	Steinernes M	4	11.53
2	Karwendel	2	11.52
3	Kitzbüheler A	3	11.33
4	N Tauern	8	11.29
5	Kaiser	1	11.27
6	H Tauern (N)	7	11.11
7	Tuxer A	18	11.04
8	Stubaier A	5	11.00
9	Goldeck	10	10.80
10	Grindelwald (S)	53	10.72
11	Gurktal A	9	10.50
12	Ötztal Alps (S)	14	9.54
13	Zillertal A	6	9.45
14	Ridnaun	59	9.21
15	Julian A (C)	11	9.00
16	Kreuzeck	23	7.92
17	Julian A (W)	12	7.65
18	Fleisstal	13	7.20
19	Hochschober	22	7.10
20	Val di Vizze	58	7.00
21	Aurine G	20	6.50
22	Defereggen G	21	5.84
23	P Mauria	26	5.73
24	Sesto	32	5.54
25	Sappada	16	5.52
26	P Rolle (W)	15	5.46
27	Lienzer Dol	27	5.42
28	Plöckenpas	33	5.26
29	Geisler G	19	5.06
30	V Zemola	81	4.57
31	M Serva	80	4.35
32	*Frassenè*	*79*	*1.92*
33	*Feltre*	*24*	*1.56*
34	*Cavallo*	*17*	*1.24*
35	*Cimonega*	*77*	*1.24*
36	*Visentin*	*78*	*0.96*
	B. Pyrenees/Cantabria		
1	Pyrenees (E)	49	10.15
2	Cantabria	51	9.25
3	Pyrenees (C)	50	7.31
4	Pyrenees (W)	48	4.42

Tab 3. Group 3 populations, arranged according to decreasing development of the postdiscal band (left), and according to decreasing development of the white pupilled ocelli (right). Band = sum of the mean scores for forewing upperside, forewing underside and hindwing upperside. Ocelli = sum of the mean scores for forewing upperside and hindwing upperside.

Rank	Locality	Sample	Ocelli
1	Pradilago	69	3.79
2	M Legnone	41	3.44
3	Val Concei	38	3.44
4	Val Malga	34	3.42
5	Pzo Redorta	42	3.14
6	Croce Domini	35	3.14
7	M Tremalzo	37	3.14
8	M Baldo	36	3.12
9	Presolana	43	3.03
10	Paganella	68	3.00
11	Brenta	67	2.70
12	Martelltal	40	2.63
13	Mendelpass	61	2.50
14	Carega	28	2.38
15	P. Rolle (E)	25	2.32
16	Pasubio	31	2.29
17	P Malghen	30	2.08
18	Lavarone	29	2.04
19	S Martino	82	2.04
20	Depaoli	83	1.82
21	Feltre	24	1.26
22	Cimonega	77	1.02
23	Frassenè	79	0.83
24	Cavallo	17	0.74
25	Visentin	78	0.61

Rank	Locality	Sample	Band
1	Val Malga	34	11.33
2	M Legnone	41	10.96
3	Pzo Redorta	42	10.93
4	Croce Domini	35	10.90
5	Presolana	43	10.59
6	Val Concei	38	10.56
7	M Baldo	36	10.52
8	Paganella	68	10.44
9	M Tremalzo	37	10.14
10	Pradilago	69	10.04
11	Mendelpass	61	10.00
12	Brenta	67	9.90
13	Martelltal	40	9.83
14	Lavarone	29	9.06
15	Carega	28	8.36
16	Pasubio	31	8.14
17	P Malghen	30	7.72
18	P. Rolle (E)	25	5.18
19	S Martino	82	5.02
20	Depaoli	83	3.22
21	Frassenè	79	1.92
22	Feltre	24	1.56
23	Cavallo	17	1.24
24	Cimonega	77	1.24
25	Visentin	78	0.96

sitional group follows the Cismon valley and the Brenta valley south of the confluence with the Cismon.

Wing characteristics of groups and subgroups (Tab. 4)

Wing characteristics of the *adyte* group and the *euryale* group were adequately described long ago (Warren 1936). Hence, differentiating characteristics of group 3 will be emphasised here.

Group 1 (the *adyte* group) is characterised by the white pupilled apical ocelli (males 90%, females 100%) and the reduced white postdiscal scaling on the male hindwing underside, which is often absent or confined to a white wedge on nerve 4 (81%).

Group 2. Common characteristics of all (melanistic and non-melanistic) subspecies in the *euryale* group are the blind apical ocelli on the forewing upperside (males 98%, females 71%) and the brown ringed ocelli on the hindwing underside (males 89%, females 81%).

Tab. 4. Results for wing pattern elements, summarised per group, in percent. Col = colour of the postdiscal band on the female hindwing underside.

	FwUpOc			HwUpOc			FwUnOc			HwUnOc			FwUpB						HwUpB					FwUnB				HwUn White				Col	
	0 (no ocelli)	1 (ocelli without white pupil)	2 (ocelli with white pupil)	0 (no ocelli)	1 (ocelli without white pupil)	2 (ocelli with white pupil)	0 (no ocelli)	1 (black ocelli)	2 (black with white pupil)	0 (no ocelli)	1 (black spots)	2 (black with brown ring)	0 (no band)	1 (rings around ocelli)	2 (drop shaped spots)	3 (band broken up)	4 band continuous, constricted)	5 (band continuous, straight)	0 (no band)	1 (rings around ocelli)	2 (band broken up)	3 (spots touching)	4 (continuous band)	0 (no band)	1 (separate spots)	2 (interrupted band)	3 (complete band)	0 (no white scaling)	1 (wedge on nerve 4)	2 (more than wedge)	3 (white streak from costa to n4)	1 white	2 yellow
MALES																																	
Alpine subspecies																																	
ssp. *adyte*	0	8	92	3	5	92	0	0	100	7	80	13	0	0	0	4	94	1	0	0	1	27	72	0	0	0	100	33	48	14	4		
ssp. *isarica*	2	93	4	7	88	5	2	48	50	2	1	97	0	0	4	10	24	62	0	1	11	44	44	0	0	2	98	13	44	30	14		
transitional *isarica / ocellaris*	5	94	1	8	92	1	1	73	26	6	3	92	0	9	50	20	14	6	2	18	46	28	7	0	1	15	84	32	41	24	3		
ssp. *ocellaris*	2	97	1	8	92	0	2	71	27	11	4	85	1	44	49	5	1	0	5	62	32	1	0	0	5	41	54	46	31	21	2		
euryale group	3	95	2	8	90	2	1	64	34	6	2	91	0	19	34	11	12	22	2	28	29	23	17	0	2	18	78	31	38	20	6		
ssp. *pseudoadyte*	0	23	77	12	38	49	0	1	99	19	77	4	0	0	0	7	79	13	0	1	11	53	34	0	0	1	99	14	17	36	33		
transitional *pseudoadyte / kunzi*	3	46	51	47	44	9	4	11	85	67	30	2	7	17	29	22	23	2	25	25	24	24	1	4	6	33	57	18	31	35	16		
ssp. *kunzi*	34	49	18	93	7	0	37	17	46	92	8	0	67	31	2	0	0	0	92	8	0	0	0	51	18	25	5	61	25	14	0		
kunzi group	9	37	54	44	33	24	10	8	81	53	44	2	19	13	10	11	41	6	31	11	13	30	15	14	6	13	62	27	24	21	19		
All subspecies																																	
adyte group	0	10	90	6	7	87	0	0	100	10	78	12	0	0	0	4	95	1	0	0	1	31	67	0	0	0	100	33	48	14	4		
euryale group, non melanistic	2	93	4	9	85	6	1	47	51	2	1	96	0	0	5	14	25	57	0	2	17	41	39	0	0	2	98	21	42	29	7		
euryale group, transitional	5	94	1	8	91	1	1	73	25	10	7	84	0	8	48	21	13	10	2	18	48	27	5	0	1	14	86	38	39	20	3		
euryale group, melanistic	2	97	1	10	90	0	2	73	26	13	5	81	2	43	49	5	1	0	6	61	31	1	0	0	5	41	53	48	30	20	2		
euryale group	3	94	2	9	88	3	1	61	37	7	4	89	1	14	29	13	15	28	2	23	29	26	19	0	2	14	82	33	38	20	4		
FEMALES																																	
Alpine subspecies																																	
ssp. *adyte*	0	0	100	0	1	99	0	0	100	6	91	3	0	0	0	1	98	1	0	0	2	33	65	0	0	0	100					87	13
ssp. *isarica*	2	56	42	2	58	41	2	11	87	3	5	92	0	0	0	3	41	56	0	0	7	53	41	0	0	0	100					84	16
transitional *isarica / ocellaris*	0	68	32	1	81	18	0	15	85	3	26	70	0	13	31	27	17	12	0	12	42	39	7	0	0	0	100					67	33
ssp. *ocellaris*	0	90	10	0	94	6	0	14	86	11	11	77	0	44	47	7	0	1	0	67	31	2	0	0	1	14	86					50	50
euryale group	0	75	25	1	81	18	0	14	86	7	14	79	0	24	31	13	15	18	0	33	29	26	12	0	0	4	94					63	37
ssp. *pseudoadyte*	0	1	99	7	16	76	0	0	100	17	83	0	0	0	1	4	80	15	0	3	12	56	29	0	0	0	100					86	14
transitional *pseudoadyte / kunzi*	1	5	94	43	33	25	1	1	98	62	36	1	4	18	38	21	16	3	30	41	19	9	1	0	1	16	82					91	9
ssp. *kunzi*	20	18	62	96	4	0	18	2	80	89	11	0	73	24	2	0	0	0	98	2	0	0	0	13	13	49	24					76	24
kunzi group	3	5	92	34	22	44	3	1	97	46	53	1	11	11	18	11	42	8	26	20	14	28	13	2	2	7	83					87	13
All subspecies																																	
adyte group	0	0	100	1	2	98	0	0	100	9	89	3	0	0	0	2	98	1	0	1	4	34	62	0	0	0	100					86	14
euryale group, non melanistic	1	52	47	3	51	46	1	9	90	4	4	91	0	0	1	12	34	52	0	3	10	47	40	0	0	0	100					68	32
euryale group, transitional	0	68	32	1	81	18	0	15	85	3	26	70	0	13	31	27	17	12	0	12	42	39	7	0	0	0	100					67	33
euryale group, melanistic	0	90	10	0	94	6	0	14	86	11	11	77	0	44	47	7	0	1	0	67	31	2	0	0	1	14	86					50	50
euryale group	0	71	28	1	76	22	0	13	87	7	12	81	0	21	28	15	16	21	0	30	28	27	15	0	0	3	94					61	39

Group 3a (differences with ssp. *adyte*). Both have basically the same wing pattern. In group 3a most wing pattern elements are somewhat less developed, both in males and in females. Some 23% of the group 3a males lack the white pupil in the apical ocelli on the forewing upperside (8% in *adyte*), and 65% of them have a discontinuous band on the hindwing upperside (28% in *adyte*). On the hindwing underside, on the other hand, a white streak from the costa at least to nerve 4 is present in 33% of the group 3a males, as opposed to 4% in *adyte*. These differences, in combination, will enable identification of a population; identification on the individual level will often require genital examination.

Group 3b (differences with ssp. *ocellaris*). The resemblance between both is superficial, as group 3b is an adytoid form, *ocellaris* an euryaloid one. Melanisation is more extreme in 3b than in *ocellaris*. In many individuals there is no trace of the postdiscal band on the forewing upperside (males 67%, vs. 1% in *ocellaris*, females 73% vs. 0%), on the forewing underside (males 51% vs. 0%, females 13% vs. 0%) and on the hindwing upperside (males 92% vs. 5%, females 98% vs. 0%). Most conspicuous are the males that, apart from the checked fringes, have a completely black upperside, without any trace of ocelli or postdiscal banding (32% vs. 0%)*, or only deep black apical spots on a black background (33% vs. 0%)*. In the individuals with apical spots on the forewing upperside, though, white pupils are present in 26% of the males and 77% of the females (1% and 10% in *ocellaris*). A further difference is the black instead of dark brown ground colour in the males, even on the hindwing underside. (Percentages marked with * are not directly readable from Table 4).

Genital differences between subgroups

After delimitation of the groups and subgroups, the latter were tested for differences in their genital characters. This revealed (i) that ssp. *isarica* and ssp. *ocellaris* do not exhibit significant differences, and (ii) that group 3a has a significantly lower Shoulder Index value and a significantly higher First Tooth value than group 3b (Table 5). (iii) The transitional group 3 populations are not intermediate in this respect, but equal group 3b.

Contact sites between groups

Contact site of group 3 and the *adyte* group. The area of the non-melanistic group 3 populations is surrounded by deep valleys of the rivers Adda, Rio Trafoi and Adige. The only possible contact zone with ssp. *adyte* is the Stelvio region. East of the pass *adyte* populations occur on the left bank of Rio Trafoi (sample 39 and 84), whereas group 3 was found above Sulden (sample 85), less than 9 km east (Fig. 6B). To test for gene flow, sample 85 was compared with the remaining group 3a populations, and samples 39 and 84 were each compared with the remaining *adyte* populations. Both sample 39 and 84 differed significantly from the control group in a single parameter (Table 5), which might well result from (former) interbreeding. The higher

Tab. 5. Pair wise comparison of samples or groups of samples. * = p with equal variances not assumed (Levene's $p < 0.05$). Significant differences in bold (significance level = 0.05).

Groups compared	N	Test	First Tooth	Shoulder Index	Tooth Length
			p	*p*	*p*
ssp. *isarica*	60	Student's t	0.501	0.114	0.700
ssp. *ocellaris*	105				
group 3a	128	Student's t	**<0.001***	**<0.001**	0.928*
group 3b	77				
group 3a	128	Student's t	**<0.001**	**0.001**	0.204
group 3 trans.	100				
group 3b	77	Student's t	0.144	0.667	0.386*
group 3 trans.	100				
sample 39	10	Mann-Whitney H	0.968	**0.025**	0.822
ssp. *adyte*	104				
sample 84	30	Mann-Whitney H	0.430	0.069	**0.031**
ssp. *adyte*	104				
sample 85	7	Mann-Whitney H	**0.005**	0.597	0.230
group 3a	121				
sample15	30	Student's t	0.757	0.585	0.758
ssp. *ocellaris*	75				
sample 25	30	Student's t	0.564	0.078	0.551
group 3 trans.	40				
sample 82	30	Student's t	0.637	0.389	0.477
group 3 trans.	40				

First Tooth value in sample 85, on the other hand, is opposite to the expected effect of gene flow.

Contact site of group 3 and the *euryale* group. Contact sites of ssp. *ocellaris* and group 3b populations can be expected near the Passo Rolle, and in the Biois valley between Valle di Gares and Falcade. Four samples were available from the Passo Rolle region (see Fig. 6C). Populations of group 3 live south of the pass height, both in the glades of the *Larix* wood (sample 82) and above the timberline (sample 25), whereas ssp. *ocellaris* is common on its north side, in the clearings of the *Picea* wood (sample 15) and above the tree line (sample 96). The shortest distance between populations of both groups is 1.5 km (samples 25 and 96). Group 3 populations on the southern side of the pass are transitional melanistic/non-melanistic populations. A wide range of intermediate individuals occur, some of which would not be distinguishable from ssp. *ocellaris* by their upperside wing pattern. None of them, though, has the brown ringed ocelli on the hindwing underside, typical of the *euryale* group. In an attempt to detect gene flow in genital characters, sample 15 was compared with the remaining *ocellaris* populations, and samples 25 and 82 were each compared with the remaining transitional group 3 populations. No significant differences were found (Tab. 5). Thus genital characters do not reveal any sign of intermingling here. As far as can be judged from the available data, the ranges of the *euryale* group and group 3 are in contact without building a hybrid zone.

Discussion

The taxonomical implications

1 The valid names of the subspecies of group 3

The melanistic subspecies. Verity (1953: 217) was the first to recognise the peculiar character of the melanistic populations of group 3, when he described the population in the Valle di Gares as subrace *totenigra*. This name is not available, though, as Verity explicitly gave it infra-subspecific rank (ICZN 2000, art. 45.6.1). Heinkele (2007) described a population of the eastern foothill of the Monte Cavallo (Pala Fontana) as ssp. *kunzi*. The type locality lies within the range of group 3b, so *kunzi* is the only available and thus the valid name of the eastern (melanistic) subspecies of group 3.

Distribution. The territory of ssp. *kunzi* comprises the eastern Venetian pre-Alps (Monte Grappa, Col Visentin and Monte Cavallo), the Feltre Dolomites and the Pale di San Martino, as far north as the Passo Rolle – Falcade line.

The non-melanistic subspecies. For the western (non-melanistic) subspecies of group 3 no name is available within its geographic range. Dannehl's *mendolana* (Dannehl 1927) from the mountains around the Mendelpass (sample 85) is not available, as it is explicitly published as an aberration. Hence the non-melanistic populations of group 3 are described here as **ssp. n.**

Erebia euryale pseudoadyte ssp. n. (Fig. 8)

Material. Holotype: ♂, 'Monte Baldo (It)'|'Mte Altissimo di Nago'|'1500–1700m.'|'12.VII.2001'|'F. Cupedo leg.', CFC; – Paratypes: 37♂, 4♀, same label, CFC; 7♂, 1♀, same label, coll. ZMAN; 16♂, 8♀, 'Monte Baldo (It)'|'Mte Altissimo di Nago'|'1700–2000m.'|'12.VII.2001'|'F.Cupedo leg.', CFC; 5♂, 6♀, same label, coll. ZMAN.

Description. Valve shape. Male valve with a prominent, hump-shaped shoulder on its dorsal edge. The part of the dorsal ridge proximal to the shoulder is free of spines. Wing pattern. Male forewing length 21–23 mm, androconial scales absent. Fringes checked black and white. Postdiscal band distinct, reddish brown, often contracted below the apical spots. The apical ocelli bear a white pupil in 77% of the individuals. Postdiscal band on hindwing upperside broken up into isolated spots, whose inner edge is suffused. Hindwing underside with a white streak from the costa at least to nerve 4 in a third of the males. Female upperside basically as in males, banding and ocelli more developed. Postdiscal band on hindwing underside either white or yellow/orange, variable in width.

Diagnosis. Differs from all ssp. of the *euryale* group and the *adyte* group by the pronounced shoulder on the dorsal edge of the valve, and the longer spine-free proximal part of the valve. Differs from ssp. *kunzi* by its non-melanistic wing pattern.

Etymology. The name refers to the strong similarity, in its wing pattern, with ssp. *adyte*.

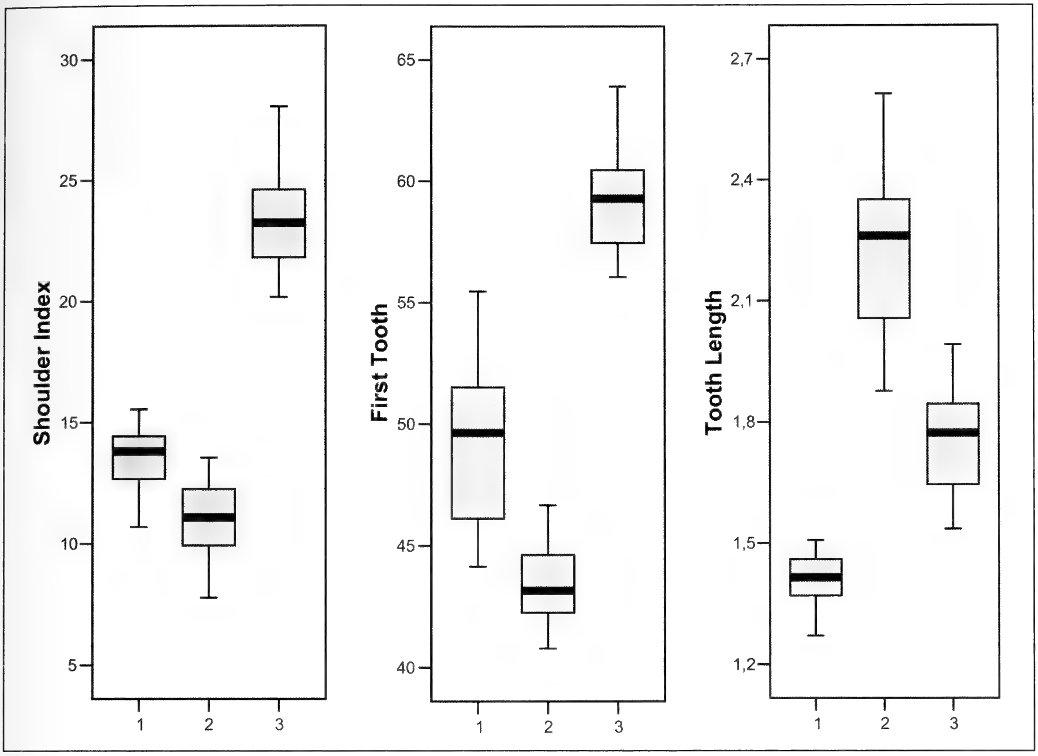

Fig. 5. Boxplots per group of populations for each genital parameter. X-axis: group number.

Distribution. ssp. *pseudoadyte* inhabits the Southern Rhaetian Alps (Ortler, Adamello-Presanella, Brenta and Nonsberger Alps); the Bergamasque Alps and pre-Alps; the Brescian and Garda pre-Alps (see Fig. 6A).

The transitional populations. The Venetian pre-Alps west of the Canale di Brenta (Altipiani, Piccole Dolomiti and Monti Lessini), the Lagorai chain and the Cima d'Asta group in the south-western Dolomites are inhabited by populations that are intermediate between ssp. *pseudoadyte* and ssp. *kunzi*. The transitional zone is separated from the territories of both subspecies by natural barriers, which makes a hybrid origin less obvious than in the case of *isarica/ocellaris*. Three observations even contradict a hybrid origin. (i) Populations 25, 82, 83 and 77 show a clinal variation in all wing characters on the eastern slope of the upper Cismon valley (Tab. 3). This is an indication of former infiltration from the Lagorai chain into the Pala group, and not vice versa. (ii) The white/yellow ratio in the colour of the postdiscal band on the female hindwing underside is different in the sister taxa *pseudoadyte* and *kunzi*, as it is in the sister taxa *isarica* and *ocellaris*. In contrast with the *euryale* group, though, transitional populations in group 3 do not show an intermediate value (Tab. 4), suggesting that these populations have independently been subjected to genetic drift. (iii) With respect to genital differences between groups 3a and 3b, the transitional populations are not intermediate either, but fit into group 3b. These

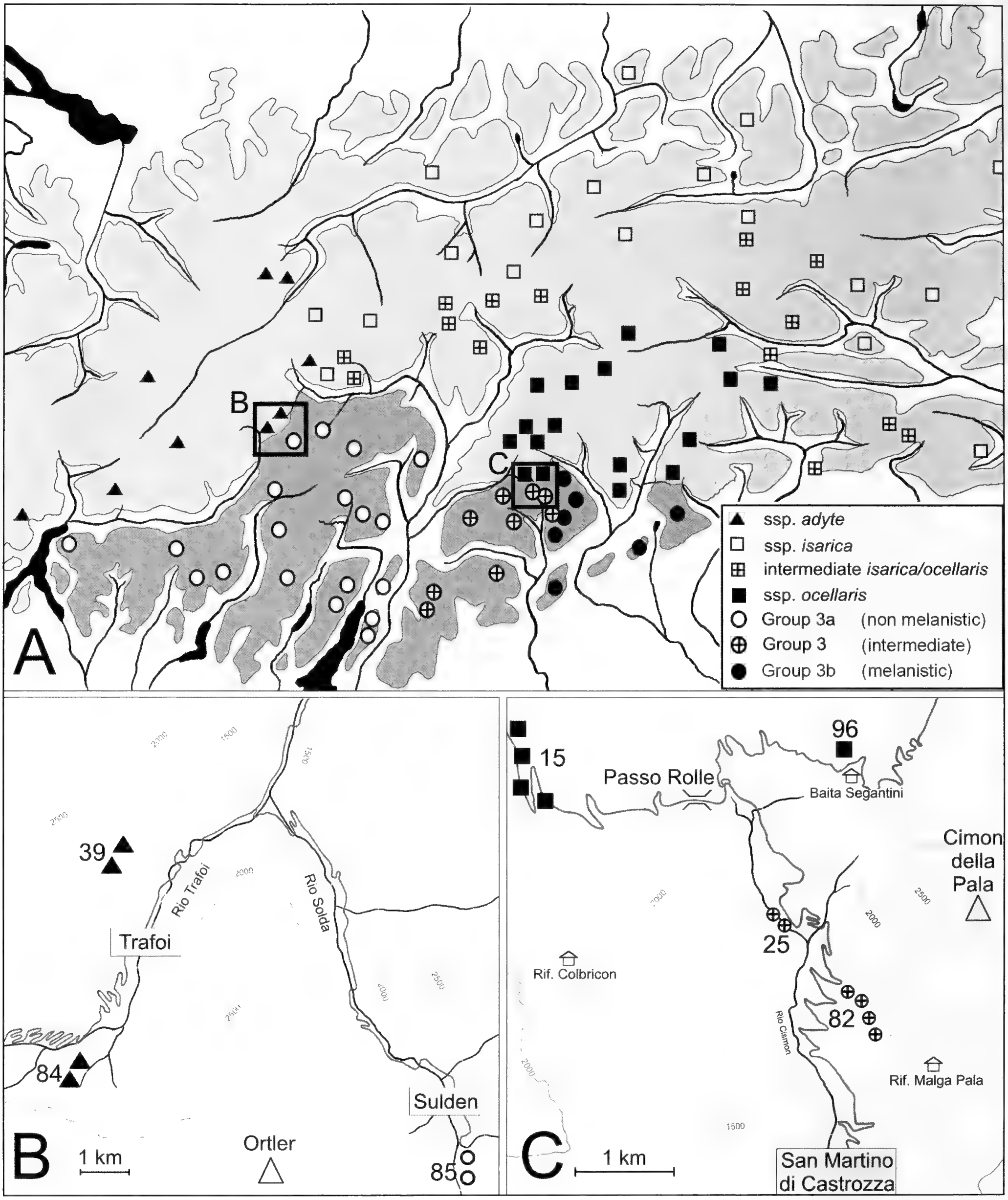

Fig. 6. A. Distribution of the groups and their subgroups in the eastern Alps. Light and dark grey: mountains above 1000 m. Dark grey: distribution area of group 3. Squares: contact areas. B. Contact area near Sulden. Grey: roads. C. Contact area at Passo Rolle. Grey: roads.

arguments cast doubt on the hybrid character of the transitional populations, and are suggestive of an autochthonous origin. Because morphologic data alone cannot be decisive here, the the transitional populations are, provisionally, placed within ssp. *kunzi*. This choice is based on the corresponding values for the genital parameters.

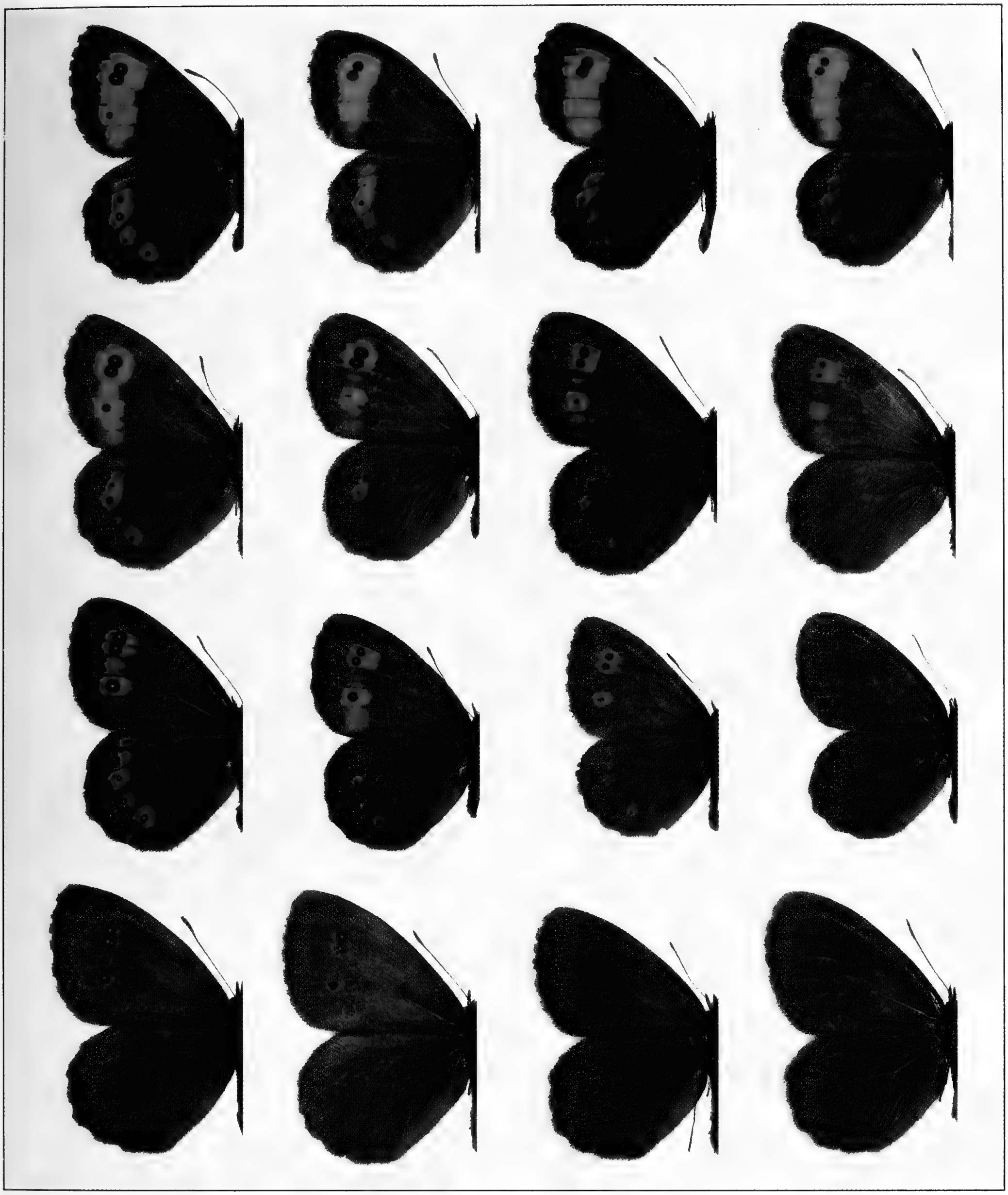

Fig. 7. Variation range in group 3. Row 1: non-melanistic population (sample 36). Row 2+3: transitional populations (samples 28 and 82). Row 4: melanistic population (sample 24).

2 The valid names of the three groups

The populations of *E. euryale* split up into three genital-morphologic, geographically coherent groups of populations. There is limited, if any, gene exchange between these groups. Each of them comprises more than one subspecies. Where two subspecies of one group meet, hybrid populations occur. The groups thus represent a differentiation level between species and subspecies. This kind of hierarchic structuring is expressed

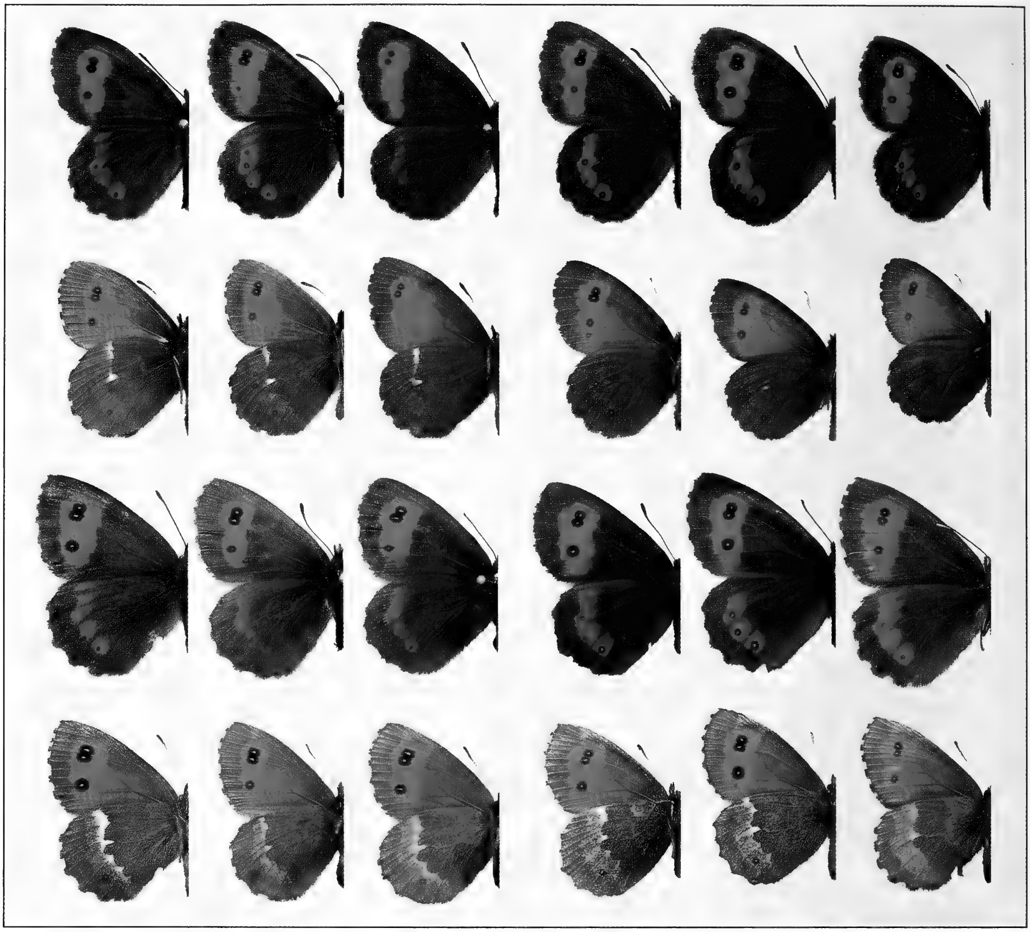

Fig. 8. Left: *E. euryale pseudoadyte* **ssp. n.** (Monte Baldo, I, sample 36). Right: *E. euryale adyte* (Ticino, CH, sample 60). Row 1: males upperside; 2: males underside; 3: females upperside; 4: females underside. Upper left, row 1+2: holotype.

in nomenclature by inserting a group name, in parenthesis, after the species name in the trinomen. According to art. 6.2 of the Code (ICZN 2000) the groups should be named *Erebia euryale* (group *euryale*), *Erebia euryale* (group *adyte*) and *Erebia euryale* (group *kunzi*). The slender shaped valve and the weak differentiation of wing pattern suggest closer affinities of the *kunzi* group to the *adyte* group than to the *euryale* group.

Conclusions

The infraspecific variation in *Erebia euryale* is hierarchically structured in two levels: wing pattern based subspecies are clustered in groups that are defined by their genital anatomy. In the genus *Erebia* this is a recurrent pattern, which was described earlier in the *E. sudetica/melampus* complex, in *E. manto* and in *E. pandrose* (Cupedo 1996, 1997, 2007).

The combined genital/wing morphologic approach revealed two longstanding misinterpretations that affected the existing subspecific classification of *E. euryale*: (i) the melanistic populations in the southern Alps, hitherto considered a coherent group and known as ssp. *ocellaris*, are not monophyletic but result from convergent adaptations, and (ii) the "*adyte* habitus" remained practically unchanged during the divergence of the *adyte* group and the *kunzi* group, giving the false impression of one, morphologically well-defined taxon. These misconceptions being corrected, the infraspecific structure reconstructed here is expected to reflect the phylogenetic relations more accurately than earlier classifications did.

Checklist

This list aims to rearrange the described subspecies of *E. euryale* into three group. It is no taxonomic revision; the justification of subspecies remains undiscussed.

1 *Erebia euryale* (group *euryale*)

Diagnosis: male valve broad, dorsal edge with irregular spines, short proximal spine-free part. Postdiscal ocelli on male hindwing underside black with a brown ring.

E. euryale (euryale) euryale (Esper, 1805) (LT. Giant Mountains, CZ.)
E. euryale (euryale) isarica Heyne, 1895 (LT. Mountains surrounding the Isarvalley, Tyrol, A.)
E. euryale (euryale) syrmia Fruhstorfer, 1909 (LT. Trebević, Bosnia-Herzegowina.)
E. euryale (euryale) tramelana Reverdin, 1918 (LT. Tramelan, Jura, CH.)
E. euryale (euryale) phoreta Fruhstorfer, 1918 (LT. Mont Dore, Auvergne, F.)
E. euryale (euryale) antevortes Verity, 1927 (LT. Cauterets, Hautes Pyrenées, F.)
E. euryale (euryale) pyraenaeicola v.d. Goltz, 1930 (LT. Vernet-les-Bains, Pyrenées Orientales, F.)
E. euryale (euryale) cantabricola Verity, 1927 (LT. Puerto Pajares, Asturias, E.)
E. euryale (euryale) euryaloides Tengström, 1869 (LT. Finland.)
E. euryale (euryale) arctica Poppius, 1906 (LT. Kanin peninsula, RU.)
E. euryale (euryale) ocellaris Staudinger, 1861 (LT. Carinthia, A.)

2 *Erebia euryale* (group *adyte*)

Diagnosis: male valve slender, dorsal spines fine and separate, with a large spine-free proximal part.

E. euryale (adyte) adyte (Hübner, 1822) (LT: Wallis, CH.)
E. euryale (adyte) etobyma Fruhstorfer, 1909 (LT: Col de Tende, Alpes Maritimes, F.)
E. euryale (adyte) brutiorum Turati, 1911 (LT. Gran Sasso, Abruzzo, I.)

3 *Erebia euryale* (group *kunzi*)

Diagnosis: male valve slender, with a prominent shoulder and a spine-free proximal part that reaches to the base of the shoulder.

E. euryale (kunzi) kunzi Heinkele, 2007 (LT. Pala Fontana, Monte Cavallo, Friuli-Venezia Giulia, I.)

E. euryale (kunzi) pseudoadyte **ssp. n. (**LT. Monte Baldo, Trentino, I.)

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Appendices

Appendix 1

Morphologic differences between the traditionally recognised groups in *E. euryale*: the *euryale* group, the *adyte* group and the *ocellaris* group.

Male wing pattern (according to Warren 1936)
(i) The *euryale* group.
Forewing upperside: ocelli without white pupils. Postdiscal band complete.
Hindwing underside: postdiscal band conspicuous. Ocelli with a brown ring.
(ii) The *adyte* group.
Forewing upperside: ocelli with prominent white pupils. Postdiscal band complete, restricted below the apical spots.
Hindwing underside: postdiscal band faintly indicated. Ocelli without brown ring. White streak lining the discal field often reduced to a small tooth, projecting basad along nervure 4.
(iii) The *ocellaris* group.
Forewing upperside: ocelli without white pupils. Postdiscal band reduced, broken up into spots around the ocelli.
Hindwing underside: ocelli black with brown ring.

Female wing pattern
Upperside wing pattern as in males, but more luxurious.
Underside hindwing: the colour of the postdiscal band is either white or yellow (nuances disregarded).

Valve morphology
Valvae of ssp. *adyte* are slender, with a dorsal shoulder; in ssp. *ocellaris* and ssp. *isarica* (*euryale* group) they are broader without marked shoulder (Arnscheid & Roos 1977). In ssp. *adyte* the valvae bear fine and regularly spaced spines, in ssp. *isarica* (*euryale* group) these are larger, irregularly in shape and arrangement. The proximal spine-free part of the valve is larger in ssp. *adyte* than in ssp. *isarica*. (Sonderegger 2005)

Appendix 2

Quantification criteria for wing pattern elements.
Postdiscal band on forewing upperside (males and females)
0 = absent.
1 = narrow ring around ocelli (ocellaroid). As a rule no spot in cell 3.
2 = rings stretched drop shaped, but separated. As a rule a spot in cell 3.
3 = incomplete band. Spots in cell 2 and 3 not united, or spot in cell 3 strongly constricted (narrower than high).
4 = band continuous, outer margin concave.
5 = band continuous, outer margin straight or convex.

Postdiscal band on forewing underside: (males and females)
0 = absent.
1 = spots separated, band often incomplete.
2 = band complete, strongly constricted or disrupted in cell 3
3 = complete band.
Postdiscal band on hindwing upperside (males and females)
0 = absent.
1 = ocellaroid.
2 = spots united at least in cells 4-5-6, detached in cells 2 and 3.
3 = band continuous.
Ocelli on forewing upperside, forewing underside and hindwing upperside (males and females)
0 = absent
1 = black
2 = pupilled white
Ocelli on hindwing underside (males)
0 = absent
1 = without brown ring
2 = with brown ring
White pattern on hindwing underside (males)
0 = absent
1 = white tooth on nerve 4
2 = additional white along costa, even if weak
3 = a continuous white streak from costa to at least nerve 4
Colour of postdiscal band on hindwing underside (females)
1 = white
2 = yellow or orange

A significant range extension for *Pyrgus cacaliae* (Rambur, 1839) with the first record from the western Balkan Peninsula (Hesperiidae)

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Abstract. The European montane endemic *Pyrgus cacaliae* is reported for the first time from the Dinarid mountain chain in Bosnia and Herzegovina based on a previously misidentified museum specimen. The respective distributions and distinguishing characters of *P. cacaliae* and its closest relative, *Pyrgus andromedae* (Wallengren), are described. The significance of this record from biogeographical and conservation points of view is discussed. This discovery is a prime example of the advantages of systematic, long-term accumulation of scientific material and the resulting high value of properly managed scientific collections.

Introduction

Pyrgus cacaliae (Rambur, 1839) is a species endemic to Europe, with most of its range located in the Alps. Much smaller, peripheral isolates are found in the Pyrenees, the Carpathians of Romania, and the highest mountains of Bulgaria (Fig. 1). The closest relative of *P. cacaliae* is *Pyrgus andromedae* (Wallengren, 1853) which has a roughly similar range in southern and central Europe (Fig. 1): the Alps, the Pyrenees, the Romanian and Ukrainian Carpathians, the Dinarides of former Yugoslavia south to Šar Mt. in FYROM, and Pirin Mts. in Bulgaria (Jakšić 1988; Tolman 1997; Kolev 2002; Dincă et al. 2008). In addition, and unlike *P. cacaliae*, *P. andromedae* also occurs in the mountains of Fennoscandia as well as in Polar Ural.

In the Balkan Peninsula, *P. cacaliae* has so far only been known with certainty from the two highest mountains of Bulgaria: Rila (2925 m) and Pirin (2914 m). There are also old reports from Vitosha (2280 m) and central Stara Planina (2374 m) (Buresch & Tuleschkow 1930). However these reports have not been confirmed since, despite considerable activity in both massifs (Stoyan Beshkov, pers. comm. for central Stara Planina; pers. obs. on Vitosha almost yearly since 1998). Moreover, I have not found material of *P. cacaliae* from either mountain in public collections in Bulgaria. Thus the presence of this species in the said massifs, while entirely possible, is in need of confirmation (Kolev 2009). There are no published records of *P. cacaliae* between the Bulgarian populations and those in the Julian Alps of Slovenia, separated by nearly 900 km. It should however be noted that the old Slovenian records (Jakšić 1988) have not been confirmed in recent times and the species is currently excluded from the butterfly fauna of Slovenia (Verovnik 2007).

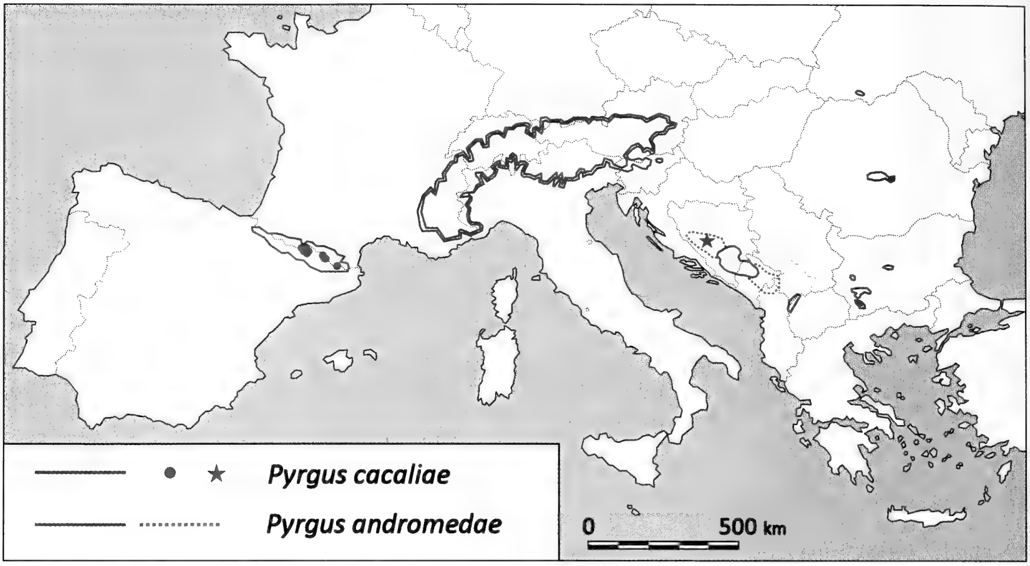

Fig. 1. Distribution of *Pyrgus cacaliae* (red) and *P. andromedae* (green) in South and Central Europe. Dots: single records of *P. cacaliae* in the Pyrenees, star: Makljen pass, Bosnia and Herzegovina. Solid line: recorded range, dotted line: possible range extent for *P. andromedae* in the Dinarides.

New record of Pyrgus cacaliae

In the course of cataloguing melanistic Lepidoptera in the collection of FMNH (Finnish Museum of Natural History, University of Helsinki, Finland), I came upon a female specimen from "Bosnia" which has been labelled as "*Pyrgus andromedae*" by Russian lepidopterologist Dr. Pavel Gorbunov. The specimen (Figs 2a, 2b), however, shows several morphological traits which distinguish it from *P. andromedae* (Figs 2d, 2e) and identify it without doubt as *P. cacaliae*:

- a single, faint whitish spot in space Cu2 of the forewing upperside, with minute traces of a second spot in space Cu1; in *P. andromedae*, there is typically a total of three large, clear white spots in these spaces (Fig. 2: 1);
- evenly diffused and poorly contrasting whitish suffusion on the upperside, particularly in the submarginal area of the hindwing, where this suffusion typically forms a conspicuous whitish band in *P. andromedae* (Fig. 2: 2);
- the absence of a whitish mark in the basal area of the hindwing discal cell underside; such a mark is present in *P. andromedae* (Dincă et al. 2008) (Fig. 2: 3).

Discussion

This specimen represents the first record of *Pyrgus cacaliae* from the western part of the Balkan Peninsula, and for Bosnia and Herzegovina. The label with locality data is shown in Fig. 2c. The pass of Makljen (sic), indicated as the place of capture of this specimen, is situated 65 km west of Sarajevo (43° 50,58' N, 17° 35,64' E, Fig. 1). As the label indicates, the specimen has been part of the collection of Otto Leonhard, a coleopterologist from Blasewitz-Dresden. He visited Bosnia and Herzegovina during the Austrian occupation of the region where he collected Lepidoptera and Coleoptera (Rebel 1904: 133). Leonhard managed to amass a large collection of Lepidoptera from this region and became a well-known expert of Balkan Lepidoptera (Lelo 2000). Most of Leonhard's materials from the Balkan Peninsula were however not collected by himself, but by Moritz Hilf, an experienced collector who at the end of the XIXth Century travelled extensively in the western Balkans on behalf of the National Museum of Bosnia and Herzegovina. Beginning in 1900 Hilf began working for Leonhard, and in 1901 and 1902 he collected on the massifs of Raduša and Čvrsnica as well as the Makljen pass and the village of Prozor, 2 km SE of Makljen (Rebel 1904: 133). Rebel (1904: 136) stated that he examined Hilf's materials in the collection of Leonhard for his pioneering work "Studien über die Lepidopterenfauna der Balkanländer", including material from "Maklenpaß" (see below). Therefore, it is remarkable that *P. cacaliae*, a rather easy species to identify, is absent from Rebel's monograph. Since Rebel also did not list *P. andromedae* among the species collected in "Maklenpaß" or anywhere in the vicinity (Rebel 1904: 191), we may assume that Rebel has not mistaken the specimen for *P. andromedae*. This assumption is supported by the fact that this specimen was originally acquired by FMNH under an identity other than *P. andromedae*, and determined erroneously as the latter species by P. Gorbunov, as a separate label next to the specimen testifies, during a visit to FMNH in the mid-1990's. Therefore this specimen must have been misdetermined already in Leonhard's collection, but not as *P. andromedae*.

Indeed, Rebel's monograph provides evidence that this is the case. Rebel (1904: 191–192) lists, in genus "*Hesperia*", three *Pyrgus* species from Makljen: *Pyrgus serratulae* (Rambur, 1839), *Pyrgus alveus* (Hübner, [1803]) and *Pyrgus malvae* (Linnaeus, 1758). Of these *P. serratulae* is the only species for which Rebel gave exact data from Makljen: "Nur von Koinsko polje (12./7. [19]02 Stur[any].) und dem Maklenpaß (24.–30./6. '[19]02 Hilf-Leonh[ard].) nachgewiesen, in einer Höhe von ca. 1100–1300 m erbeutet. Die Stücke vom Maklenpaß gehören zum Teile der kleineren, oberseits zeichnungsloseren (alpinen) var. *Caecus* Frr. an." (Rebel 1904: 191). The explicitly mentioned smaller size and reduced upperside markings of the "*serratulae*" from Makljen not only match the discussed *cacaliae* specimen, but are highly significant because they contradict the characters of Balkan *P. serratulae*. The latter, referred to the subspecies *P. serratulae balcanica* (Warren, 1926) and *P. serratulae major* (Staudinger, 1879), are characterized by an on average larger size and larger forewing upperside white markings than the *serratulae* group of subspecies (De Jong 1972). The ecological form caecus, in which these markings are strongly reduced, is most common in the Alps at altitudes of over 2000 m but has not been noted from anywhere in the Balkans despite the examination of abundant material (De Jong 1972: 4, 69–71). Moreover, neither the prominence of white markings nor the wingspan of Balkan *serratulae* vary in the direction of f. caecus even at the upper altitudinal limit of its occurrence (Bulgaria, Mt. Pirin, below Vihren peak, 1900–2000 m, Z. Kolev, pers. obs.). One of the most widely known characters of *P. serratulae* is that the basal white spot between the costal and subcostal veins on the hindwing underside is clearly rounded and entirely, or nearly so, encircled by the darker background colour. However, the same character state may occur in *P. cacaliae*, as in the discussed specimen (Fig. 2: 4). It is thus easy to see how the latter could have been mistaken for a smaller form of *P. serratulae* with reduced upperside pattern. That Rebel might have mistaken the specimen as either of the two remaining *Pyrgus* species (*malvae* or *alveus*) reported by him from Makljen (Rebel 1904: 191–192) is highly unlikely due to their clearly distinct external morphology. Finally, the stated date of collecting of the *cacaliae* specimen, 27.6.1902 (Fig. 2: c), fits in the date range of the "*serratulae*" series from Makljen, "24.–30./6. '[19]02" (Rebel 1904: 191). There is therefore sufficient basis to conclude that the here reported specimen of *P. cacaliae* is one of a presently unknown number of specimens collected by Hilf for Leonhard and reported as "*Hesperia Serratulae*" "var. *Caecus* Frr." by Rebel (1904: 191).

While there is no reason to doubt the provenance of this *P. cacaliae* specimen, its collecting locality is probably somewhat imprecisely stated. The pass of Makljen, while situated in mountainous terrain, lies at an altitude of only ca. 1120 m. This altitude appears low for *P. cacaliae*, which in Bulgaria has never been recorded below 1800 m and flies typically higher than 2100 m (Buresch & Tuleschkow 1930; Z. Kolev, pers. obs.). Likewise Tolman (1997) indicated a lower altitudinal limit of 1800 m for this species. Satellite imagery and geotagged photographs from Makljen (accessed in Google Earth ®) show that the vegetation in and immediately around the pass is alternating dense woodland and meadows; such habitats are unsuitable for the mostly alpine *P. cacaliae*. Therefore, it appears more likely that the actual collecting locality of the *P. cacaliae* specimen is a higher mountain adjacent to Makljen. The fact that Hilf labeled his material from this locality as collected over a whole week is remarkable considering the very limited area of the pass, and in my opinion also indicates the possibility that he collected elsewhere besides Makljen during that time. There are several massifs within a 30-km radius of Makljen that qualify as potential localities for *P. cacaliae* by virtue of approaching or exceeding 2000 m in height. Closest to Makljen is Raduša (1956 m), which rises immediately to the west of the pass and where M. Hilf collected on 15.6.1902, just prior to collecting in Makljen (Rebel 1904: 148). Satellite imagery and geotagged photographs from Raduša (accessed in Google Earth ®) show that the summit zone of the mountain above ca. 1700 m has extensive subalpine meadows and several small lakes. These habitats appear superficially suitable for *P. cacaliae* on account of the preference of this species for grassy areas around alpine lakes in Mt. Rila (Z. Kolev, pers. obs.). Another possible locality for *P. cacaliae* is Vranica (2110 m, 9 km NE of Makljen), a mountain with a true alpine zone where according to material listed by Rebel (1904: 185) Hilf collected between 14. and 22.7.1902. The absence of subsequent records from the vicinity of Makljen does not disprove the occurrence of *P. cacaliae*, since apparently nobody has collected there after Hilf (S. Lelo, pers. comm.). There is no reason to suppose that *P. cacaliae* might have become extinct in the area due to habitat degradation after the reported specimen was captured: this mountainous region is sparsely populated and human impact on the summit zones of the mountains, mostly by livestock grazing, is negligible (S. Lelo, pers. comm.).

This discovery suggests that *P. cacaliae* may eventually be discovered in other high mountains of the Dinarid chain. Larval host plant can hardly be a limiting factor for

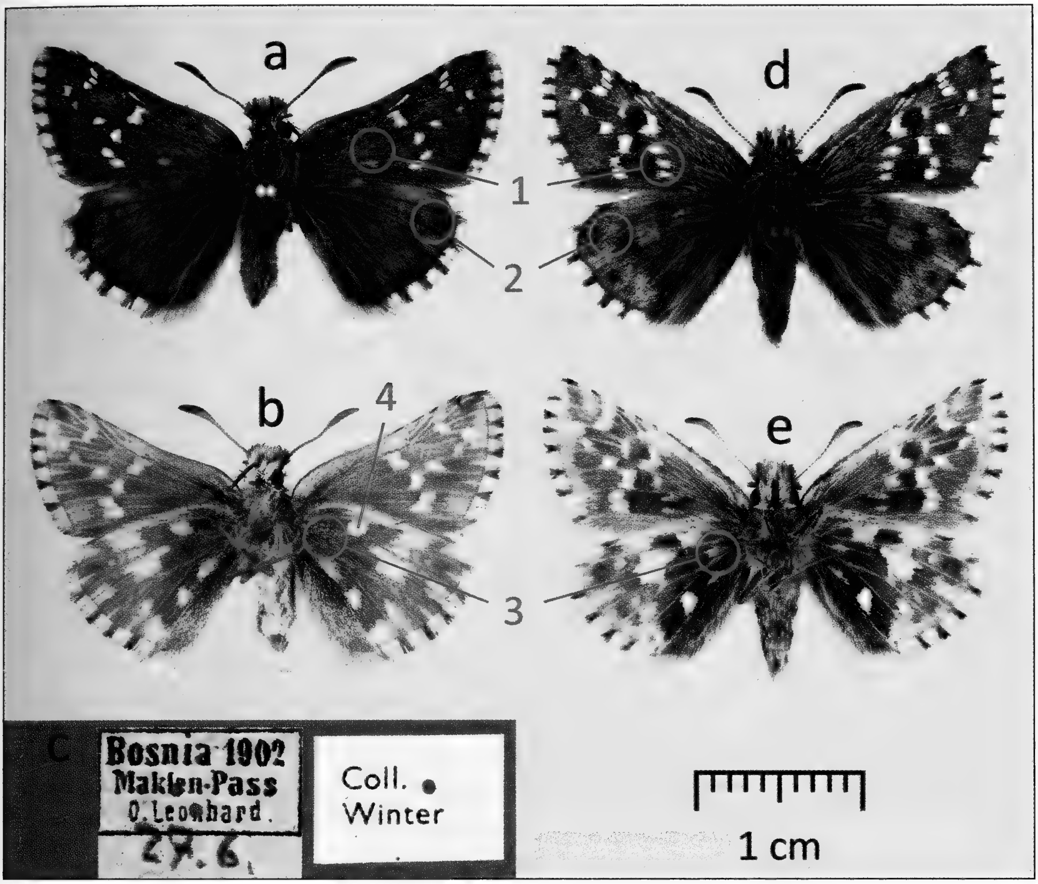

Fig. 2. *Pyrgus cacaliae* ♀ from Bosnia-Herzegoniva (a: upperside, b: underside, c: labels (at twice the magnification of the rest of the figures) and *P. andromedae* ♂ (d: upperside, e: underside) from northern Finland, Kilpisjärvi, 4.07.1948, Lingonblad leg. in coll. FMNH. **1–3**: diagnostic characters (see text); **4**: rounded basal spot as in *Pyrgus serratulae*.

the occurrence of *P. cacaliae* there, as its larvae feed on *Potentilla aurea* L. (Rosaceae) and other montane species of this genus (Wagner 2003, 2006; Settele et al. 2008: 62). Several species of *Potentilla* are widespread in the high mountains of the Balkan Peninsula, including *P. aurea* in some massifs of the Dinarides (Andreev et al. 1992; Polunin 1997). The butterfly fauna of this region is known to be very diverse (Rebel 1904; Jakšić 1988), but as a whole it has remained sporadically studied due to the sheer size of the area and the difficulty of access to vast parts thereof, exacerbated by political and civil unrest in the 1990's. I hope that this discovery will stimulate further research on the butterfly fauna of the vast mountain system of the western Balkan Peninsula. It is also important to re-examine carefully the existing collection material of *Pyrgus* from this region. In this respect, it can also be expected that *P. andromedae*, which to this day has remained unrecorded from the vicinity of Makljen (Rebel 1904: 191; Jakšić 1988), may occur there and may in general be more widespread in the Dinarides than currently known (Fig. 1).

Conclusion

The here reported occurrence of *P. cacaliae* in the western Balkan Peninsula bridges the large gap between the Alpine and eastern-Balkan populations of the species. As such the present record represents a significant range extension for this European endemic. The provenance of the specimen on which the record is based is discussed and shown to be generally reliable, though the actual collecting locality remains to be clarified by future research. This record is of relevance to nature conservation as well because the smaller, widely isolated populations of *P. cacaliae* are considered to be vulnerable in the event of significant climate warming (Settele et al. 2008: 62).

This discovery is also a testimony to the benefits of a systematic, scientifically sound approach to collecting, and of large and well-managed collections of long standing such as FMNH. In the ongoing public debate about whether insect collecting should be consigned to the past, the present record provides one more example of the overwhelming advantage and importance of the traditional methods of gathering and preserving scientific data.

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Review of the genus *Flavinarosa* Holloway (Zygaenoidea: Limacodidae) with description of four new species

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Abstract. The genus *Flavinarosa* Holloway, 1986 is reviewed; its diagnosis is expanded. The genus includes nine species, four of them described as new: *F. luna* **sp. n.** (China: Fujian; holotype in ZFMK), *F. acantha* **sp. n.** (China: Hainan; holotype in MWM), *F. kozyavka* **sp. n.** (northern Thailand; holotype in MWM), and *F. ptaha* **sp. n.** (China: Sichuan; holotype in MWM). A key to the species is given. The systematic position and relationships of the genus are briefly discussed.

Zusammenfassung. Die Gattung *Flavinarosa* Holloway, 1986 wird revidiert und ihre Diagnose verbessert. Sie umfasst neun Arten, von denen vier hier neu beschrieben werden: *F. luna* **sp. n.** (China: Fujian; Holotypus in ZFMK), *F. acantha* **sp. n.** (China: Hainan; Holotypus in MWM), *F. kozyavka* **sp. n.** (Nordthailand; Holotypus in MWM), und *F. ptaha* **sp. n.** (China: Sichuan; Holotypus in MWM). Die systematische Stellung der Gattung wird kurz diskutiert und ein Bestimmungsschlüssel für die beschriebenen Arten gegeben.

Резюме. Род *Flavinarosa* Holloway, 1986 ревизован, его диагноз дополнен. Род в настоящее время включает 9 видов, 4 из которых прежде были неизвестны науке и описываются в этой статье: *F. luna* **sp. n.** (Китай: Фуджиань; голотип в MWM), *F. acantha* **sp. n.** (Китай: Хайнань; голотип в MWM), *F. kozyavka* **sp. n.** (северный Таиланд; голотип в MWM) и *F. ptaha* **sp. n.** (Китай: Сычуань; голотип в MWM). Дан ключ для определения всех видов. Рассмотрены филогенетические связи рода и его систематическое положение.

Introduction

The genus *Flavinarosa* Holloway, 1986 was erected with type-species *Narosa holoxanthia* Hampson, 1900 and three associated taxa: *F. holoxanthia holoxanthia* Hampson, *F. holoxanthia paucispina* (Holloway, 1986) and *F. obscura* (Wileman, 1915). The genus was established with the following diagnostic features: presence of several rows or tufts of cornuti in male genitalia and corpus bursae bearing a triangular field of scobination in female genitalia (Holloway 1986: 72). Before 1986 both species *F. holoxanthia* and *F. obscura* were associated with the genus *Narosa* Walker, 1855. Apart from these two, many other limacodid species were associated with *Narosa* on a base of yellow ground colour, smaller size, filiform male antennae and sinuous R1 in forewing. Further work on *Narosa*-complex was done by Solovyev & Witt (2009), where the diagnosis of the genus was improved and several new genera were recognized.

The number of known species of *Flavinarosa* is increased to nine with *F. holoxanthia paucispina* raised to full specific level (Solovyev & Witt 2009) and with the addition of four newly described herein. This number of taxa is not believed to be final because there are few specimens represented in entomological collections. Furthermore, the identification of the species at this time is based largely on male genitalia.

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Abbreviations

BMNH	Natural History Museum [formerly British Museum (Natural History)]; London, Great Britain
MWM	Entomological Museum Thomas J. Witt; Germany, Munich (later to be transferred to ZSM)
ZFMK	Zoologisches Forschungsinstitut und Museum "Alexander Koenig"; Bonn, Germany

Material and methods

The material of MWM is the main basis for this study. Also material from ZFMK and BMNH was examined. In total about 70 specimens were investigated.

The genitalia of both sexes were examined using standard methods. The abdomen was macerated in 10% aqueous solution of alkali for 10 minutes whilst heating. The genitalia were dissected using micro-forceps; the aedeagus was separated and kept in "Evans blue" dye (0.1% aqueous) for 5 minutes for staining of the vesica. The complete female genitalia were stained with this dye. After this, the genitalia were mounted in Euparal and labeled.

The digital images were made using digital camera Nikon Coolpix 5400 and binocular microscopes MBS-9 and MBS-10. The images were improved and prepared for publication using Corel Draw 13 and Corel Photo-Paint 13.

Results

Flavinarosa Holloway, 1986

Moths of Borneo **1**: 72.
Type species: *Narosa holoxanthia* Hampson, 1900, by original designation.

Redescription. Moths small with forewing length 7–10 mm; wingspan 15–21 mm in males; 11–12 mm and 23–26 mm in females (Figs 1–12). Male antennae filiform. Labial palps strongly upcurved, with 2nd segment as long as 1.2 diameter of eye; terminal segment very short, 1/8–1/9 length of 2nd one. Ground colour yellowish ochre; forewings uniformly coloured, without distinct pattern, but with darker scales in medial region. Hindwings pale yellow. In forewing, vein R1 sinuous; R5 branched from common R3+R4; medial stem not divided (Fig. 13). In hindwing, common vein Sc+R1 sinuous; cross vein between Sc+R1 and radial stem of discal cell well developed, very long, set in proximal third of wing, and very characteristic for the genus (Fig. 14). Hind tibia bears 4 spurs.

Species not sexually dimorphic; females slightly larger than males, with more elongated forewings.

Male genitalia with uncus slender, usually with pair of distinct, apical, horn-shaped processes and long subapical spur (Figs 15–24). Gnathos slender, strongly curved up medially. Valvae elongated, with large cucullus, lacking saccular processes. Saccus short, ovoid. Juxta highly diagnostic, flattened, usually with different kinds of lateral lobes (Figs 25–33). Aedeagus tubular, slender, and S-shaped. Vesica with series of basal, medial and apical cornuti often associated in defined tufts. Eight tergite slightly produced (Holloway 1986: 72).

Female genitalia with ovipositor lobes ovoid; both pairs of apophyses slender; posterior apophyses much longer than anterior ones (Figs 34–36). Antrum distinct, wide. Ductus bursae irregularly spiraled, sclerotized medially. Corpus bursae ovoid, with pair of elongated, sclerotized and wide signa (Figs 37, 38).

Immature stages unknown.

Diagnosis. The members of the genus are similar externally to *Narosa* Walker, 1855, *Heringarosa* Holloway, 1986, *Quasinarosa* Solovyev & Witt, 2009, *Tennya* Solovyev & Witt, 2009, and *Caelestomorpha* Solovyev & Witt, 2009 in their yellow ground colour, small size, filiform male antennae, and sinuous R1 in forewing. They were all previously placed in the *Narosa* complex, but *Flavinarosa* can easily be distinguished from these by the monotonous ochre forewings and uniformly yellow hindwings. In male genitalia the vesica containing a series of bristle-shaped cornuti and in female genitalia the double, wide, elongated signum are diagnostic.

Remarks. The systematic position of the genus is unclear so far, but it was considered as the probable sister genus of *Heringarosa* Holloway, 1986 (Holloway 1986: 72). The females of *Heringarosa* are still unknown, as are the larvae of both genera, but the external characters of the males and the morphology of their male genitalia are similar. Both genera have "*Narosa*"-like habitus (Holloway 1986) with yellow ground colour and are characterized by the produced abdominal 8th tergite, the uncus with two apical horn-shaped processes and slender subapical spur, the valvae without saccular processes, and the wide cucullus.

The genus ranges from India to Sundaland and includes the following nine species: *F. holoxanthia* (Hampson, 1900), *F. obscura* (Wileman, 1915), *F. paucispina* Holloway, 1986, *F. alius* Solovyev & Witt, 2009, *F. glaesa* Solovyev & Witt, 2009, *F. luna* sp. n., *F. acantha* sp. n., *F. kozyavka* sp. n., and *F. ptaha* sp. n.

The species of the genus are not separable externally, but the male genitalia are diagnostic; the most important diagnostic features in species identification are the shape of the juxta and the shape and topography of the cornuti on the vesica. A key to all species based on male genitalia is given after the species accounts.

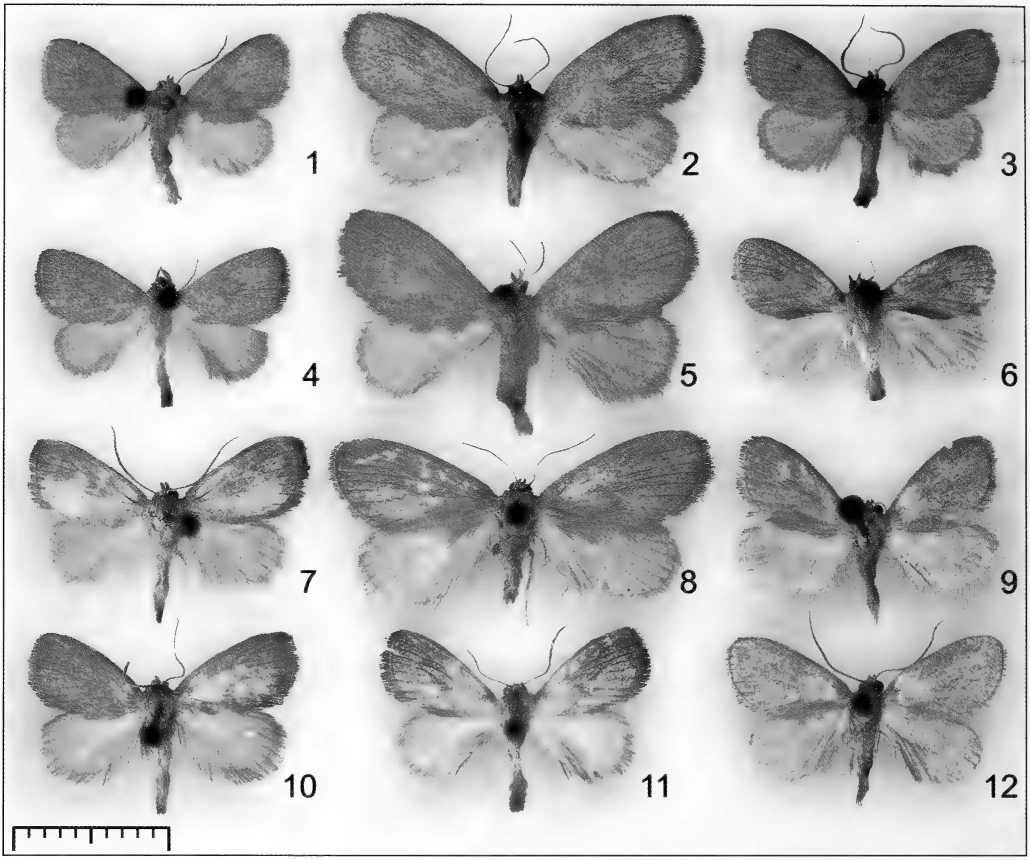
Flavinarosa holoxanthia (Hampson, 1900) Figs 1, 15, 25, 34, 37

Narosa holoxanthia Hampson, 1900: 232. Type-locality: [NE India] "Khásis". Holotype: ♂ (BMNH) [examined].

Diagnosis. In male genitalia, the lateral lobes of juxta are ovoid, with very small, dorsad apical spur and waved upper margin; its medial incision is running up to 2/3 juxta (Figs 15, 25). The juxta is similar to those of *F. luna* sp. n., but in *F. holoxanthia* the lobes of the juxta have a small inner spur and the vesica lacks large and stout apical cornuti.

Distribution. North-eastern India (Meghalaya).

Biology. The phenological data are scanty; the flight period was recorded in mid and late July at an altitude of 800 m.



Figs 1–12. External aspect of *Flavinarosa* spp. **1.** *F. holoxanthia* (Hampson, 1900), ♂, north-eastern India, MWM. **2.** *F. obscura* (Wileman, 1915), ♀, Taiwan, MWM. **3.** *F. obscura* (Wileman, 1915), ♂, Taiwan, MWM. **4.** *F. paucispina* Holloway, 1986, ♂, Borneo, MWM. **5.** *F. paucispina* Holloway, 1986, ♀, Borneo, MWM. **6.** *F. glaesa* Solovyev & Witt, 2009, ♂, holotype. **7.** *F. alius* Solovyev & Witt, 2009, ♂, holotype. **8.** *F. alius* Solovyev & Witt, 2009, ♀, paratype, northern Vietnam, MWM. **9.** *F. luna* sp. n., ♂, paratype, China: Fujian, MWM. **10.** *F. acantha* sp. n., ♂, holotype. **11.** *F. kozyavka* sp. n., ♂, holotype. **12.** *F. ptaha* sp. n., ♂, holotype. Scale bar: 1 cm.

Flavinarosa obscura (Wileman, 1915) Figs 2, 3, 16, 26

Narosa obscura Wileman, 1915: 18. Type-locality: [Taiwan] "Kanshirei". Holotype: ♀ (BMNH) [examined].

Diagnosis. The species is distinguished from other congeners by the juxta of male genitalia where two lateral lobes divided by a medial incision running up to 1/2 juxta and each juxtal lobe with a large, triangular, pointed, small dorsal process and a larger triangular process on its outer margin (Figs 16, 26).

Distribution. Taiwan.

Biology. The moths were collected in late March, late April, early July, and early and mid September at altitudes of 130–1150 m. The early stages are unknown.

Comments. Two females are noted in the original description of *obscura* Wileman; one female was collected on 30th April 1908 (with collection number 1353) and the second one was taken on 8th September 1907 (with collection number 1272). It was believed before that both females were included in the type series of the species (Wang 1995: 72); moreover, both bear labels written by Wileman's hand with the inscription "Type" and "Cotype" correspondingly. However, the original description contains the following statement: "Fore wings of the September example are paler than those of the type described" which means indirectly that the specimen taken on April 30th is the holotype by original designation, whereas the other female should be regarded as a paratype.

Flavinarosa paucispina Holloway, 1986 Figs 4, 5, 17, 27, 35, 38

Flavinarosa holoxanthia paucispina Holloway, 1986: 72. Type-locality: "Sarawak: Gunong Mulu Nat. Park, Site 25, G. Api, 900 m, lower montane forest". Holotype: ♂ (BMNH) [examined].

Diagnosis. The juxta of male genitalia has two lateral lobes divided by the medial incision running up to 1/2 juxta length (Figs 17 & 27). Each lobe is elongated, with rounded apices and similar to that of *F. kozyavka* sp. n., but in *F. paucispina* the lobes are much wider, with not so deep incision. The vesica bears very characteristic single, large, stout, claw-shaped basal cornutus.

Distribution. Peninsular Malaysia, Sumatra, Borneo (Holloway 1986: 73; 1990: 35).

Biology. The flight period falls in early February, April, and late September. The moths were taken in montane forests between altitudes of 900–1620 m.

Nomenclatorial notes. This taxon was elevated to species rank by Solovyev & Witt (2009).

Flavinarosa alius Solovyev & Witt, 2009 Figs 7, 8, 18, 28, 36

Flavinarosa alius Solovyev & Witt, 2009. Type-locality: "Vietnam, Prov. Nghe An, Distr. Que Phong, Ban Khom, 280 m, 19°40.5' N, 104°54.1' E. Holotype: ♂ (MWM) [examined].

Diagnosis. The male genitalia are similar to those of *F. luna* sp. n. by the juxta with large, slender and pointed dorsal spurs, but the juxta of *F. alius* is weakly divided on the lateral lobes, with an indistinct medial incision; each lobe has an arcuate upper margin (not sinuous); the spurs of the lobes are longer, with the length of 1/3 of juxtal height (Figs 18, 28).

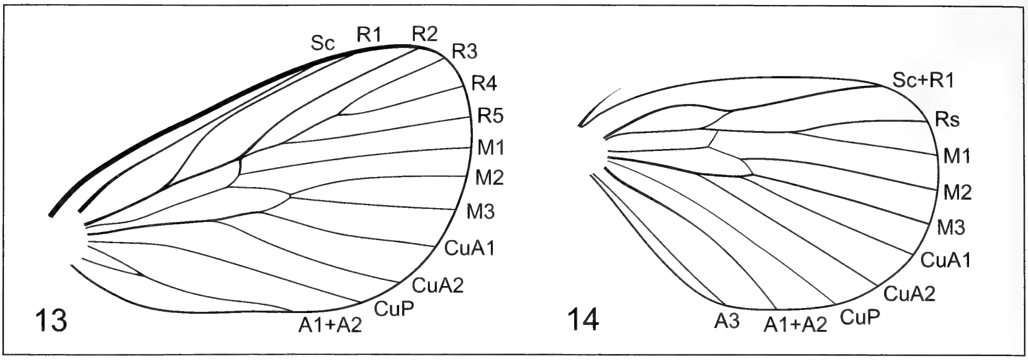
Distribution. Northern Vietnam.

Biology. The moths were collected in late January, April, mid May, and late November at altitudes of 280–1800 m.

Flavinarosa glaesa Solovyev & Witt, 2009 Figs 6, 19, 29

Flavinarosa glaesa Solovyev & Witt, 2009. Type-locality: "Sued-Vietnam, Bao Loc, Rung Cat Tien, 1500 m, 11.32'N 107.48'E". Holotype: ♂ (MWM) [examined].

Diagnosis. The species differs from all congeners by the semilunar wide medial incision of the juxta and by the shape of the juxtal lobes with an almost straight apical margin and with a distinct small spur on the inner margin (Figs 19, 29).



Figs 13–14. Wing venation of *Flavinarosa*. **13.** Forewing. **14.** Hindwing.

Distribution. Vietnam.

Biology. The flight period falls in late April – early May, August, and mid December. The species is known from altitudes of 900–1500 m.

Flavinarosa luna sp. n. **Figs 9, 20, 30**

Material. Holotype ♂, "[**China**] Kuatun (2300) 27.40 n. Br. | 117.408.ö.L. J. Klapperich | 10.6.1946 <"46" stamped on 1938> (Fukien)", ZFMK. – Paratypes: 1♂, **China**, same data as holotype, ZFMK; 2♂, same data but 1.vi.1938, MWM (genital slide 13809); 1♂, Kuatun, Prov. Fukien, Höne, 26.v.1939, ZFMK; 1♂, WuyShan, Jiangxi – Fujian border, 50 km SE of Yingtan, 27°56'N, 117°25'E, 1600 m, v.2002, leg. Siniaev & local coll., MWM (genital slide 13802); 1♂, Prov. Hunan, Hoengshan, 16.v.1933, Höne, ZFMK; 2♂, same data but 16.vii.1933, ZFMK; 1♀, same data but 21.vii.1933, ZFMK.

Description. Male (Fig. 9). Forewing length: 8–9 mm; wingspan: 17–18 mm. Filiform antennae as long as 2/3 of forewing costa. Otherwise identical to congeners externally.

Male genitalia (Figs 20, 30). Uncus slender, with long and pointed subapical spur and with pair of weakly sclerotized, horn-shaped, small, apical processes. Gnathos slender, curved up medially with concave distal part. Valvae elongated, with small sacculus and wide cucullus; with concave costa. Saccus distinct. Juxta flattened; lateral lobes separated by deep medial incision (of 3/5 of juxta length); each lobe almost parallel-sided, with sinuous apical margin and with large inner, as long as 1/5 rest of juxta, dorsal spur. Aedeagus weakly S-curved, narrowed apically, with finger-shaped apex. Vesica basally with two tufts of hair-like cornuti, medially with row of cornuti decreasing in size, and apically with two large cornuti.

Diagnosis. The species is easily distinguished from the congeners by the shape of the juxta. It is similar to that of *F. holoxanthia*, but the juxtal lobes are almost parallel-sided in *luna* sp. n., and their inner spur is larger. From *F. alius* the new species is separated by the deeper medial incision in the juxta and by the sinuous apical margin of the juxtal lobes.

Distribution. Eastern China: Fujian, Hunan.

Biology. The moths were collected from May to mid July at altitudes of 1600–2300 m.

Etymology. "*Luna*" means "moon" in Latin. Luna was the Roman goddess of the moon, frequently depicted driving a white chariot through the night sky.

Flavinarosa acantha sp. n. Figs 10, 23, 31

Material. Holotype ♂, "**China** | Hainan Dao | He Ling Mts. Und | Wuzhi Shan | 1000–1800 m | E.II.–E.V.2000 Lf. | lg. J.L. Li, Slg. Maier | Museum Witt", MWM (genital slide 13829). – Paratypes: 2♂, **China**, Hainan Isl., Wuzhi-Shan Mts., 1500 m, 18°53'N, 109°43'E, 20.ii–10.iv.2001, leg. local collector, MWM (genital slide 13813).

Description. Male (Fig. 10). Forewing length 8 mm and wingspan 18 mm. Similar to congeners externally.

Male genitalia (Figs 23, 31). Uncus slender, with two small horn-like apical processes and large, slender, subapical spur. Gnathos slender, curved up medially. Valvae elongated, with concave costa and wide cucullus. Saccus rounded. Juxta flattened, with deep medial incision, as deep as 2/3 juxta length; each lateral lobe of juxta narrowed distally and pointed apically. Aedeagus slightly S-shaped. Vesica contains basally large tuft of robust cornuti and single cornutus, and medially dispersed row of cornuti of different size.

Female. Unknown.

Diagnosis. The male genitalia are similar to those of *F. kozyavka*, but the juxtal lateral lobes are narrow and pointed apically here, and the vesica bears basally a single tuft of robust cornuti and a separate single cornutus.

Distribution. Southern China: Hainan.

Biology. The moths were collected from late February to late May at altitudes of 1000–1800 m.

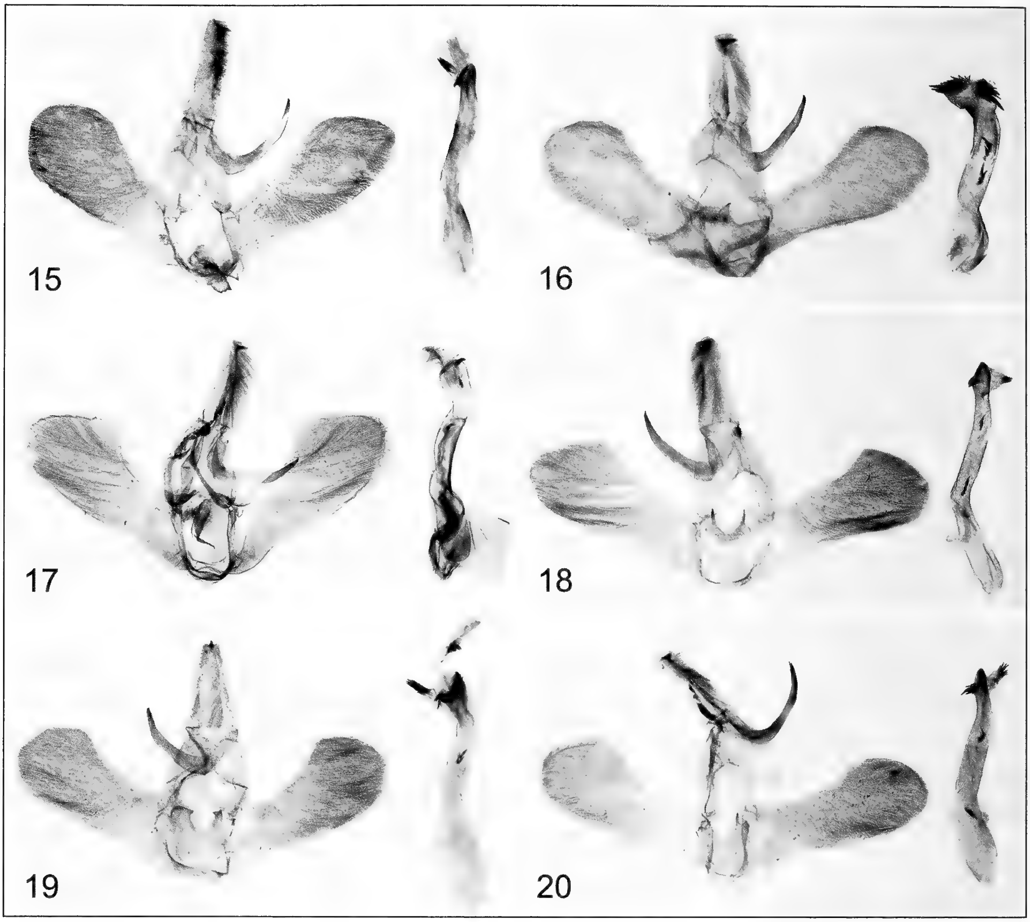
Etymology. "Acantha" is a Latinized form of Greek "Ακανθα", which means „thorn, prickle", because of the shape of lateral parts of the juxta.

Flavinarosa kozyavka sp. n. Figs 11, 21, 22, 32

Material. Holotype ♂, "**Thailand** | Changwat Mae Hong Song | 10 km NE of Pai | 1560 m, 28.I.1999 | leg. A. Szabó & Z. Czere", MWM (genital slide 13820). – Paratypes: 1♂, **Thailand**, Changwat Phayao, 15 km SE Chiang Muan, 640 m, 26.xi.1998, leg. Tibor Csövári & László Mikus, MWM (genital slide 13729); 1♂, Changwat Nan, 5 km N of Bo Luang, 1000 m, 4.ii.2000, leg. Hreblay & Szabó, MWM (genital slide 13816); 1♂, Changwat Chiang Mai, 20 km NW of Mae Ai, 1650 m, 9.ix.1999 leg. A. Szabó & Z. Czere, MWM (genital slide 13817); 1♂, Changwat Mae Hong Song, 10 km NE of Pai, 1560 m, 3.xii.1998, leg. M. Hreblay, Y. Sherpa & I. Soós, MWM (genital slide 13818); 2♂, Changwat Chiang Mai, 4 km SE of Pang Faen, 1100 m, 14.xi.1999, leg. Márton Hreblay, MWM (genital slides 13819, 13822); 1♂, Changwat Chiang Mai, 7 km W of Pa Pae, 1230 m, 27.xi.1998, leg. Tibor Csôvári & László Mikus, MWM (genital slide 13821); 3♂, Chiang Mai, between Fang and Nor Lae, 1600 m, 20°02'N, 99°06'E, 28.x.2002, leg. B. Herczig & G. Ronkay, MWM (genital slide 13800); 1♂, as previous but 7.xi.2002, MWM (genital slide 13815); 1♂, Chiang Mai, Queen Sirikit Botanical Garden, km 12, Mae Rim-Sameong Rd., 715 m, 18°52.855'N, 98°51.743'E, at MV light, 19.vii.2006, leg. G. Martin, BMNH (genital slide 1429).

Description. Male (Fig. 11). Forewing length 7–9 mm and wingspan 17–19 mm. Filiform antennae as long as 2/3 of forewing costa. Externally similar to other congeners.

Male genitalia (Figs 21, 22, 32). Uncus slender, with two apical, horn-like, small processes and large, slender subapical spur. Gnathos slender, curved up medially, concave distally. Valvae elongated, with small sacculus and wide cucullus; costa concave. Saccus rounded. Juxta has two lateral lobes divided by deep incision running to 3/5



Figs 15–20. Male genitalia of *Flavinarosa* spp. **15.** *F. holoxanthia* (Hampson, 1900), north-eastern India (slide MWM 11327). **16.** *F. obscura* (Wileman, 1915), Taiwan (slide MWM 13803). **17.** *F. paucispina* Holloway, 1986, holotype (slide BM-Limac 392). **18.** *F. alius* Solovyev & Witt, 2009, holotype (slide MWM 13836). **19.** *F. glaesa* Solovyev & Witt, 2009, holotype (slide MWM 13801). **20.** *F. luna* sp. n., paratype, China: Fujian (slide MWM 13802).

length of juxta; each lobe elongated, parallel-sided, rounded apically. Aedeagus slender S-shaped; vesica contains basal two tufts of long, hair-like cornuti, medial row of few small cornuti and apical tuft of small cornuti.

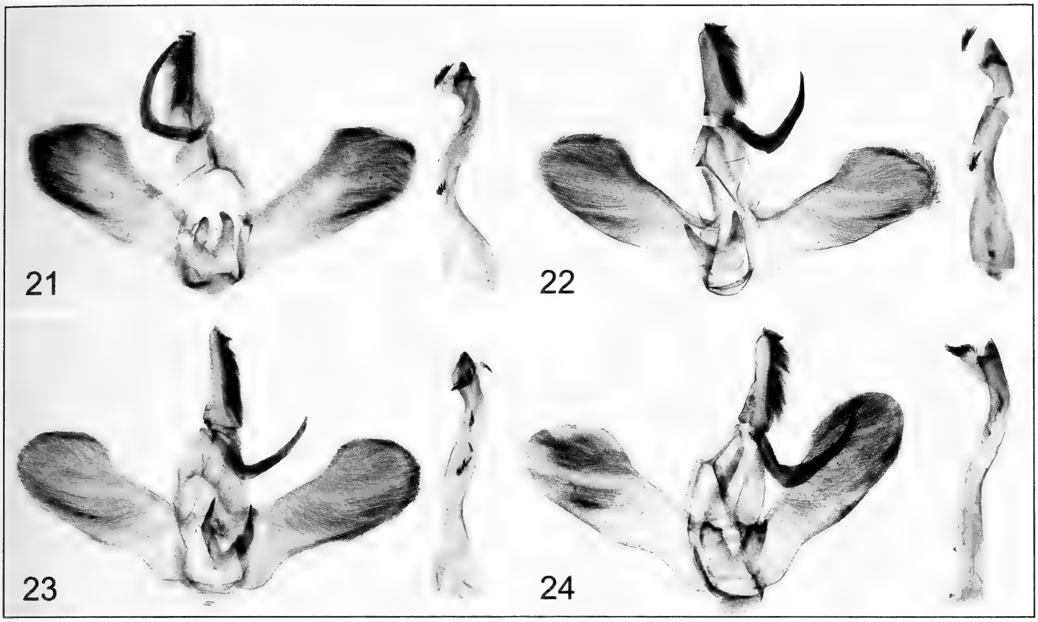
Female. Unknown.

Diagnosis. The species is similar to *F. paucispina* in male genitalia but the lateral lobes of the juxta are much narrower in *F. kozyavka* and the vesica bears basally two tufts of large cornuti instead of a single stout basal cornutus in *F. paucispina*.

Distribution. Northern Thailand: Chiang Mai, Phayao, Nan.

Biology. The moths were collected late January – early February, mid July, early September, and late October – early December at altitudes of 640–1650 m. Several generations per year.

Etymology. "Kozyavka" means any small insect in Russian.



Figs 21–24. Male genitalia of *Flavinarosa* spp. **21.** *F. kozyavka* sp. n., holotype. **22.** *F. kozyavka* sp. n., paratype, BMNH (slide BM-Limac 1429). **23.** *F. acantha* sp. n., holotype. **24.** *F. ptaha* sp. n., holotype.

Flavinarosa ptaha sp. n. Figs 12, 24, 33

Material. Holotype ♂, "**China** | Prov. Sichuan | Siguliang Shan | Volong Reserve | 31'09" N 103'20" E | Juli 2005 leg. | team of V. Siniaev, Museum Witt", MWM (genital slide 13834). – Paratype: 1♂, **China**, Sichuan, env. Baoxing, 1600 m, 11.vii.2003, leg. S. Murzin, MWM (genital slide 13814).

Description. Male (Fig. 12). Forewing length 9–10 mm and wingspan 18–19 mm. Species not separated externally from other congeners which described in the generic account.

Male genitalia (Figs 24, 33). Uncus narrow, with long subapical spur and two small horn-like apical processes. Gnathos curved up medially, concave distally. Valvae elongated, with concave costa and wide cucullus. Juxta divided by incision running to its half on two lateral lobes. These lobes parallel-sided, with almost straight apical margin, without distinct processes. Saccus wide, ovoid. Aedeagus slightly S-curved. Vesica with two basal tufts of large cornuti and medial row of unequal in size, dispersed cornuti.

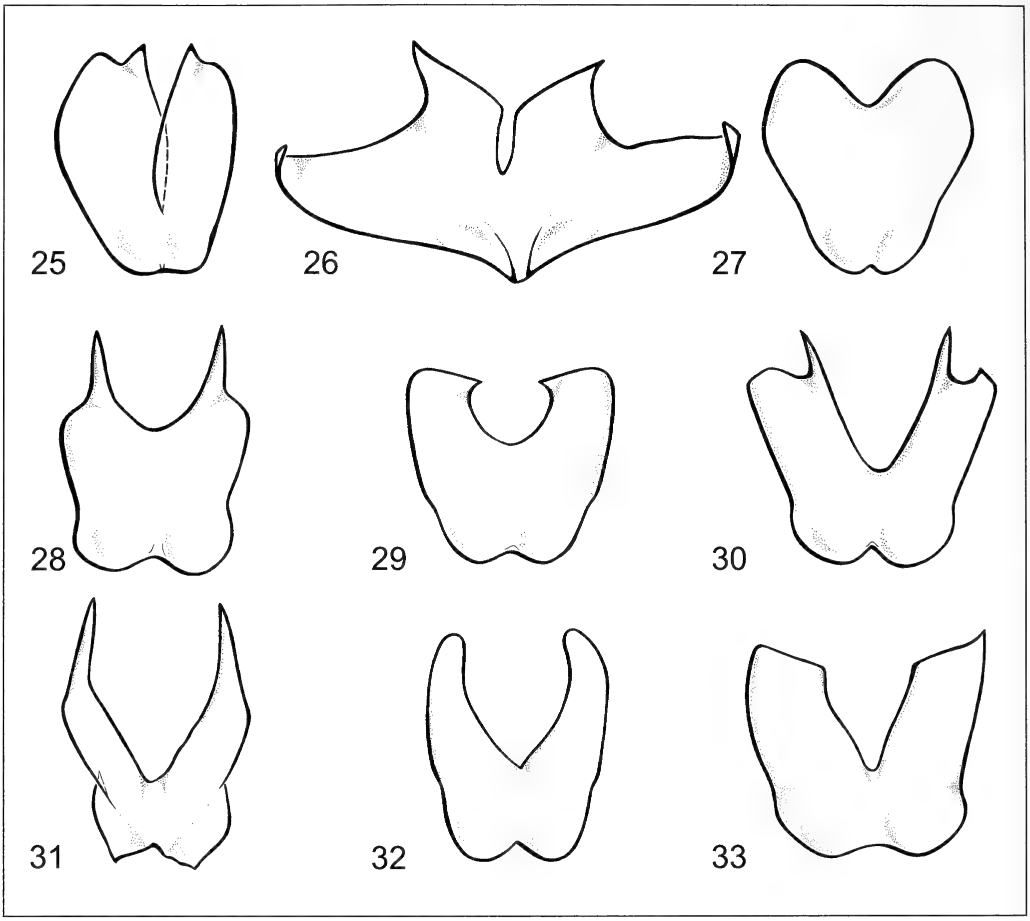
Female. Unknown.

Diagnosis. The male genitalia are similar to those of *F. luna* sp. n. but the lobes of the juxta of *F. ptaha* sp. n. lack dorsal spurs and have an almost straight apical margin, and the vesica is without large apical cornuti.

Distribution. South-western China: Sichuan.

Biology. The flight period falls in July. The moths were collected at an altitude of 1600 m.

Etymology. The species name derives from "Ptah", an Egyptian god associated with creation and the arts.



Figs 25–33. Juxta of *Flavinarosa* spp. **25.** *F. holoxanthia* (Hampson, 1900). **26.** *F. obscura* (Wileman, 1915). **27.** *F. paucispina* Holloway, 1986. **28.** *F. alius* Solovyev & Witt, 2009. **29.** *F. glaesa* Solovyev & Witt, 2009. **30.** *F. luna* sp. n. **31.** *F. acantha* sp. n. **32.** *F. kozyavka* sp. n. **33.** *F. ptaha* sp. n.

Key to species based on male genitalia

1. Vesica with single, large, claw-shaped basal cornutus as long as 2/3 width of aedeagus (Fig. 17) .... ***paucispina***

– Vesica with basal tuft (-s) of cornuti sometimes with additional separate single cornutus **2**

2. Lateral lobes of juxta gradually narrowed distally **3**

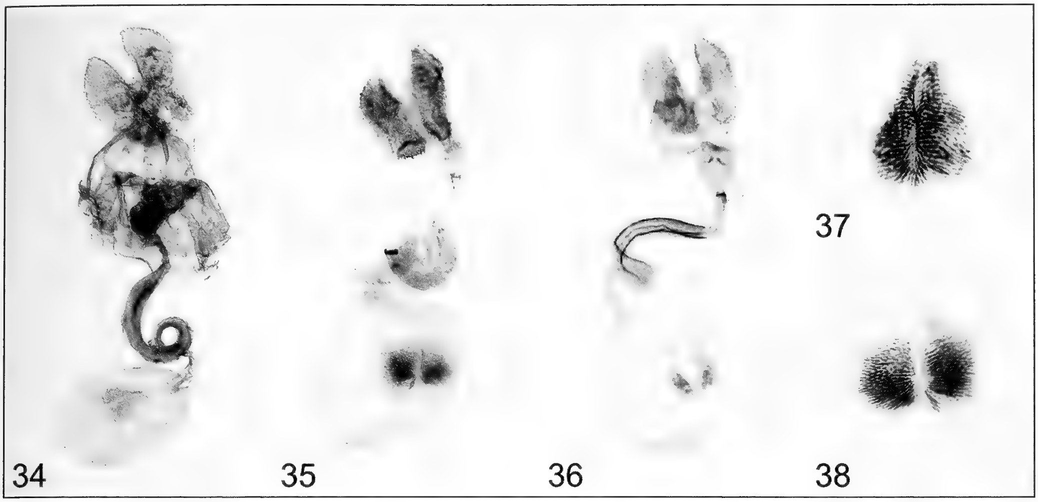
– Lateral lobes of juxta of different shapes but not narrowed distally **4**

3. Lateral parts of juxta pointed apically (Fig. 31). Vesica basally with single tuft of large cornuti and separate single large cornutus (Fig. 23). China: Hainan .... ***acantha*** sp. n.

– Lateral parts of juxta rounded apically (Fig. 32). Vesica basally with two tufts of large cornuti (Figs 21, 22) .... ***kozyavka*** sp. n.

4. Lateral parts of juxta prominent, wide and triangular; width of juxta greater than its height (Figs 16, 26) .... ***obscura***

– Lateral parts of juxta not prominent; the width of juxta is smaller than its height. Not insular species **5**



Figs 34–38. Female genitalia of *Flavinarosa* spp. **34.** *F. holoxanthia* (Hampson, 1900), Khasis, BMNH (slide 630). **35.** *F. paucispina* Holloway, 1986, Borneo, MWM (slide 11337). **36.** *F. alius* Solovyev & Witt, 2009, paratype, MWM (slide 13833; photo: V. Zolotuhin). **37.** Signum in corpus bursae of *F. holoxanthia* (Hampson, 1900), Khasis, BMNH (slide 630). **38.** Signum in corpus bursae of *F. paucispina* Holloway, 1986, Borneo, MWM (slide 11337).

5. Lateral parts of juxta with apical dorsad spur **6**
– Lateral parts of juxta without distinct apical dorsad spur **8**
6. Dorsal margin of juxtal lobes arcuate. Apical spur of juxta of 1/3 height of rest juxtal part (Figs 18, 28) .... ***alius***
– Dorsal margin of juxtal lobes waved or sinuous. Apical spur of juxta shorter **7**
7. Lateral lobes of juxta parallel-sided; apical spur as long as 1/5 juxta (Fig. 30). Vesica with 2 large apical cornuti (Fig. 20) .... ***luna*** sp. n.
– Lateral lobes of juxta not parallel-sided, ovoid; their apical spur smaller (Figs 15, 25) .... ***holoxanthia***
8. Lateral lobes of juxta with laterad spur on inner margin; medial incision rounded (Figs 19, 29) .... ***glaesa***
– Later lobes of juxta without any spur on inner margin; medial incision narrowed ventrally (Figs 24, 33) .... ***ptaha*** sp. n.

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Frogs eat butterflies: temporary prey-specialization on the Painted Lady butterfly, *Vanessa cardui*, by Sahara frog, *Pelophylax saharicus*, in the Moroccan Anti Atlas

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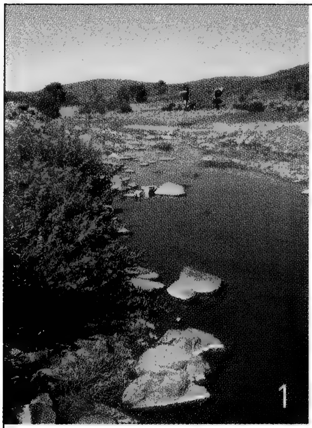
Abstract. Observations of predation of adult butterflies in the wild are normally very difficult to obtain. Although there is the popular belief that frogs are amongst the natural enemies of butterflies, empirical evidence for such a relationship is almost lacking. In this note we report various observations showing that this predator-prey interaction seems to occur on a regular basis between the Sahara frog, *Pelophylax saharicus*, and the Painted Lady, *Vanessa cardui*. Following seasonal increases in the local abundance of the Painted Lady in the Moroccan Anti Atlas, *P. saharicus* shows temporary prey-specialization on this migrant butterfly.

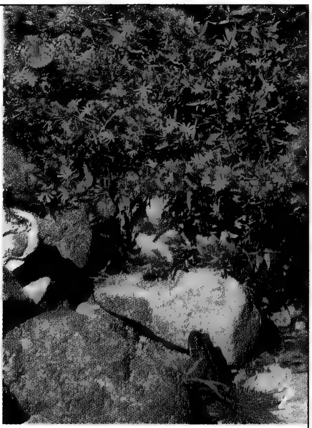
> "*Frogs Eat Butterflies. Snakes Eat Frogs. Hogs Eat Snakes. Men Eat Hogs*"
> Wallace Stevens (1879–1955)

Introduction

The title of a poem from Wallace Stevens's first book of poetry, *Harmonium* (1922), brings to our minds a frog extending its fleshy tongue or leaping with its mouth open in an attempt to catch a butterfly. Although this is a rather usual image in illustrated children's books showing animal interactions (see, for example, *About Flies and Elephants*, Lemniscat, Rotterdam, 1994, where a Marsh frog is trying to catch a Red Admiral), one may ask if there is indeed any empirical evidence that frogs eat butterflies. So far, we have only found an old report of American Bullfrogs, *Rana catesbeiana* (Shaw), catching and eating a dozen large yellow and black swallowtails (probably *Papilio glaucus* L.) mud-puddling on a pool's banks in North Hampshire (Mavourneen 1916). The author vividly described how four big Bullfrogs came out of the water and approached the butterflies "in the stealthy manner of a cat stalking a mouse", crawling on all four legs, sometimes advancing rapidly and sometimes stopping short until the butterflies were within a foot. Then the frog would jump upon the butterfly, catch it in its mouth, and immediately swallow it whole. This process was repeated until all but one butterfly had been captured, with one frog having eaten at least five butterflies.

During two expeditions to Morocco in 2003 and 2009, we were able to record this kind of interaction again, this time between Sahara frogs *Pelophylax saharicus* (Boulenger *in* Hartert, 1913) and *Vanessa cardui* (L., 1758). Far from being an exceptional phenomenon, it seems to represent a particular, but regular, case of temporary prey-specialization following seasonal increases in the local abundance of this migrant butterfly.





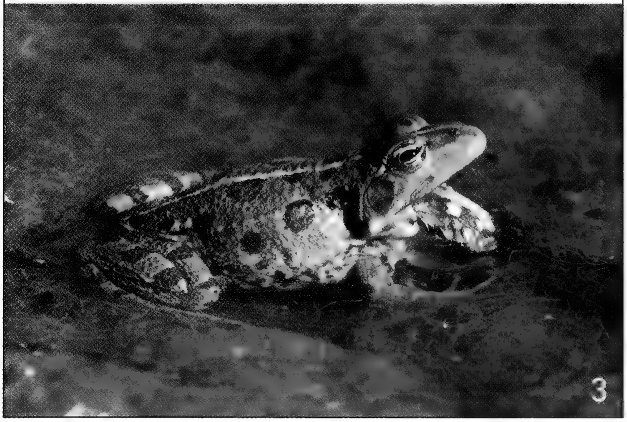


Fig. 1. The creek near Ouarzazate where most of the observations of Sahara frogs, *Pelophylax saharicus*, catching Painted Ladies, *Vanessa cardui*, were made.
Fig. 2. A frog in ambush, before trying to catch a Painted Lady nectaring on *Dittrichia viscosa*.
Fig. 3. A frog returning to the water after having caugth a Painted Lady.
(photo credits: 1–2. C. Stefanescu; 3. T. Webb).

Field observations

The expeditions were mainly focused around the Jbel Sarhro (the region in the Anti Atlas lying between Ouarzazate, Agdz and Boumaine-du-Dades) in the second fortnight of October, that is, in a period when *V. cardui* engages in southward migration from the European continent and arrives in North Africa for autumn breeding (pers. obs.). Population levels of *V. cardui* across Europe had been very high in spring and summer in both 2003 and, especially, in 2009 (e.g. Stefanescu et al. 2007, submitted; Fox in press), for which reason the butterfly was incredibly common in central Morocco by the time the expeditions took place.

The first records were obtained in a visit to Tizgui waterfalls, not far from Agdz (N 30° 46' 34.38", W 6° 31' 44.41"), on 19 October 2003. Painted Ladies were congregating in great numbers on the brook banks, for mud-puddling (a common behaviour in Morocco, under hot and dry weather). For a period of about two hours around noon, we observed numerous frogs from the dense population occurring in the area trying to capture the butterflies. The typical behavioural sequence comprised the detection of a Painted Lady shortly after landing while the frog was still in the water, a change in the frog's body direction orientating directly towards the butterfly, a rapid approach through the water and, once out, the characteristic stalking approach until the butterfly was within

Figs 4–5. Two sequences of a Sahara frog engulfing a Painted Lady, after a successful attac.
(photo credits: 4–5. G. Hatherley).

leaping reach, exactly as described by Mavourneen (1916). However, contrary to that earlier report, not a single attack ended successfully: all Painted Ladies escaped in the very last moment, thus avoiding the hopping frogs. On several occasions, we even saw how a single butterfly was simultaneously detected by two or three frogs, which truly competed for the potential prey causing it to flee.

The second set of observations was made around noon on 24 October 2009, along a creek by the road going from Ouarzazate to Agdz (N 30° 49' 59.70", W 6° 47' 1.90"). While taking pictures of a vast concentration of Painted Ladies nectaring on various bushes of *Dittrichia viscosa* (L.) W. Greuter growing on the shores of the stream (Fig. 1), we realized that dozens of frogs were hidden among rocks under most of the plants, waiting in ambush for the butterflies (Fig. 2). We soon spotted the first of ca. 10 successful attacks, which invariably followed the same sequence: when a Painted Lady landed on a near flower, the frog would creep slowly closer, rotate the body towards the butterfly, stretch the front legs to raise the body and, once within striking distance, eventually lunge towards the prey with its mouth open. In approximately one out of three trials, the attack ended successfully, with the frog immediately engulfing the butterfly; in a few cases, it took a while before the butterfly was completely swallowed up, its wing tips protruding from the frog's mouth for a few seconds (Figs 3–5). As previously recorded, it was not rare to see several frogs competing for the same butterfly, especially under some isolated plants where up to four or five frogs congregated.

The third and last observations were obtained on the river banks near Tassetifte, south of Tazenakht (N 30° 22' 37.40", W 6° 52' 8.30"), on 26 October 2009. Once again, around noon, we saw numerous Painted Ladies coming to the shores for mud-puddling, and the local population of frogs trying to capture them in the way described by Mavourneen (1916). On that occasion, we only recorded a single successful attack among a dozen failures.

Discussion

Our observations showed a remarkable coincidence in timing and spatial location. This leads us to suggest that the predator-prey interaction between Sahara frogs and Painted Ladies is not a casual one but occurs on a regular basis in those areas of the Anti Atlas that are seasonally colonized by *V. cardui*. Following mass migration (as in 2003 and 2009), the butterfly can reach extremely high population levels and becomes a major feeding resource for the Sahara frog and other opportunistic predators. For instance, it seems beyond doubt that, at least in October 2009, the diet of the frogs in the creek near Ouarzazate mainly consisted of Painted Ladies effectively captured through a well developed ambush behaviour. A similar situation is to be expected in similar habitats, perhaps throughout all the Maghreb region, where *P. saharicus* is the most common amphibian species (IUCN 2009). On the other hand, the hunting strategy did not work so well on bare ground along river banks, where Painted Ladies are used to congregating for mud-puddling. Without the camouflage provided by the vegetation, the frogs were normally detected by the butterflies, allowing the butterflies to escape from the attacks. However, it is possible that this same behaviour is still effective for other slower butterfly species, as for example the Swallowtails reported by Mavourneen (1916).

Interestingly, opportunistic feeding specialization on migrant butterflies had been recorded previously, but always involving some bird species taking advantage of massive concentrations or predictable movements of migrants. Larsen (1992) described such a situation for a group of Bluecheeked Bee-eaters, *Merops persicus* (Pallas), specializing in *Catopsilia florella* (F.) in Botswana. As for the Painted Lady, Larsen (1989) and Stefanescu & Julià (2002) reported various observations of insectivorous birds (e.g. Spotted Flycatcher *Muscicapa striata* (Pallas) and European Bee-eater *Merops apiaster* (L.)) preying upon spring migrants. A further example of opportunistic behaviour by insectivorous birds was recorded in Morocco in October 2009, when different bird species were often seen patrolling along road banks in search of Painted Ladies recently killed by the cars (C. Stefanescu & F. Páramo, in prep.).

Our field observations indicate that opportunistic feeding specialization on an abundant butterfly species also occurs in the Sahara frog and, perhaps, in other frogs showing similar feeding behaviour. In this respect, the closely related Perez's frog, *Pelophylax perezi* (Seoane), and Marsh frog, *Pelophylax ridibundus* (Pallas), are highly generalist predators that include unidentified Lepidoptera in their diet, specialize in temporary abundant prey, and use a sit-and-wait strategy similar to that described in this paper (e.g. García París et al. 2004; Balint Szeibel et al. 2008). In conclusion, although difficult to observe, there are good reasons to believe that, indeed, frogs eat butterflies.

Acknowledgements

We are extremely grateful to the BBC Natural History Unit crew (Theo Webb, Victoria Bromley, Graham Hatherley and Simon Bell), who took part in the 2009 expedition and kindly allowed us to use and reproduce their excellent photographic material. Some of the sequences of frogs catching Painted Ladies will appear in the BBC documentary "Butterflies, a very British obsession", to be released in the UK by late 2010. Marta Miralles shared our observations in 2003. Salvador Carranza helped in the bibliographical search and kindly commented on the manuscript. Jordan Jarrett revised the English version.

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Recent geographic range expansion of *Brephidium exilis* (Boisduval, 1852) (Lycaenidae) in Oman, Arabian Peninsula

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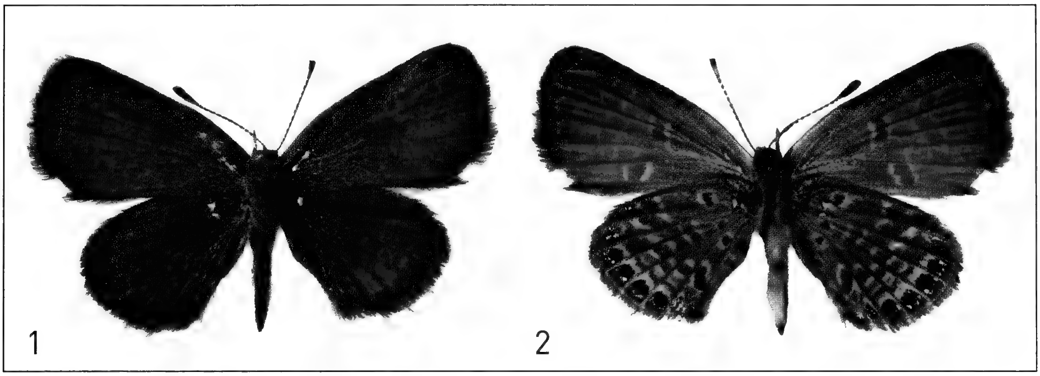

Figs 1, 2. *Brephidium exilis* (Boisduval), 27 November 2008, Qurm, Oman. **1.** recto. **2.** verso.

On 27 November 2008 I caught one specimen of a tiny lycaenid butterfly (wingspan 16 mm, Figs 1, 2) at Qurm, a little settlement west of Muscat, the capital of Oman. The insect was flying over a more or less disturbed and untidy roadside. The species could not be identified with the existing works on Arabian butterflies (Larsen & Larsen 1980; Pittaway 1985). But many butterfly species in the Arabian Peninsula are of Afrotropical origin (Larsen & Larsen 1980; Larsen 1984). The next step was searching recent literature on African butterflies (Larsen 1996, 2005) without result. In Penninton's Butterflies (Dickson 1978), I found at last the genus *Brephidium* with the species *metophis* Wallengren, 1860, an endemic and very small lycaenid from South Africa, whose appearance was very similar to my Oman butterfly. However, it was not the same species!

A search on the internet showed that genus *Brephidium* also occurs in North America, where it is represented by several species. Comparison with existing photos on the site 'Butterflies of America' (Warren et al. 2009) identified my Oman lycaenid as the Western Pygmy Blue *Brephidium exilis* (Boisduval, 1852). To confirm my diagnosis, I sent photographs to Andrew D. Warren, one of the authors of this site. His answer was very clear: "Yes, you do appear to have *Brephidium exilis*". He also kindly drew my attention to a paper dealing with this species in the Emirates (Larsen 2000).

Torben Larsen sent me an exellent paper by Pittaway et al. (2006), where one record of *Brephidium exilis* was published from the extreme north of Oman: Buraimi & Mahdah. In the same paper a survey is given on the distribution of this lycaenid in the Arabian Peninsula, where it has been found in Saudi Arabia, United Arab Emirates, and Oman.

It is suggested that the butterfly was accidently introduced during the early 1990s through the import of North American halophytes (Pittaway et al. 2006).

My record suggests the species is still extending its range in Oman since Qurm is situated much further south than Buraimi (near Al Ain). It will be very interesting to follow this tiny species in its efforts to occupy other suitable habitats.

Fig. 3. Map of Oman with the two localities of *Brephidium exilis* (Boisduval).

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New and little-known Ethmiidae (Gelechioidea) from Central Asia

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Abstract. Three new species of Ethmiidae are described from Central Asia: *Ethmia falkovitshi* **sp. n.** (type locality: Western Kazakhstan, Mangistau Region, N 43°44'04" E 53°37'17", in coll. ZISP), *E. nykta* **sp. n.** (type locality: Southwest China, Sichuan, Chang Jiang river basin, environs Bana-Dzhun, in coll. ZISP), and *E. albolinella* **sp. n.** (type locality: Southwest China, Sichuan, Chang Jiang river basin, environs Bana-Dzhun, in coll. ZISP). Images of the adults and genitalia structures of type specimens of the little-known *E. vidua flavilaterella* Danilevsky, 1975, *E. soljanikovi* Danilevsky & Zaguljaev, 1975, *E. sibirica* Danilevsky, 1975, *E. ubsensis* Zagulajev, 1975, *E. elimatella* Danilevsky, 1975, *Dasyethmia hiemalis* Danilevsky, 1969, and *E. zaguljaevi* Kostjuk, 1980 are given. The previously unknown females of *E. elimatella* Danilevsky, 1975 and *E. turkmeniella* Dubatolov & Ustjuzhanin, 1998 are described. The species *E. turkmeniella* Dubatolov & Ustjuzhanin, 1998, originally described from Turkmenistan, is found in Kalmyk Republic and is therefore new for Russia and Europe.

Резюме. Из Средней Азии описаны три новых вида этмий: *Ethmia falkovitshi* **sp. n.** (типовая местность: Western Kazakhstan, Mangistau Region, N 43°44'04" E 53°37'17" в колл. ЗИН РАН), *E. nykta* **sp. n.** (типовая местность: Southwest China, Sichuan, Chang Jiang river basin, environs Bana-Dzhun, в колл. ЗИН РАН), и *E. albolinella* **sp. n.** (типовая местность: Southwest China, Sichuan, Chang Jiang river basin, environs Bana-Dzhun, в колл. ЗИН РАН). Для малоизвестных: *E. vidua flavilaterella* Danilevsky, 1975; *E. soljanikovi* Danilevsky & Zaguljaev, 1975; *E. sibirica* Danilevsky, 1975; *E. ubsensis* Zagulajev, 1975; *E. elimatella* Danilevsky, 1975; *Dasyethmia hiemalis* Danilevsky, 1969; and *E. zaguljaevi* Kostjuk, 1980 приведены изображения типовых экземпляров и структур гениталий самцов. Описаны ранее неизвестные самки для *E. elimatella* Danilevsky 1975, and *E. turkmeniella* Dubatolov & Ustjuzhanin 1998. Известная ранее только из Туркмении *E. turkmeniella* Dubatolov & Ustjuzhanin, 1998 найдена в республике Калмыкия и является новой для России и Европы.

Introduction

In May 2007, on the Southern Ustyurt (Western Kazakhstan) I collected an unknown *Ethmia* species (Fig. 1). The species belongs to the *distigmatella* group and is new to science. A long series of the same moth from Uzbekistan, collected mainly by M. I. Falkovitch, was assembled during work with the collection of the Zoological Institute of the Russian Academy of Sciences (ZISP) (St. Petersburg, Russia). An examination of ethmiids of Central Asia in ZISP revealed two more unknown species. One of them belongs to the *pyrausta* species group (Fig. 2), another to the *nigripedella* species group (Fig. 3). These moths were collected by P. K. Kozlov in China (Sichuan Province of Southwest China, Chang Jiang river basin) in 1901 during an expedition of the Imperial Russian Geographical Society.

Many Ethmiidae kept in the collection of ZISP are still little known. They were described in Russian after the publication of Sattler's outstanding work (Sattler 1967) but access to literature and specimens remains difficult for non-Russian scientists. Eight new taxa from the Asian part of Russia and neighboring territories were described in the following thirty years after Sattler's monograph. In 1969, the remarkable

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winter-flying *Dasyethmia hiemalis* was described by Danilevsky from the deserts of Kazakhstan. In 1975, he described two more new taxa: *Ethmia elimatella* Danilevsky from Ordubad, Azerbaijan, and *Ethmia vidua flavilaterella* Danilevsky – the central Siberia. Three more species were described in 1975 by Zaguljaev and Danilevsky from Mongolia: *E. soljanikovi* Danilevsky & Zaguljaev, *E. sibirica* Danilevsky, 1975 and *E. ubsensis* Zagulajev, 1975. In 1980, Kuznetsov edited the paper "A key to Ethmiidae of the European part of USSR" by the late Danilevsky where he systematized all known data on the Ethmiidae. The same year, Kostjuk described *E. zaguljaevi* from the Altai Republic. In 1997, *E. sibirica, E. ubsensis*, *E. soljanikovi, E. vidua flavilaterella* were mentioned by Sinev in a work devoted to the Ethmiidae of the Far East of Russia. The same year Dubatolov, Ustjuzhanin & Zintshenko (1997) published a review of the Ethmiidae from the Asian part of Russia and neighboring territories, omitting *Ethmia elimatella* and *Dasyethmia hiemalis*, but a distribution of *E. sibirica* was provided with new data. In 1998, Dubatolov & Ustjuzhanin described *Ethmia turkmeniella* from the SW Kopet-Dagh Mts (Turkmenistan). In 2007, Wei, Kun & Yen wrote that all of the taxa listed above were considered as separate species, but had not been assigned to any of the species groups proposed by previous authors. Also in 2007, *E. elimatella* was mentioned by Kun in his "Studies on Palaearctic *Ethmia* Hb."

There remain some little-known ethmiids from Central Asia (mainly described from China). Unfortunately I did not have the opportunity to investigate these additional species, and so this manuscript only includes the Ethmiidae described in the Russian literature or kept in the collections of Russian museums.

None of these taxa described in the Russian literature have ever been illustrated in colour. Besides, practically all original descriptions are in Russian and therefore difficult to access. The situation becomes more complicated because these descriptions were often based on single specimens and additional material was absent from the museums visited. The aim of this paper is to provide information on the systematics and distribution of these taxa. Re-descriptions of these rare species are given, and illustrated by images of type specimens, based on the examination of type material and additional data on distribution found by myself or cited in local papers.

Abbreviations

LSSU	Laboratory of Animal Systematics and Faunistics, Samara State University (Samara, Russia)
CDSS	Collection of Dmitry Shovkoon, Samara
LNK	Landessammlung für Naturkunde, Karlsruhe (Germany)
SZMN	Siberian Zoological Museum, Institute of Animal Systematic and Ecology, Siberian Division of Russian Academy of Sciences (Novosibirsk, Russia)
ZISP	Zoological Institute of Russian Academy of Sciences (St. Petersburg, Russia)
ZMKU	Kiev University Zoological Museum (Ukraine)

Ethmia turkmeniella Dubatolov & Ustjuzhanin, 1998 (Figs 8, 15)

Ethmia turkmeniella Dubatolov & Ustjuzhanin, 1998, Nota Lepidopterologica 21(2): 101, Figs 1, 2. Type locality: "SW Turkmenistan, SW Kopet-Dag Mts., Kara-Kala". Holotype: male (SZMN) [not examined].

References: Dubatolov & Ustjuzhanin (1998: 101) (*Ethmia*).

Material. 21♂, 2♀, **Turkmenistan**, Repetek southeastern Kara-Kum, 08.v.1981 leg. Falkovitsh (ZISP); 1♂ Turkmenistan, Repetek southeastern Kara-Kum, 06.vi.1981 leg. Falkovitsh (ZISP); 2♂, Turkmenistan, Repetek, 19.v.1981 leg. Krivohatskiy (ZISP); 3♂, Turkmenistan, Amudarja river, Kerki, 18.v.1934, leg. Lupova (ZISP); 1♀, **Uzbekistan**, Kyzyl-Kum desert, tract Zhamansay, 26.v.1975, leg. Falkovitsh (ZISP); 5♂, Uzbekistan, 40 km westward from Bukhara, 15.v.1966, leg. Pastuchov (ZISP); 1♂, Uzbekistan, Kyzyl-Kum desert, tract Zhamansay, 26.v.1975, leg. Falkovitsh (ZISP); 1♂, Uzbekistan, Kyzyl-Kum desert, tract Zhamansay, 30.v.1972 - larva on *Heliotropium* sp., 15.vi.1972 – pupa, 27.vi.1972 – imago, leg. Falkovitsh (ZISP); 1♂, Uzbekistan, Kyzyl-Kum desert, tract Zhamansay, leg. Falkovitsh. 30.v.1972 – larva on *Heliotropium* sp., 14.vi.1972 – pupa, 26.vi.1972 – imago (ZISP); 2♂, Uzbekistan, Bokharan region Shafrikan, 04.ix.1971, leg. Falkovitsh; 1♀, Left coast of the Volga river, by Chagan-Aman, Justinsky area, Kalmykia, **Russia** 31.vii.2007. leg. O. Saranova (LSSU).

Note. *Ethmia turkmeniella* Dubatolov et Ustjuzhanin, 1998 was described from SW Turkmenistan, Kopet-Dag Mts, and SE Turkmenistan, Kuhitang Mts. It belongs to the *distigmatella* species group and is easily separated from the closely related species, *E. quadrinotella* (Mann, 1861). The species was described from seven male specimens deposited now in the collection of SZMN. The female of the species is so far unknown, and the moth was occasionally found in LSSU from Kalmyk Republic and identified from the characteristic set of spots on the forewing. The species is therefore recorded for the first time as part of the fauna of Europe and also of Russia. The occurrence of *E. turkmeniella* in the Lower Volga Region expands its distribution more than 800 km to the north. This very interesting finding from the Kalmyk Republic needs additional male material because it is possible that another [new] species, closely related to E. *turkmeniella,* is native to the region.

Female description (Fig. 15). Wingspan 16–18 mm (Moth from Kalmyk Republic, 17 mm). Head, thorax, tegulae and antennae covered with whitish scales; head bearing well developed frontal crest with sharp outer edge. Palpi white, long, first segment with dense brush of scales. Legs whitish-grey. Forewings whitish-grey, to some extent darker than hindwings; four contrasting grey spots arranged into two lengthwise rows and 6 or 7 black dots along outer margin; fringes of same colour as wing ground colour. Hindwing evenly white, slightly transparent, without spots.

Female genitalia (Fig. 8). Ovipositor conical, papillae anales rounded, setose. Posterior apophyses slender, slightly longer than papillae; apophyses anteriores very reduced. Ductus bursae very long, spiral, with 5 complete turns. Corpus bursae pyriform, rather large, with signum and loose-lying mass disc form, found in three of five females investigated. Signum covered with more or less uniform teeth, asymmetric, with big tooth in middle (Fig. 8c, d).

Diagnosis. The species belongs to the *distigmatella* species group. The moth differs from the similar *E. quadrinotella* (Mann, 1861) by the smaller size and more grey colouring of forewings, and in the different shape and structure of the gnathos of the male genitalia.

Distribution and life history. The moths inhabit desert and semi desert regions of the Uzbekistan, Kyzyl-Kum desert, Ayakgujumdy, Turkmenistan southeastern Kara-Kum (ZISP), and Russia, Kalmykia, in the Lower Volga Region. According to label data (Falkovitsh) *Heliotropium* sp. (Boraginaceae) is the host-plant of the caterpillars. The moths were collected flying from May to June (first generation) and September (second generation).

Ethmia falkovitshi sp. n. (Figs 1, 4, 7)

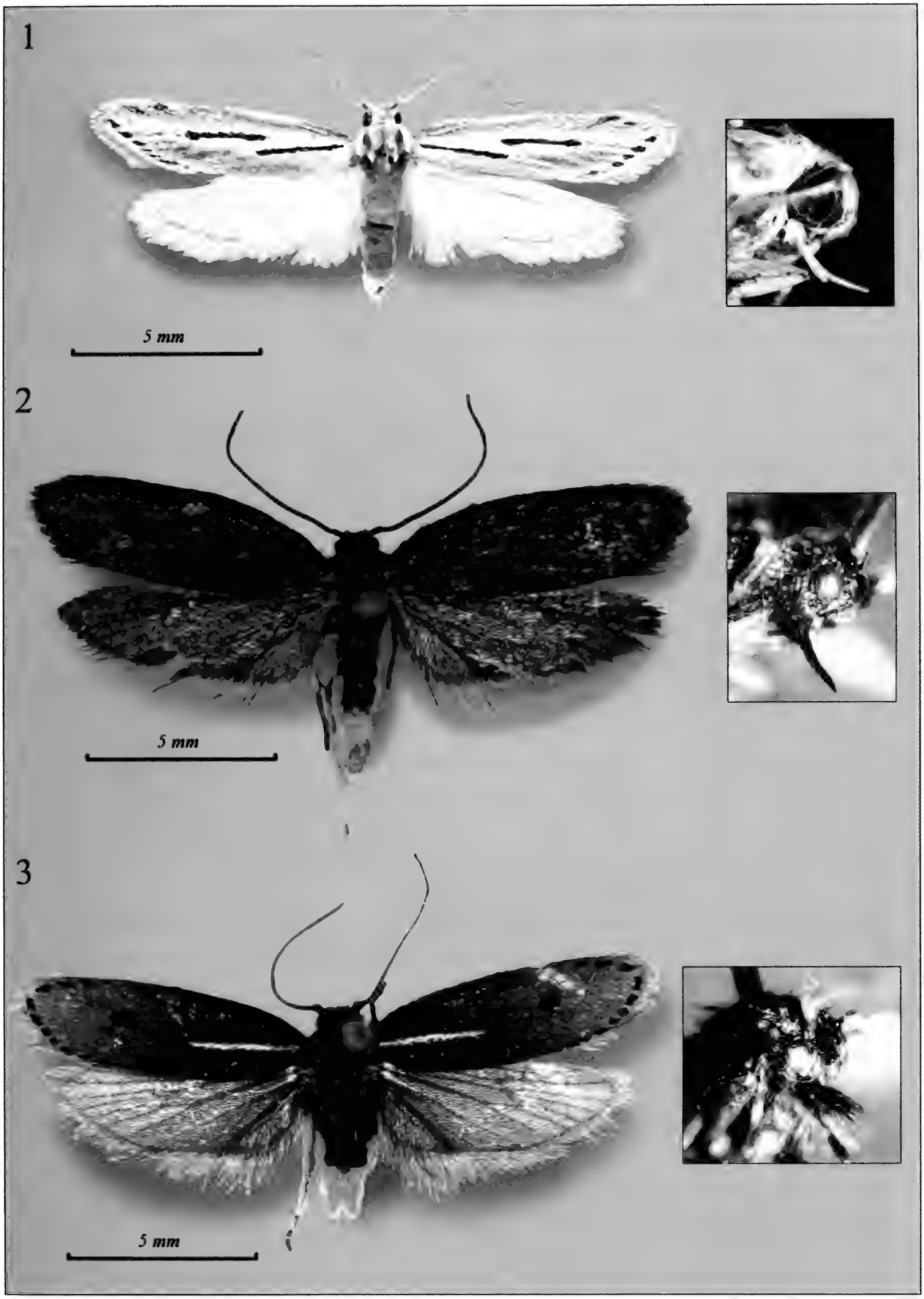
Material. Holotype ♂, '17.05.2007 **Kazakhstan**, | Mangistau Region, | N 43°44'04" E 53°37'17" | leg. Trofimova T.A. & Shovkoon D.F.' <white rectangle, printed in black ink >, 'HOLOTYPUS. | ♂ *Ethmia deserticolla* | Shovkoon | design. Shovkoon D. F. 2010' <red rectangle, printed in black ink> (ZISP). – Paratypes: 3♂, 3♀ same data as holotype (1♂, 1♀ in ZISP, 2♂ 1♀ in coll. WCA); 4♂, 16.05.2007 **Kazakhstan**, Mangistau Region, N 43°44'53" E 53°38'13", leg. Trofimova T.A. & Shovkoon D.F. (in coll. WCA); 2♂, 15.05.2007 Kazakhstan, Mangistau Region, N 43°57'39,9" E 53°45'48,0", leg. Trofimova T.A. & Shovkoon D.F. (in coll. WCA); 2♂, 18.05.2007 Kazakhstan, Mangistau Region, N 44°02'51,1" E 52°34'21,6", leg. Trofimova T.A. & Shovkoon D.F. (in coll. WCA); 1♂, 19.05.2007 Kazakhstan, Mangistau Region, N 44°04'55,3" E 52°23'15,6", leg. Trofimova T.A. & Shovkoon D.F. (in coll. WCA); 1♀, 70 км S Тамды-Булака пуст. Кызылкум Узб. Пастухов 1.v.965 [01.05.1965 **Uzbekistan**, Kyzyl-Kum desert, 70 km S Tamdi-Bylak, leg. Pastuhov] (ZISP); 1♀, Аякгужумды 40 км О Джинг. Кызылкум Узб. Фалькович 28.iv.65 [28.04.1965 Uzbekistan, Kyzyl-Kum desert, Ayakgujumdy, leg. Falkovitsh] (ZISP); 1♂, Аякгужумды 40 км О Джинг. Кызылкум Узб. Фалькович 29.iv.65 [29.04.1965 Uzbekistan, Kyzyl-Kum desert, Ayakgujumdy, leg. Falkovitsh] (ZISP);1♀, Аякгужумды 40 км О Джинг. Кызылкум Узб. Фалькович 28.iv.65 [28.04.1965 Uzbekistan, Kyzyl-Kum desert, Ayakgujumdy, leg. Falkovitsh] (ZISP); 1♀, Аякгужумды 40 км О Джинг. Кызылкум Узб. Фалькович 14.iv.66 [14.04.1966 Uzbekistan, Kyzyl-Kum desert, Ayakgujumdy, leg. Falkovitsh] (ZISP); 1♂, 1♀, 7 км N Тамды-Булака пуст. Кызылкум Узб. Фалькович 5.v.965 [05.05.1965 Uzbekistan, Kyzyl-Kum desert, 70 km S Tamdi-Bylak, leg. Falkovitsh] (ZISP); 1♂, уроч. Жамансай Кызылкум Узбек. Фалькович 12.v.966 [12.05.1966 Uzbekistan, Kyzyl-Kum desert, tract Zhamansay, leg. Falkovitsh] (ZISP); 1♂ Жамансай 140 км NW Шафрикана Узбек. Фалькович 10.v.969 [10.05.1969 Uzbekistan, Kyzyl-Kum desert, tract Zhamansay, leg. Falkovitsh] (ZISP); 1♂, уроч. Жамансай Кызылкум Узбек. Фалькович 26.v.975 [26.05.1975 Uzbekistan, Kyzyl-Kum desert, tract Zhamansay, leg. Falkovitsh] (ZISP); 1♂, 1♀, уроч. Жамансай Кызылкум Узбек. Фалькович 24.iv.976 [24.04.1976 Uzbekistan, Kyzyl-Kum desert, tract Zhamansay, leg. Falkovitsh] (ZISP); 1♀, уроч. Жамансай Кызылкум Узбек. Фалькович 29.iv.976 [29.04.1976 Uzbekistan, Kyzyl-Kum desert, tract Zhamansay, leg. Falkovitsh] (ZISP).

Description (Fig. 1). Wingspan 13–16 mm, in holotype 15 mm. Antenna filiform, white; flagellum white; maxillary palpus reduced. Labial palpus with white scales; base of proboscis with white scales; frons and tegulae similarly white. Costal half of forewing suffused with grey scales; basal half with two little lines, black marginal dots present, tiny; cilia pale grey. Hindwing pale grey, with white cilia; costal brushes absent. Legs pale grey. Abdomen and thorax with grayish scales. Wing venation (Fig. 4c) with forewing Sc vein set in middle costal border of wing; R_4 and R_5 on long stalk (1/2 general length of veins); R_4+R_5 connate or slightly stalked with M_2; M_2 slightly stalked with M_3. Hindwing: M_3 slightly stalked with Cu_1.

Male genitalia (Fig. 4a, b). Uncus developed, hood-like, apically bifurcated. Anellus sclerotized, with two dentate processes. Labis short, bristly. Valva elongate. Cucullus with thin appendix, covered scattered bristles.

Female genitalia (Fig. 7). Ovipositor conical, papillae anales rounded, setose. Posterior apophyses slender, as long as papillae; apophyses anteriores absent. Ductus bursae very long, spiral, with 6 complete turns. Corpus bursae rather large, oval. Signum large, covered with more or less uniform teeth, asymmetric, with big tooth in middle and two marginal teeth (Fig. 7c, d).

Diagnosis. Two prominent black streaks in the forewing pattern of *E. falkovitshi* sp. n. easily distinguishes it from other moths of the *distigmatella* species group (*quadrinotella* Mann, 1861; *quadrinotella atticella* Caradja, 1920; *galaxaea* Meyrick, 1922*; quinquenotella* Chrétien, 1915; *quadrinotella heratella* Amsel, 1969; *quadrinotella huai-*



Figs 1–3. Adults of *Ethmia* spp. **1.** *Ethmia falkovitshi* sp.n., male, holotype. **2.** *Ethmia nykta*, sp.n., male, holotype. **3.** *Ethmia albolinella*, sp.n., male, holotype.

rouana Yang, 1977, and *cribravia* Wang & Li, 2004). In male genitalia the new species (Fig. 4a, b) is very similar to *E. q. quadrinotella* (Mann, 1861), differing in the shape of the valva being more round. In the female genitalia the new species is also very similar to *E. q. quadrinotella* (Mann, 1861), differing in the more echinated and rough signum.
Distribution and life history. From our data, the moths inhabit desert and semi desert regions of Western Kazakhstan at an altitude of 150 m. Besides, the species is native to Uzbekistan, Kyzyl-Kum desert, Ayakgujumdy, where it is known from elevations of 150–300 m (ZISP). The biology and immature stages are unknown. The moths are common night-fliers from mid April to late May.
Etymology. The species is dedicated to Dr Mark Isaakovitsh Falkovitsh (St. Petersburg), the author of many outstanding works on Lepidoptera who initially collected this remarkable species.

Ethmia vidua flavilaterella Danilevsky, 1975 (Figs 10, 20)

Ethmia *vidua flavilaterella* Danilevsky, 1975: Entomogicheskoe obozrenie **54**(3): 616. Fig. 3. Type locality: "Central'naya Sibir', Wilui" [Russia, Central Siberia, Wilui]. Holotype: male (ZISP) [examined].

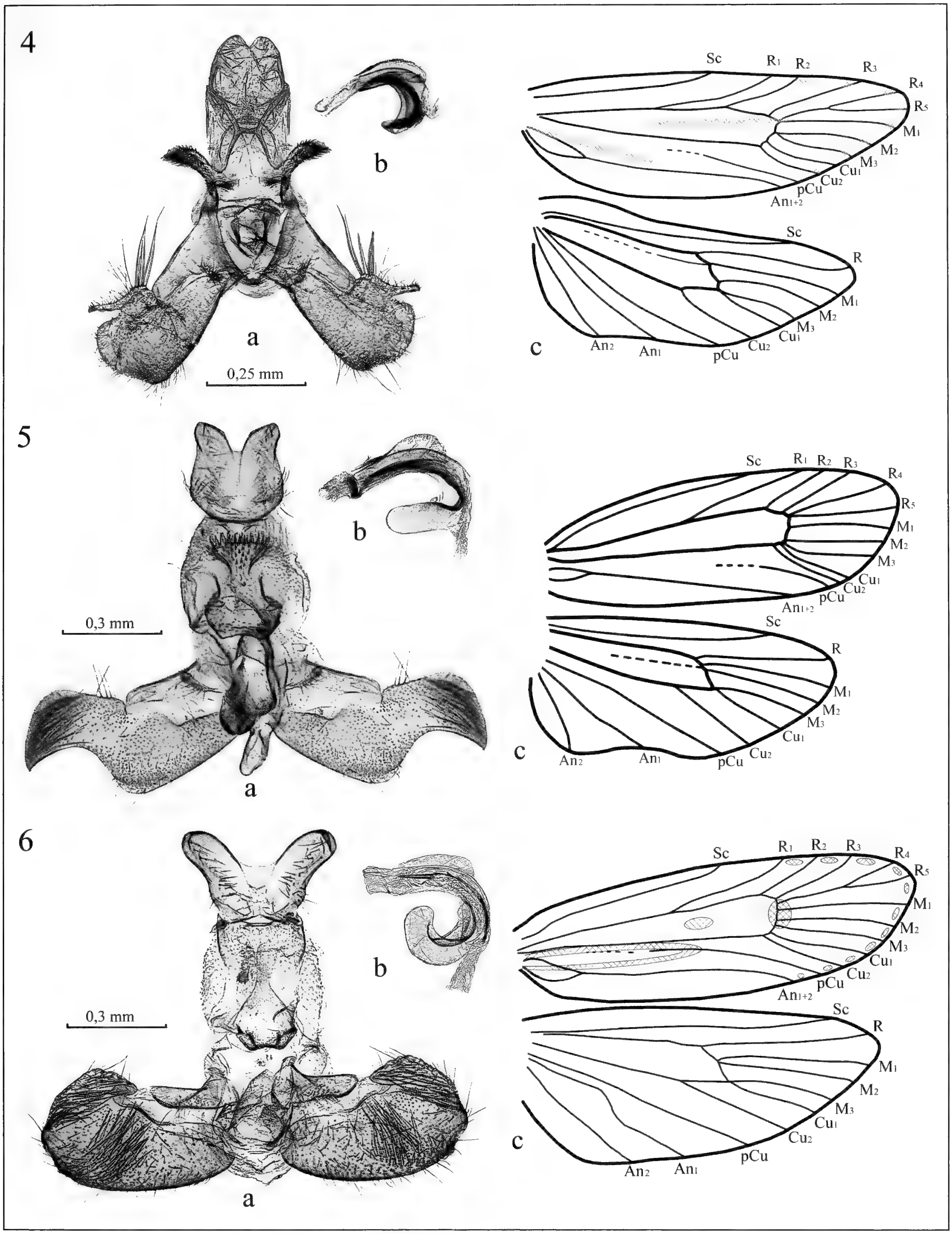
References: Danilevsky (1975: 616); Danilevsky (1976: 32); Danilevsky (1980: 343); Zagulajev (1981: 644) (*Ethmia*).

Material. Holotype ♂ with labels: '♂ | Wilui', on the back '20 VII 89, | O. Herz' <white rectangle, in black ink>, 'кол. б. Вел Кн. | Николая | Михайловича' [collection of Grand Duke Nikolay Mikhailovich] < white rectangle, printed in black ink >, 'Holotypus. | *Ethmia vidua* | flavilaterella Danil.' <red rectangle, written in black ink> (ZISP). – Paratype: 1♀ with same data (ZISP).

Redescription (Fig. 10). Wingspan of holotype 21 mm, paratype 20 mm. Antenna filiform, clay-colored. Labial palpus smooth, somewhat clay-colored; base of proboscis with clay-colored scales; frons, vertex, thorax, tegulae, and legs similarly clay-colored. Male abdomen dark, ventrally from segment 7 and lateral from segment 4 yellow. Female with yellow scales only on top of abdomen.
Diagnosis. In contrast *E. vidua vidua* (Staudinger, 1879) lacks the black points on the thorax. Forewing clay-colored, with four black points located just as in *E. vidua vidua* Stgr, black marginal dots absent.
Male genitalia (Fig. 20). From *E. vidua vidua* (Fig. 21) differs in a shape of cucullus.
Taxonomic notes. This subspecies is known from the type series only. It is thought that it is a good species, but the lack of additional material does not allow confirmation of this status with certainty.

Ethmia nykta sp. n. (Figs 2, 5)

Material. Holotype ♂, 'ок. ур. Бана-Джун | Камъ, бас. Голубой | Козловъ. 1/2 iv 01 [environs Bana-Dzhun, Kam, valley of Goluboy River, leg. Kozlov. 1/2. iv.1901]' <white rectangle, printed in black ink >, 'HOLOTYPUS. | ♂ *Ethmia nykta* | Shovkoon | design. Shovkoon D. F. 2010' <red rectangle, printed in black ink> (ZISP). – Paratype: 1♂, р. Дза-чю, Камъ басс. Голубой Козловъ. 26 iv 01 [Dza-chju River, Kam, valley of Goluboy River, leg. Kozlov. 26. iv.1901] (ZISP).



Figs 4–6. Male genitalia and venation of *Ethmia* spp. **4.** *Ethmia falkovitshi* sp.n.: **a** and **b.** male genitalia, holotype; **c**. wing venation. **5.** *Ethmia nykta*, sp.n.: **a** and **b.** male genitalia, holotype; **c**. wing venation. **6.** *Ethmia albolinella*, sp.n.: **a** and **b.** male genitalia, holotype; **c**. wing venation.

Description (Fig. 2). Wingspan: holotype 18 mm, paratype 17 mm. Antenna filiform, black; flagellum black; maxillary palpus reduced. Labial palpus with black scales; base of proboscis with black scales; frons, vertex, thorax, tegulae, and forelegs, similarly black. Midlegs and hindlegs: femur black, tarsus with yellow scales. Wings completely black, without any patterning. Wing venation (Fig. 5c) with forewing: Sc vein at 2/3 along costa; M_3 slightly stalked with Cu_1. Hindwing: M_3 and Cu_1 on short stalk. Abdomen: segments 3–5 laterally yellow, segments 6–8 with yellow scales.

Male genitalia (Fig. 5a,b). Uncus developed, hood-like, bifurcated to top. Caudal part of gnathos armed with thorns, anterior part roughly sclerotized, with broad base. Labis short, bristly. Valva long, pointed. Cucullus broad at base, tapering apically into pointed apex. Phallus gun-shaped, without cornuti.

Female unknown. It can be expected that the female of this early vernal species may be brachypterous, by analogy with the brachypterous female of *E. discrepitella* (Rebel, 1901) (Shovkoon 2008).

Diagnosis. This species belongs to the *pyrausta* species group. It is easily separated from *E. pyrausta* (Pallas, 1771) and *E. discrepitella* (Rebel, 1901) by the absence of black spots on the forewings. The shape of the valva of the new species (Fig. 5a, b) is highly diagnostic.

Distribution and life history. The moths were collected from the Chang Jiang river basin, Sichuan Province (SW China): N 31°59'55", E 99°22'02", altitude above sea level – 3650 m (Kozlov, 1906). The biology and immature stages are unknown.

Etymology. Nykta (Nyx in Greek) was born of Chaos, and was the primordial goddess of the night. Nykta stood at or near the beginning of creation, and was the mother of personified gods such as Hypnos (sleep) and Thánatos (death).

Ethmia zaguljaevi Kostjuk, 1980 (Figs 19, 29)

Ethmia zaguljaevi Kostjuk, 1980, Entomologicheskoe obozrenie **59**(4): 858, Figs 1, 2. Type locality: "Altai, Kuraisky hr. u rudn. Aktash, 2600 m, gornaya tundra" [Altai Republic, Kurai range, near Aktash pit, 2600 m, mountain tundra]. Holotype: male (ZMKU) [examined].

Material. Holotype ♂ with labels: 'Алтай, Курайский хребет | у Акташа, верхов. р. Ярлы– | Яры, 2600 м, горная тундра | 18 июня 1976 Ю.Костюк' [**Russia**, territory of Altai Republic, at the Aktash pit at 2600 m above sea level, 18. vi 1979, leg. Ju. Kostjuk] <white rectangle, print in black ink>, 'Алтай, Курайский хр | у рудн. Акташ, 2600 м | Костюк 18 vi 1976' [Russia, territory of Altai Republic, at the Aktash pit at 2600 m above sea level, 18. vi 1979, leg. Kostjuk] <white rectangle, print in black ink>, 'горная тундра' [mountain tundra] <white rectangle, print in black ink>, 'Holotypus *Ethmia* | *zaguljaevi* | ♂ Kostjuk' <red rectangle, written in black ink> (ZMKU). – Paratypes: 2 ♂, same data as holotype (ZMKU).

Figs 7–9. Female genitalia of *Ethmia* spp. **7.** *Ethmia falkovitshi* sp.n.: **a.** general view; **b.** ventral view; **c.** signum, dorsal view; **d.** signum right-side view. **8.** Ethmia *turkmeniella* Dubatolov et Ustjuzhanin, 1998, moth from Kalmykia, Russia: **a.** general view; **b.** ventral view; **c.** signum, dorsal view; **d.** signum right-side view. **9.** Ethmia *elimatella* Danilevsky, 1975, moth from Nakhichevan, Ordubad, Azerbaijan. **a.** general view; **b.** ventral view; **c.** signum, dorsal view; **d.** signum right-side view.

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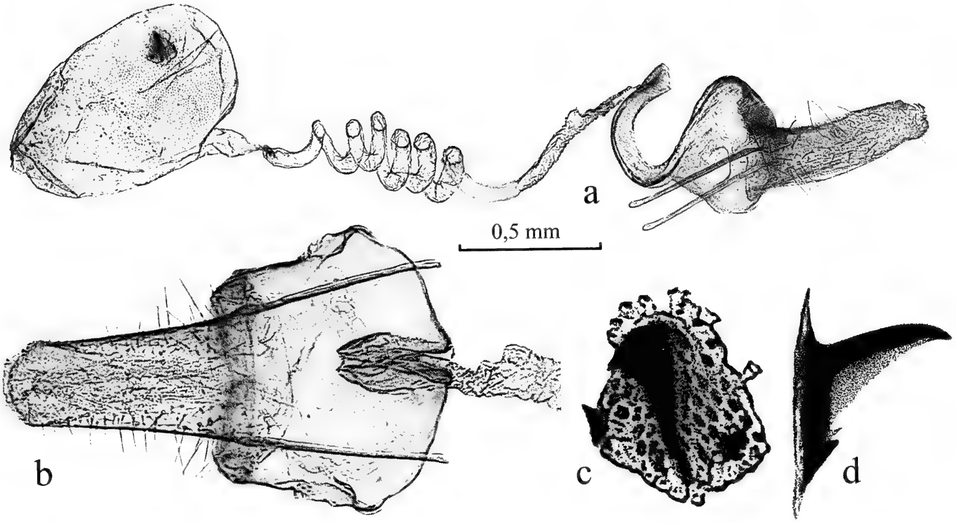

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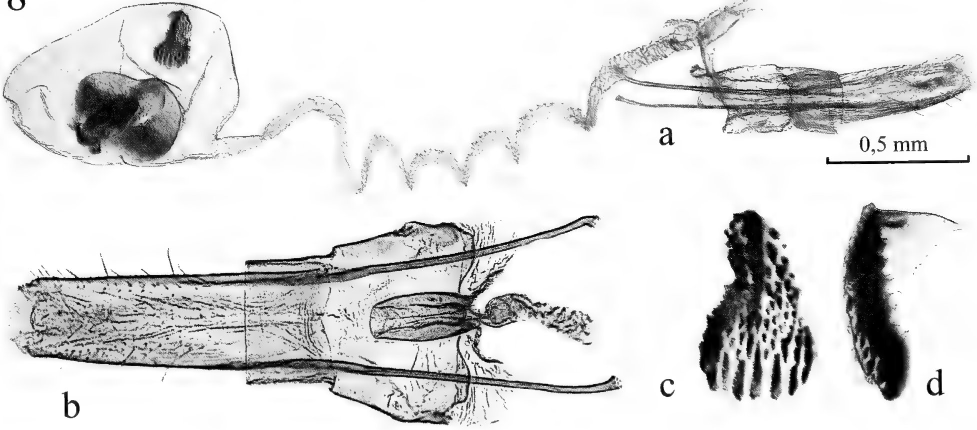

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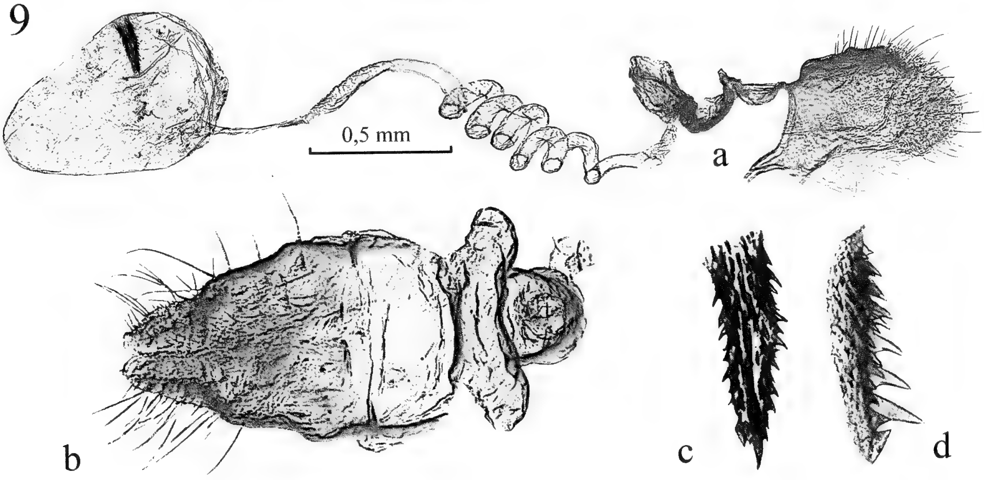


Remarks. Kostjuk (1980) stated that holotype was transferred to the Zoological Institute of the Russian Academy of Sciences (St. Petersburg, Russia), but this was not done and the specimen is actually kept in the Institute of Zoology, Ukraine Academy of Sciences, Kiev. The data cited below are based on the original description.

Redescription (Fig. 19). Wingspan of holotype 15.5 mm. Antenna with cilia, dark brown; labial palpus dark brownish. Proboscis slightly exceeding length of labial palpus. Thorax and tegulae shining, raven black-coloured. Forewing smooth, greyish black. Forewing markings formed by 3 large black spots. Hindwing of same colour as forewing, slightly transparent, costal brushes absent. Forelegs, midlegs, and hindlegs brownish black, tarsi with yellow scales. Abdomen from 4th segment laterally orange, from 7th segment entirely orange.

Male genitalia (Fig. 29). Valva long, pointed. Uncus developed, hood-like with two pointed hook-shaped bent processes. Caudal part of gnathos in form of triangularly expanded sclerotizatized formation armed with thorns, anterior part roughly sclerotized, with broad base. Labis' hornlike process rather long, slightly bent to top. Phallus gun-shaped, with one cornutus (Fig. 29).

Female unknown.

Diagnosis. The small size of the moths and three characteristic black spots on the forewing easily distinguish *Ethmia zaguljaevi* from other *Ethmia* species. Also the different shape and structure of the gnathos of the male genitalia are diagnostic.

Distribution and life history. The moths inhabit the territory of Altai Republic in SW Siberia, at the Aktash pit they are known from mountain tundra at the altitude of 2600 m. The biology and immature stages are unknown. The moths fly in June.

Taxonomic notes. The moth habitus and the structure of the male genitalia suggest a close relationship with the *bipunctella* and *chrysopyga* groups sensu Sattler (1967).

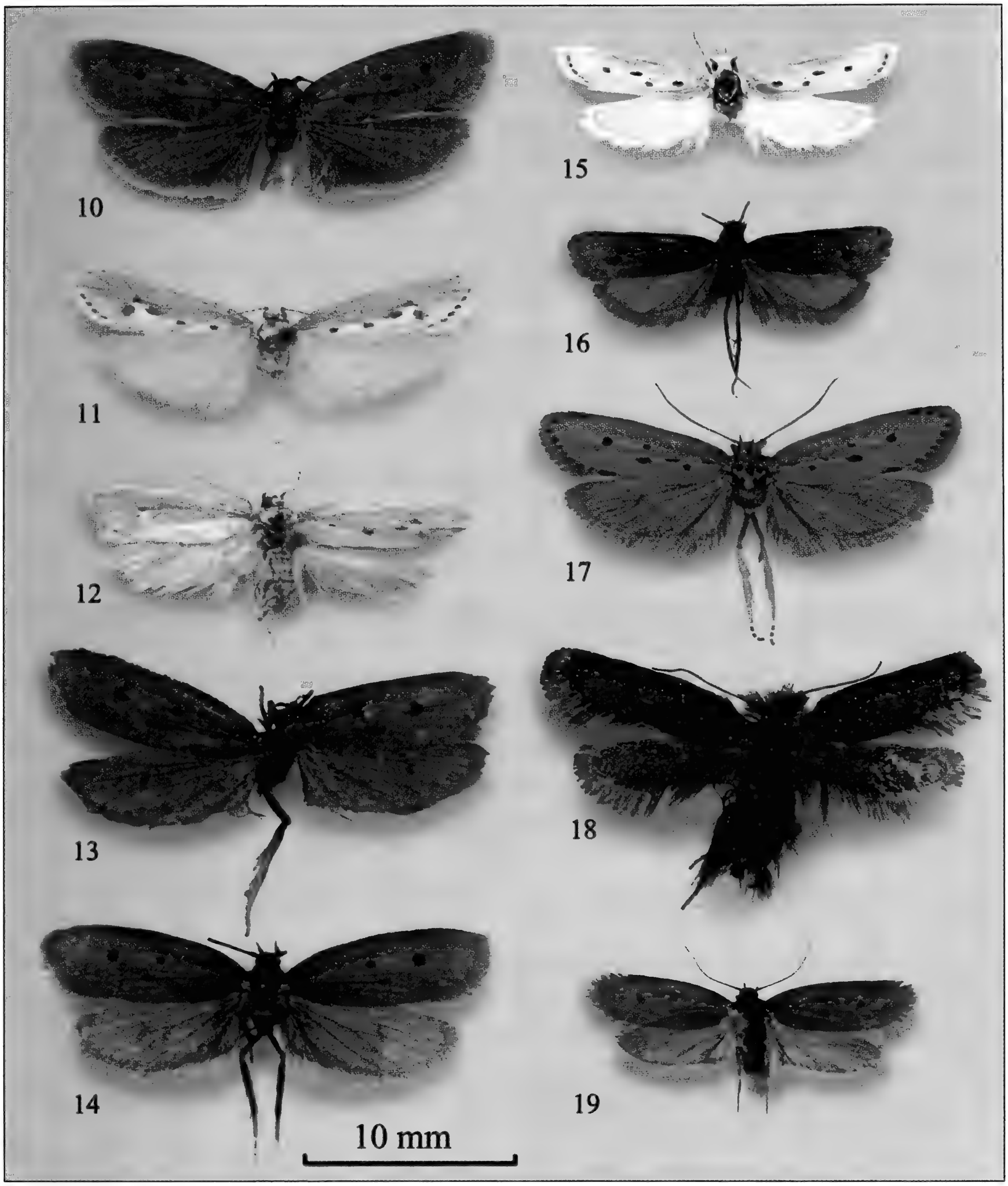
Ethmia elimatella Danilevsky, 1975 (Figs 9, 11, 12, 22)

Ethmia *elimatella* Danilevsky, 1975, Entomogicheskoe obozrenie **54**(3): 615. Fig. 1. Type locality: "Azerbaijan, Ordubad". Holotype: male (ZISP) [examined].

References: Danilevsky (1975: 615); Danilevsky (1976: 32); Danilevsky (1980: 334); Kun (2007: 104); Wei et al. (2007: 66) (*Ethmia*).

Material. Holotype ♂ with labels: '♂ | Ordubad', on the back '8.5.83, | Chr.' <white rectangle, in black ink>, 'кол. б. Вел Кн. | Николая | Михайдовича' [collection of Grand Duke Nikolay Mikhailovich] <white rectangle, printed in black ink>, 'Holotypus. | *Ethmia* | *elimatella* Danil.' <red rectangle, written in black ink> (ZISP). – Additional material. 1♂, 1♀, Nus-nus, Araks river basin, Nakhichevan, Ordubad, Azerbaijan. 31.vii.1995 leg. Zagulajev (ZISP).

Redescription (Figs 11, 12). Wingspan of holotype 19.5 mm, female 20 mm. Antenna of male with cilia, antenna of female filiform, without cilia. Labial palpus smooth with clay-colored scales; base of proboscis with clay-colored scales; frons, vertex, tegulae, forelegs, midlegs, and hindlegs similarly clay-colored. Thorax with pale grey pattern. Costal half of forewing with grey scales, basal half white with 5 separated black spots placed below border of darker costal and dorsal half of wing; margin with 7 black dots; cilia pale grey. Abdomen pale grey without yellow scales.



Figs 10–19. Habitus of *Ethmia* spp. **10.** Ethmia *vidua flavilaterella* Danilevsky, 1975. Male, holotype (ZISP). **11–12.** Ethmia *elimatella* Danilevsky, 1975. **11.** Male, holotype (ZISP). **12.** Female, Nus-nus, Araks river basin, Nakhichevan, Ordubad, Azerbaijan (ZISP). **13–14.** Ethmia *soljanikovi* Danilevsky & Zaguljaev, 1975. **13.** Male, holotype (ZISP). **14.** Male, paratype, Mongolia, Hubsubul Province, Beltesin-Gol river (ZISP). **15.** Ethmia *turkmeniella* Dubatolov et Ustjuzhanin, 1998. Female, Russia, Kalmykia, left coast of the river of Volga, at settlement Chagan-Aman, Justinsky area (LSSU). **16.** Ethmia *sibirica* Danilevsky, 1975. Male, holotype (ZISP). **17.** Ethmia *ubsensis* Zagulajev, 1975. Male, holotype (ZISP). **18.** *Dasyethmia hiemalis* Danilevsky, 1969. Male, holotype (ZISP).**19.** *Ethmia zaguljaevi* Kostjuk, 1980. Male, holotype (ZMKU).

Female genitalia description (Fig. 9). Papillae anales rounded, setose; ovipositor sclerotized. Posterior apophyses absent; anterior wedge-shaped and pointed (Fig. 9a). Antrum sclerotized, very large (Fig. 9b). Ductus bursae very long, spiral, with 6 complete turns. Corpus bursae rather large, spherical. Signum large, trilobate, covered with teeth, asymmetric (Fig. 9c, d) in middle with roughly jagged crest.

Male genitalia (Fig. 22). Shape of valva similar to that of *E. infelix* and *E. derbendella* Sattler, 1967, but different in the shape and structure of the gnathos.

Diagnosis. The five separated black spots placed below the borderline of the costal and dorsal halves of the forewing easily distinguishes Ethmia *elimatella* from the similar species *E. infelix* Meyrick, 1914.

Distribution and life history. The moths are known only from the environs of Ordubad, Azerbaijan. The biology and immature stages are unknown. The moths were collected flying from early May to early July.

Taxonomic notes. Kun (2007) wrote in his review of the *wursteri* species group that based on an examination of the female genitalia slide of the paratype of *Ethmia kurdistanella* Amsel, 1959 (in coll. LNK; considered and figured as *E. infelix* by Sattler (1967) (the specimen itself was not found in LNK)) and the very few additional moths known, the possibility cannot not be precluded that this female belongs to *E. elimatella* Danilevsky, 1975 or even *E. persica* Kun, 2007.

Ethmia elimatella Danilevsky, 1975 was described from a single male, and the female of the species was unknown until now. A pair of *E. elimatella* was found by me in ZISP from the type locality (Ordubad, Azerbaijan). The genitalia of the female specimen were examined and it is confirmed here that female genitalia of *E. elimatella* Danilevsky 1975 were not figured earlier under any other species name.

Ethmia albolinella sp. n. (Figs 3, 6)

Material. Holotype ♂, 'ок. ур. Бана-Джун | Камъ, бас. Голубой | Козловъ. 1/2 iv 01 [environs Bana-Dzhun, Kam, valley of Goluboy River, leg. Kozlov. 1/2. iv.1901]' <white rectangle, printed in black ink >, 'HOLOTYPUS. | ♂ *Ethmia albolinella*| Shovkoon | design. Shovkoon D. F. 2010' <red rectangle, printed in black ink> (ZISP). – Paratypes: 2♂, same data as holotype; 1♂, дол. Голубой р., Камъ, в. Тибетъ. Козловъ. 18 iii 01 [valley of Goluboy River Kam, eastern Tibet, leg. Kozlov. 18. iii.1901] (ZISP); 1♂, р. Дза-чю, Камъ Голубая 12–12500' Козловъ. нач. v 01 [Dza-chju River, Kam, Golubaja River, 12–12500 foot, leg. Kozlov. begin. v.1901] (ZISP).

Description (Fig. 3). Wingspan 17–18 mm, holotype 17 mm. Antenna filiform, black; flagellum black; maxillary palpus reduced. Labial palpus with black scales; base of proboscis with black scales; frons, vertex, thorax, tegulae, and forelegs uniformly black. Midlegs and hindlegs with femur black, tarsi with yellow scales. Forewing generally dark grey, almost black at base, cilia dark grey. Pattern consisting of three large black spots, a white to yellowish longitudinal streak, and tiny, black marginal dots; largest spot set at distal part of R-Cu cell, other two located one above other, approximately in center of wing; streak bordered with black scales and stretched from base of forewing to lower two spots. Abdomen: segments 4–7 laterally yellow, segments 7 and 8 entirely yellow.

Wing venation (Fig. 6c). Forewing: Sc vein set in middle of costal border of wing; R_4 and R_5 on long stalk (1/2 general long of veins). Hindwing: M_1 connate or slightly stalked with M_2; M_3 slightly stalked with Cu_1.
Male genitalia (Fig. 6a, b). Uncus developed, bifurcated. Caudal part of gnathos armed with thorns, anterior part roughly sclerotized, with broad base. Labis short, bristly. Valva pyriform. Cucullus wide, convex. Phallus gun-shaped, with row of tooth-shaped cornuti terminating with long thorn (Fig. 6b).
Female unknown.
Diagnosis. The moth belongs to the *nigripedella* species group. Worn specimens of the new species are difficult to distinguish from *E. ultima* Sattler, 1967, although the wing background of *E. albolinella* is darker; the distal part of the R-Cu cell of the forewing has one big spot (three in *E. ultima*); the streak of *E. albolinella* is bordered uninterruptedly with a black line whereas the streak of *E. ultima* is only dotted with separate black scales; and the hindwing of *E. albolinella* is unicoloured whereas that of *E.ultima* has a yellow base.
The white streak on the forewing of *Ethmia albolinella* sp. n. is the most diagnostic feature which easily distinguishes it from other moths of the *nigripedella* species group.
In male genitalia the new species (Fig. 6a, b) is very similar to *E. nigripedella* and the little-known *E. sibirica* Danilevsky, 1975 (Fig. 26), *E. ubsensis* Zagulajev, 1975 (Fig. 27), and *E. menyuanensis* Liu, 1980 (see Liu 1980, 1982) which also belong to the same species group.
Distribution and life history. The moths were collected from the Chang Jiang river basin, Sichuan Province of Southwest China, from mid March to early May at an altitude of 3200–3700 m (Kozlov 1906). The biology and immature stages are still unknown.
Etymology. The species is named for the characteristic white streak on the forewing.

Ethmia sibirica Danilevsky, 1975 (Figs 16, 26)

Ethmia *sibirica* Danilevsky, 1975, Nasekomye Mongolii [Insects of Mongolia], **3**: 347. Figs 15, 16. Type locality: "SSSR, Buryatiya, Tunkinskie Belki, 2000 m". Holotype: male (ZISP) [examined].

References: Zaguljaev (1975: 347), Danilevsky (1976: 32), Danilevsky (1980: 334), Sinev (1997: 514) (*Ethmia*).

Material. Holotype ♂ with labels: 'Тункинск. белки | Ирк.г. 2000 м. vii | [от B. Haas] 925' [**Russia**, Republic of Buryatia, Tunkinskije Belki, Tunka-Alpen – part of the Eastern Sayan, 2000 m, vii.1925 (from Bang-Haas)] <white rectangle, print in black ink>, 'Holotypus | *Ethmia sibirica* | Danilevsky, 1975' <red rectangle, written in black ink> (ZISP). – Paratypes: 1 ♂, same data as holotype (ZISP).

Redescription (Fig. 16) Wingspan of holotype 15 mm, paratype 15 mm. Head, antenna, labial palpus in long black filaments. Thorax and tegulae with brownish black scales. Forewing smooth, brownish black, dark at base. Forewing markings formed by 4 black spots and one faint streak in wing base (Fig. 16). Black marginal dots also present, tiny. Hindwing transparent, dark grey. Legs black. Abdomen: segments 6–9 laterally orange, last two segments and genitalia with orange scales.

Male genitalia (Fig. 26). Valva rather pyriform with wide, convex, poorly lobate cucullus. Uncus developed, bifurcated. Caudal part of gnathos armed with thorns, anterior part roughly sclerotized, with broad base. Phallus gun-shaped, forming almost full ring, cornuti with row of teeth finished by long thorn (Fig. 26).

Female unknown.

Diagnosis. The species is similar in external characters to *E. ubsensis* Zagulajev, 1975 but differs in its smaller size and blacker colouring of forewings. It can easily be separated from *E. cirrhocnemia* and *E. comitella* by the location and form of the black spots on the forewings. In male genitalia the species is similar to *E. nigripedella*, *E. ubsensis* (Fig. 27), *E. menyuanensis*, and *E. albolinella* sp. n. (Fig. 6a, b) and differ in the shape of the valva and gnathos (Fig. 26).

Distribution and life history. The species is known from Buryatia Republic of Russia, Tunkinskije Belki, Tunka-Alpen in the Eastern Sayan. The biology and immature stages are unknown. The moths fly in July.

Taxonomic notes. The species belongs to the *nigripedella* species group, and from the forewing pattern may be close to *E. cirrhocnemia* (*bipunctella* species group), *E. comitella* and *E. ubsensis* (Fig. 17) (*nigripedella* species group) In the shape of the male genitalia it is close to *E. nigripedella*, *E. ubsensis* Zagulajev, 1975 (Fig. 27), *E. menyuanensis* Liu, 1980, and *E. albolinella* sp. n. (Fig. 6a, b) which also belong to the *nigripedella* species group. The male genitalia of the species differ in the shape of the valva and gnathos.

Ethmia ubsensis Zagulajev, 1975 (Figs 17, 27)

Ethmia ubsensis Zagulajev, 1975, Nasekomye Mongolii [Insects of Mongolia], **3**: 347. Figs 9–14. Type locality: "Mongoliya, Ubsu-Nurskii aimak, 30 km NE Barun-Turuna, peski" [Mongolia Uvs Aimag, 30 km NE of Baruunturuun, sands]. Holotype: male (ZISP) [examined].

References: Zaguljaev (1975: 347) (Ethmia *ubsensis*), Danilevsky (1980: 334) (Ethmia *sibirica*), Sinev (1997: 514) (Ethmia *ubsensis*), Dubatolov et al. (1997) (Ethmia *ubsensis*).

Material. Holotype ♂ with labels: 'Монголия, 30 км СВ | Барун-Туруна, пески | Убсунурский аймак | Емельянов 5 vii 968' [**Mongolia** Uvs Aimag, sands, 30 km NE of Baruunturuun, 05.vii.1968] <white rectangle, print in black ink>, 'Holotypus *Ethmia* | *ubsensis* Zag. sp.n. | Mongolia. ♂. det. A.Zag.' <red rectangle, written in black ink> (ZISP). – Paratypes: 1 ♂ СССР, Тувинская АССР, пойма р. Тес-Хем у Эрзина, 26 vi 1969 Ю. Костюк [USSR, Tuva Republic, high-water bed of Tes-Khem river, near Erzin settlement 26.vi.1969, leg. Ju. Kostjuk] (ZISP).

Additional material: 1 ♂, Mongolia, Suchbaatar Aimag, Dzotol-han-ula, 21.vii.1976, leg. Gur'eva (ZISP); 1 ♂, Mongolia, Töw Aimag, SW Ulan Bator, environs Songino, steppe, 1.vii.1967, leg. Zaytcev (ZISP).

Redescription (Fig. 17). Wingspan 20 mm. Head, antenna, and labial palpus with dark grey scales. Thorax and tegulae dark grey, thorax with 4 black spots, tegulae with black spot at base. Forewing smooth, dark grey. Forewing markings formed by 4 or 5 black spots and 2 faint streaks (Fig. 17); first spot, of variable size, located in anal part of wing; second and third spots stacked approximately at 1/2 length of forewing; fourth spot – the largest – situated in distal end of cell (in moth from Tuva two more spots located below); first streak located in wing base, second between first and third spots;

margin with 10–12 oblong black marginal dots; cilia dark grey. Hindwing of same colour as forewing, without costal brushes. Forelegs and midlegs ash grey, hindlegs with femur ash grey with orange scales, tarsus black with orange bonding. Abdomen orange from second segment.

Male genitalia (Fig. 27). Valva rather pyriform with wide, convex, poorly lobate cucullus. Uncus wide, bifurcated, with narrow clasps bent aside valvae. Caudal part of gnathos membranous, without sclerotized arms, anterior part roughly sclerotized, with spinules. Phallus gun-shaped, forming almost full ring, cornuti with row of teeth terminating in long thorn (Fig. 27).

Female unknown.

Diagnosis. The moth differs from *E. sibirica* by the large size and more grey colouring of the forewings, also by the different shape and structure of the gnathos of the male genitalia.

Distribution and life history. The moths were collected from Uvs Suchbaatar and Töw Aimags of Mongolia and Tuva Republic of Russia, high-water bed of Tes-Khem river. The biology and immature stages are unknown. The moths fly from mid June to early July.

Taxonomic notes. The species belongs to the *nigripedella* species group, with similar forewing pattern as *E. cirrhocnemia* (Lederer, 1870) (*bipunctella* species group), *E. comitella* Caradja, 1927 and *E. sibirica* Danilevsky, 1975 (Fig. 16) (*nigripedella* species group). The male genitalia are similar to those of *E. nigripedella* (Erschoff, 1877), *E. sibirica* Danilevsky, 1975 (Fig. 26), *E. menyuanensis* Liu, 1980, and *E. albolinella* sp. n. (Fig. 6a, b), which all belong to the *nigripedella* species group.

According to Kuznetsov, who prepared the paper by Danilevsky (1980) for publication, *E. ubsensis* Zagulajev, 1975, should be synonymized with E. *sibirica* Danilevsky, 1975. In contrast, Sinev (1997) again separated these taxa based on a number of characters: *E. ubsensis* is larger (wingspan: 20 mm), with hind wings not translucent, and the apex of the gnathos has two closely-set blunt processes, while in *E. sibirica* these processes are pointed and widely set.

Ethmia soljanikovi Danilevsky & Zaguljaev, 1975 (Figs 13, 14, 23–25)

Ethmia *soljanikovi* Danilevsky & Zaguljaev, 1975, Nasekomye Mongolii [Insects of Mongolia], **3**: 343. Figs 1–8. Type locality: "Mongoliya, Dzabhansky aimak, severnaya okraina Hangaichkogo nagor'ya, listvennichnyi les s redkimi polyanami 1500–1600 m" [Mongolia, Zavkhan Province northern suburb of Hangajsk upland, larch forest with rare glades, 1500–1600 m]. Holotype: male (ZISP) [examined].

References: Zaguljaev (1975: 343), Danilevsky (1976: 32(, Danilevsky (1980: 334) (*Ethmia*).

Material. Holotype ♂ with labels: 'Монголия, Дзаб ♂ | Хангайское нагорье | h = 1500–1600 м. | Соляников 6.8.65' <white rectangle, written in black ink>, 'Holotypus Ethmia | soljanikovi | Zag. sp.n. | "Монголия".' <red rectangle, written in black ink> [**Mongolia**, Zavkhan Province, northern suburb of Hangajsk uplands, larch wood with rare glades, 1500–1600 m, 06.viii.1965 leg. Soljanikov] (ZISP). – Paratypes: 1 ♀ 1 ♂ same data as holotype; 1♂ Улан-Эриг близ Улясутая, 2 vii 1911 (Юрганова) [Mongolia, Zavkhan Province, near Uliassutai 02.vii.1911 leg. Jugranova] (ZISP); 1 ♂ Хубсугульский аймак: р.Уджигин-Гол, сухая каменистая степь среди лиственничников, (Соляников) 19 vi 1965 [Mongolia, Khuvsgul Province, river Udzhin-Gol, dry stony steppe among larch forest 19.vi.1965 leg.

Soljanikov] (ZISP); 1 ♂ р. Ар-сайн-Гол, 21 vi 1965, (Соляников) [Mongolia, Hubsubul Province, Arsain-Gol river 21vi.1965 leg. Soljanikov]; 2 ♂ р. Бэлтэсин-Гол, 25 vi 1965 (Соляников) [Mongolia, Hubsubul Province, Beltesin-Gol river 25.vi.1965 leg. Soljanikov] (ZISP); 3 ♂ СССР Тувинская АССР горный массив Могун-Тайга, вост. берег оз. Хиндиктиг-Холь, 3500 м на альпийском лугу 13.vii 1969 (Костюк) [**Russia**, Tuva Republic, Mongun-Tayga mountains, east coast of lake Khindiktig-Khol, 3500 m, alpine meadow, 13.vii 1969 leg. Kostjuk] (ZISP).

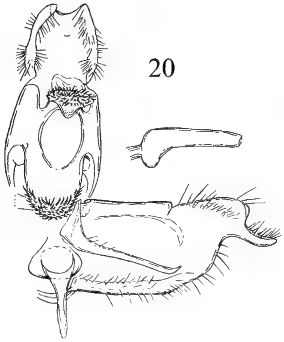
Additional material (from Dubatolov et al. 1997). Altai Republic: 4 ♂, the Yuzhno-Chuyskii Mountain Range, the headwater of the Kokuzek River, 2500 m, 5, 11 vii, 1 viii 1982 (Perunov et Goljakov leg.) (SZMN); 1 ♂, 80 km E of Kosh-Agach, 4 km NW of the Sailyugem Mountain, 2300–2400 m, 14 vii 1996 (A. et R. Dudko leg.) (SZMN); 1 ♂, Altaiskii Nature Reserve, the Shapshal Mountain Range, no other data (N. Zolotukhin leg.) (SZMN) (Not examined).

Redescription (Figs 13, 14). Wingspan of holotype 22 mm, female 26 mm. Head, antenna, labial palpus of male with blackish scales, those of female with brown tint. Tegulae of male with dark grey scales, that of female with black spot at base. Forewing smooth, greyish black, with faint tints of brown. Forewing markings formed by 4 large black spots and one faint streak at wing base; first spot of variable size, located in anal part of wing; second and third spots stacked approximately at 2/5 lengths of wing; fourth spot – largest – in distal part of cell. External edge of forewing and cilia without black spots and streaks. Hindwing more greyish than forewing; costal brushes absent. Forelegs and midlegs of male greyish black, hindlegs with femur black, tarsi with yellow scales. Female midlegs similarly greyish black, hindlegs with femur black, tarss with bright orange. Abdomen of male segments 5 and 6 laterally orange, segment 8 and scale cover of genitalia with orange scales; female abdomen orange beginning with second segment.

Male genitalia (Figs 23, 24). Valva rather rectangular with straight external edge of cucullus and extended serrate bottom edge; sacullus extend to middle valva. Uncus developed, wide with narrow clasps bent laterally to valva. Caudal part of gnathos hemisphere-shaped, armed with spinules, anterior part of gnathos armed with long thorns. Labis thin, long, slightly bent to top. Phallus gun-shaped, without cornuti.

Female genitalia (Fig. 25). Papillae anales rounded, setose; ovipositor sclerotized. Posterior apophyses slender, as long as papillae; anterior ones wedge-shaped and pointed (Fig. 7a, c). Antrum sclerotized, armed three rows of thorns. Corpus bursae rather large, spherical, covered with spinules.

Figs 20–29. Male genitalia and female genitalia of *Ethmia* spp. **20.** Male genitalia of Ethmia *vidua flavilaterella* Danilevsky, 1975, holotype (after Danilevsky, 1975). **21.** Male genitalia of Ethmia *vidua vidua* (Staudinger, 1879), holotype (after Danilevsky, 1975). **22.** Male genitalia of Ethmia *elimatella* Danilevsky, 1975, holotype (after Danilevsky, 1975). **23–25.** Ethmia *soljanikovi* Danilevsky & Zaguljaev, 1975. **23.** Male genitalia, holotype, general view and (**24.**) ventral view (after Zaguljaev, 1975) (ZISP). **25.** Female genitalia, paratype (after Zaguljaev, 1975). **26.** Male genitalia of Ethmia *sibirica* Danilevsky, 1975, holotype, prep. № 4558 (ZISP). **27.** Male genitalia of Ethmia *ubsensis* Zagulajev, 1975, holotype, prep. № 13373 (ZISP). **28.** *Dasyethmia hiemalis* Danilevsky, 1969, male genitalia, paratype (after Danilevsky, 1969). **29.** *Ethmia zaguljaevi* Kostjuk, 1980, male genitalia, paratype (after Kostjuk, 1980).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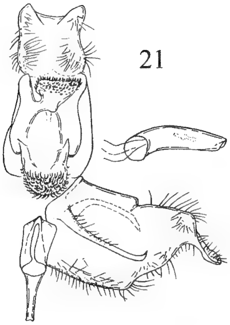
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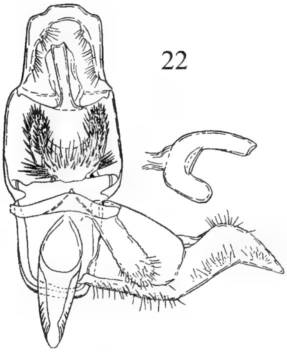
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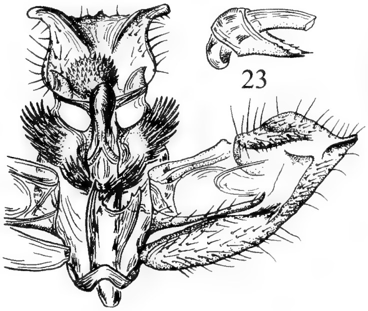
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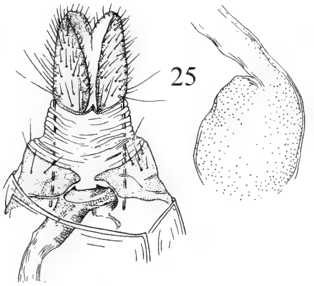
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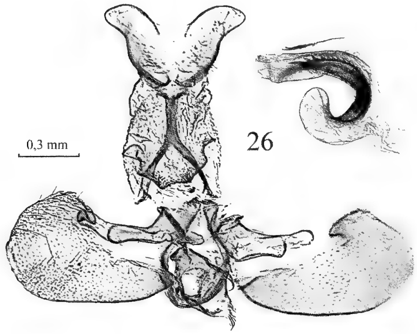
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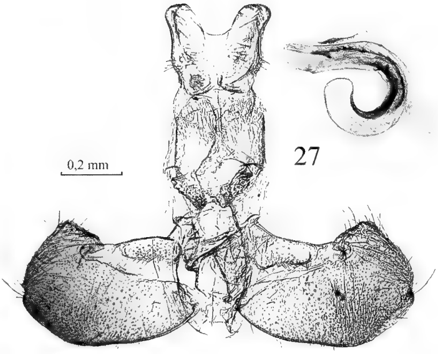
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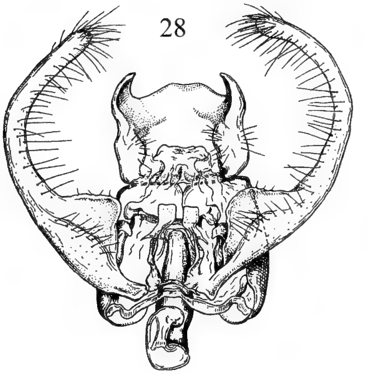
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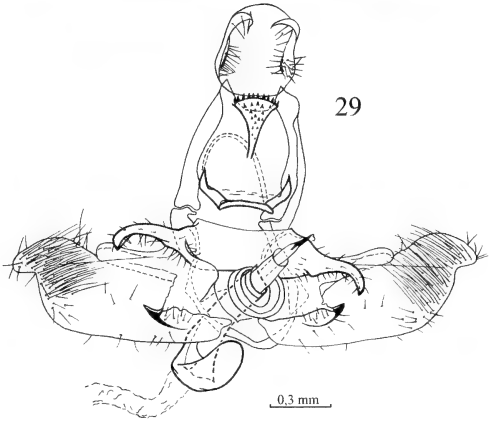
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Diagnosis. The species is similar in external characters and female genitalia to *E. xanthopleura* Meyrick, 1931, but differs in having four spots on the forewing. The shape of the male genitalia easily distinguishes Ethmia *soljanikovi* from *E. xanthopleura*.

Distribution and life history. For a long time the species was known only from Mongolia (Zavkhan Province, Khuvsgul Province, Hubsubul Province) and from Russia (Tuva Republic, Mongun-Tayga mountains, and the east coast of lake Khindiktig-Khol). Dubatolov et al. (1997) recorded its presence in the Altai (Yuzhno-Chuyskii Mountain Range, headwater of Kokuzek River; Kosh-Agach Sailyugem Mountain; Altaiskii Nature Reserve, Shapshal Mountain Range). The biology and immature stages are still unknown. The moths were collected in dry stony steppe among larch forest and in alpine meadows at 2500–3500 m in elevation. The moths fly from the second half of June to early August.

Taxonomic notes. The species is similar in external characters and female genitalia to *E. xanthopleura* Meyr (*nigripedella* species group), but the shape of the male genitalia is similar to that of *E. vidua* Staudinger (*aurifluella* species group). It is very difficult to attribute this species to any of the groups of species suggested by Sattler (1967) for the Palaearctic Region, and probably the species occupies an isolated systematic position.

Dasyethmia hiemalis Danilevsky, 1969 (Figs 18, 28)

Dasyethmia hiemalis Danilevsky, 1969, Entomologicheskoe obozrenie **48**(1): 178. Figs 1–4. Type locality: "Kazahstan, srednee techenie r. Chju, Koskudukskaya saksaul'naya lesnaya dacha" [Kazakhstan, middle course of Chu river, Koskuduksky saxaul wood summer residence]. Holotype: male (ZISP) [examined].

References: Danilevsky (1969), Zaguljaev (1975: 347), Danilevsky (1976: 32), Danilevsky (1980: 336) (*Dasyethmia*).

Material. Holotype ♂ with labels: 'КазССР, р. Чу, | Коскудукский | саксаул. Лесхоз | 25.i.1941 г. Б.Кравцов' [**Kazakh SSR**, Chu river, Koskuduk saxaul, 25.i.1941 leg. B. Kravtzov] <white rectangle, written in black ink>, 'Holotypus ♂ | *Dasyethmia* | *hiemalis* Danil.' <red rectangle, written in black ink> (ZISP). – Paratypes: 3 ♂. same data as holotype (ZISP).

Redescription (Fig. 18). Wingspan 20–22 mm, holotype 21 mm. Whole body and wings unicolorous black. Antenna densely ciliated, reaching 2/3 of forewing length. Labial palpus large, triarticulate; second segment about 2/3 total length of palpus; final segment thin, pointed, almost three times shorter than second segment. Head densely covered by thin and very long black hairs as long as thorax. Labial palpus, tegulae, and base of legs with same dense hair cover. Femur of forelegs with well developed epiphysis; midlegs with pair of spurs; hindlegs much longer than midlegs, femur with long hair brush and armed with two pairs of spurs. External margin of forewing and cilia without dark spots and streaks; cilia black, very wide, consisting of racemose and piliform scales. Hindwing coloured as forewing, costal brushes absent, cilia black, very wide (more than half of wing width).

Male genitalia (Fig. 28). Gnathos absent. Transtilla simple, weakly sclerotized. Valva strongly extended, narrow. Uncus developed, very wide, lateral corners extended in powerful hornlike processes. Phallus gun-shaped, without cornutus.

Female unknown, probably apterous.

Diagnosis. Apart from the very early flight period of the moth, the dense hairy cover and almost full reduction of the proboscis easily distinguishes *Dasyethmia hiemalis* from other *Ethmia* species. The absence of a gnathos in the male genitalia is characteristic too.

Distribution and life history. The species was described from the sands of Kazakhstan, where it inhabits the middle course of the Chu river. The biology and immature stages are unknown. The moths are January day-fliers (!) in saxaul bush.

Taxonomic notes. According to Danilevsky (1969) genus *Dasyethmia* differs from genus *Ethmia* Hübner, 1819 in a number of characters. Some of them, such as the dense hairy cover and almost full reduction of proboscis, reflect the winter way of life of the moth. This trait of specialization, although of unclear adaptive value, is expressed in other features of the morphology of *Dasyethmia*. In wing venation – the truncated median cell and strong narrowing anal part of the hindwing, that brings to full loss of vein A_2. Vein A_2 in *Ethmia* species is much thinner than others, but always present, and often bent in a characteristic way. Possibly, these features of venation are connected with the unusually long, wide cilia. In the male genitalia, the full reduction of the gnathos and simplification of the transtilla are characteristic of *Dasyethmia*. All these traits and specializations suggest the systematic isolation of *Dasyethmia*. However, until a phylogenetic analysis is done, it will be impossible to determine if this taxon should remain isolated from *Ethmia* or not. Nevertheless, all main traits of the structure of wings and genitalia are typical of the Ethmiidae (Danilevsky 1969). The genus *Dasyethmia* remains still monotypical.

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Geometrid larvae and their food-plants in the south of Madrid (Central Spain) (Geometridae)

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Abstract. Between January 2004 and May 2006 15 plant species were inspected for geometrid larvae in the gypsym soils of Ciempozuelos (Madrid, 600 m), which resulted in the collection of 1,625 larvae (25 species; four subfamilies). Although Sterrhinae larvae were only represented by seven species, their abundance was important numerically, with 497 individual larvae (35.8%) taken, of which just two species: *Scopula asellaria dentatolineata* (Wehrli, 1926) and *Casilda consecraria* (Staudinger, 1871) provided 486 specimens (29%) of the total. In the Larentiinae, in contrast, a mere of 173 individual larvae were collected (16.5%), whilst in the Ennominae, there were 503 larvae collected (36%), 282 (17%) individuals corresponding to just one species: *Petrophora convergata* (Villers, 1789). The study also looked at whether the species in question were monophagous, oligophagous or polyphagous; it has been difficult to come to a definitive conclusion with some species for example, *Camptogramma bilineata* (Linnaeus, 1758) and *Hospitalia flavolineata* (Staudinger, 1883) did not accept in captivity the plants on which they were found in or under in the wild. Three species: *Idaea incisaria* (Staudinger, 1892), *Idaea longaria* (Herrich-Schäffer, 1852) and *Idaea cervantaria* (Millière, 1869) cannot be placed into any of these categories, as they are detrivores. Of the other 20 species in the sample, 13 species can be regarded as monophagous (65%), 7 species as polyphagous (35%).

Resumen. Entre enero 2004 y mayo 2006 se inspeccionaron 15 especies de plantas para la recolección posterior de larvas en la familia Geometridae en Ciempozuelos (Madrid, 600 m) ubicada en suelos yesosos. Como resultado se recogieron 1.625 larvas (25 especies; cuatro subfamilias). A pesar de su representación faunística relativamente baja en la Sterrhinae, con siete especies recogidas, tenía un peso cuantativamente importante, con 497 larvas (35,8%) recogidas, de las cuales dos especies: *Scopula asellaria dentatolineata* (Wehrli, 1926) y *Casilda consecraria* (Staudinger, 1871) dieron 486 ejemplares (29%) del total. Sin embargo, la subfamilia Larentiinae, se vio representada únicamente por 173 larvas (16.5%), mientras, la subfamilia Ennominae se aportaron 503 larvas (36%), 282 (17%) de las cuales correspondía a una especie *Petrophora convergata* (Villers, 1789). Las estrategias alimenticias se refieren a monofagia, oligofagia o polifagia; es posible que no se haya llegado a una conclusión definitiva, ya que *Camptogramma bilineata* (Linnaeus, 1758) y *Hospitalia flavolineata* (Staudinger, 1883) no aceptaron las plantas por debajo de las cuales se encontraron en el estado silvestre. Tres especies: *Idaea incisaria* (Staudinger, 1892), *Idaea longaria* (Herrich-Schäffer, 1852) e *Idaea cervantaria* (Millière, 1869) no entran en ninguna de estas categorías porque son especies detrivoras. De las veinte especies restantes en la muestra, 13 especies son monófagas (65%) y 7 especies son polífagas (35%).

Introduction

Soria (1987), Gómez de Aizpúrua (1987; 1989), Domínguez & Baixeras (1995), Oltra et al. (1995), Gómez de Aizpúrua et al. (2003, 2005, 2006) and King (2000, 2002, 2004, 2005) have contributed to an understanding of the biology of a limited number of geometrids in the Iberian Peninsula, but if one considers the extraordinary richness of the Iberian fauna, there is something amiss. For example, the subfamily Sterrhinae has an important focus on the Mediterranean basin with 70% of the 196 European species recorded there (Hausmann 2004). Certain genera are well represented in the Iberian Peninsula, for example, *Idaea* Treitschke, 1825 contains some 125 species in Europe, 115 being recorded from Iberia, with an important endemic component (Hausmann 2004). The genus *Scopula* Schrank, 1802 (with subgenus *Glossotrophia* Prout, 1913) is represented by seven species in the Mediterranean basin, reaching the steppes of central Asia, with two subspecies and one species in the Iberian Peninsula (Hausmann 1993, 2004).

Study area

The two localities which formed the basis for the collection of geometrid larvae were southeast of Madrid in the Tagus Valley: Ciempozuelos (40°09'09.1 N 003° 36'27.1W, 518 m) Cerros de Vallecas (40°21'09.1 N 003°40'42.6 W, 504 m). The Miocenic and Triassic gypsyperous soils are relatively frequent in the Iberian Peninsula in the Tagus and Ebro basins, and the south-east Peninsular (Ferrandis et al. 2005). The climate is Mesomediterranean, with important drought conditions from June to September. The little rain that falls does so in the spring (March–May), and in the autumn (September–November). In the winter, conditions of thermic inversion tend to prevail (Izco 1984). The general lack of precipitation and the corresponding aridity ensures that the influence of the gypsym soils is constant, with a consequential effect on the vegetation which is generally understood to be included in the botanic order Gypsophiletalia. This order includes three syntaxonomical alliances: *Lepidion subulati*, *Thymo-Teucrion verticillati* and *Gypsophilion hispanicae*; the first of these alliances is found in the centre and south of the Iberian Peninsula, occuring in both Madrid and Castilla-La Mancha (Rivas Martínez & Costa 1970). However, Ferrandis, Herranz & Copete (2005) question the validity of the alliance *Lepidion subulati* in the centre of the Iberian Peninsula, and that this supposed alliance coincides entirely with *Thymo-Teucrion verticillati* which includes such plants as: *Gypsophila struthium* L. in Loefl. (Caryophyllaceae), *Helianthemum squamatum* (L.) Dum. (Cistaceae), *Thymus lacaitae* Pau.(Labiatae) and *Lepidium subulatum* L.(Cruciferae).

Abbreviations

GEK	Gareth Edward King
JMC	Dr José María Cano
LR	Dr Luis Romera

Methodology

The study areas were visited at least once every six or seven days from January 2004 until the end of May 2006 (Cerros de Vallecas was incorporated into the study only from February 2006). All visits were made in the day, the intention being to avoid the extreme midday heat from mid-May to the end of August. On arrival an area of about 20 m^2 was chosen in which all plants were examined methodically and the space underneath each plant and the associated leaf litter were also searched in order to be able to locate those species which are regarded as detriphagous, especially those in the genus

Tab. 1. Larvae taken January 2004–May 2006; Ciempozuelos (Madrid). * includes data Cerros de Vallecas (Madrid, 600 m).

Year	2004	2005	2006*	2004–2006
Total per year:	584	672	346	1,625
Larvae not indentified:	2.2% (14 larvae)	1.3% (9 larvae)	0.6% (2 larvae)	1.5% (25 larvae)
Total species:	22	18	14	14

Idaea (Ryrholm, 1989). Larvae found were collected into a vial with details annotated as to the plant on which they were taken, as well as the stadia in which they were found, the latter being assessed according to larval size and morphology, which in some species e. g. *Phaiogramma etruscaria* (Zeller, 1849), is very characteristic. In captivity, larvae were generally kept in plastic boxes in an unheated room with the windows open, and a sprig of the food-plant in water, if this was regarded as necessary, along with dry vegetable matter so that the larvae could perch away from the plant. In some cases, such as the Sterrhinae, rearing was extremely easy. In others, such as the Ennominae, it was necessary to maintain the larvae in open net cages exposed to light and air, but even so, mortality rate was high. Another function of the leaf litter was to provide material for the larvae to pupate without disturbance, as well as structural support for the emerging insect. Inside the rearing containers labels were kept which indicated: date of pupation (when the larva either ceases to feed, begins wandering, evacuates its gut, changes cuticular colour, or begins to spin a cocoon), date of larval-pupal metamorphosis, date of emergence of imagines, pairing records etc. Where possible, all records of larval events were kept in a separate collection, with the material being maintained alongside in capsules and vials, including dead larvae in good condition (preserved in alcohol), pupal excuvia, and all records of hymenopterous or dipterous parasitoides (Diptera: Tachinidae; Hymenoptera: Braconidae, Ichneumonidae) for future studies.

Results

Between 25.i.2004 and 27.v.2006 130 visits were made (Ciempozuelos 121 visits; Cerros de Vallecas seven visits; Valdemoro two visits); 15 species of plants from 11 plant families were inspected. The total of larvae taken was 1,625 of 25 species; Table 1 indicates how many larvae were taken in each of the three years and the proportion of larvae which were not identified at the time of collection (a majority of specimens are preserved in alcohol for later analysis).

Systematic account

Taxonomic order and nomenclature according to Dantart (2000); Hausmann (2001, 2004); Scoble & Krüger (2002); Mironov (2003) and Sihvonen (2005).

Geometrinae Leach, 1815

Phaiogramma etruscaria (Zeller, 1849)

Published records of food-plants: *Quercus ilex* (Fagaceae), *Clematis vitalba* (Ranaculaceae) (Cuní i Martorell 1881); *Quercus* sp. (Fagaceae) (Rebel 1910; Forster & Wohlfahrt 1981); *Paliurus* (Rhamnaceae) (Schwingenschuss & Wagner 1926); *Pimpinella*, *Peucedanum*, *Seseli*, *Eryngium*, *Melilotus*, *Rosa* etc. (Carrara 1926–1928); *Gypsophila struthium* (Caryophyllaceae) (King 2000, 2002); *Ferula communis* (Apiaceae), *Retama sphaerocarpa* (Papilionaceae) (Gómez de Aizpúrua et al. 2003).

Food-plants recorded from the study area: In the summers of 2004 (73 larvae) until 2005 (163 larvae) 236 larvae of this species were taken in Ciempozuelos. The larvae of *P. etruscaria* utilise four different plants each one of these belonging to a different family, characteristic of a typical polyphage (Hering, 1950; Huemer, 1988). It is also floricolous, this species feeding on the flowers according to their availability over the summer. For example, *Ruta montana* (Rutaceae) has a very short flowering season (end of May to end of June), whilst *Gypsophila struthium* flowers are available from June until well into October, when the first autumn rains destroy the flowers. Even so, in 2004, the total of larvae found on *Ruta montana* was 21 (28. 8%); in 2005, 96 larvae (55. 5%) were found on this plant. The relation that the species maintains with *Gypsophila struthium* seems more stable: in the two-and-a-half years of the study (not including 2006 as the study finished at the end of May); in 2004, 48 larvae (65. 8%) were collected between the months of July and October on this latter plant, whilst in 2005, 42 larvae (24.3%) were collected between June and October. It is important to point out, however, that the availability of flowers is not absolutely necessary: for example considering *P. etruscaria* and its relationship with *Limonium dichotomum* and *Foeniculum vulgare*, flowers of both these species are widely available, and yet the flowers of these plants are not always used by the immature stages of the moth; with 3 larvae (4.1%) of the 73 larvae collected in 2004, and 1 larva (0.6%) of the 163 collected in 2005 on the flowers of *Limonium dichotomum*, but never on the leaves of either of these plants. In 2004, 1 larva (1.36%) and in 2005 21 (12.9%) larvae were taken on *Foeniculum vulgare*. Hausmann (2001) emphasises the fact that *P. etruscaria* is a species to be found in areas with a high concentration of umbelliferous plants (Apiaceae), however, the only umbel used by this species was *Foeniculum vulgare*, and then only marginally, although this could be an artefact of the study. Nevertheless, on 16.vi.2007, after the study finished, eight larvae were collected on the flowers and fruits of a species of *Torilis* (Apiaceae) in Ciempozuelos (King, pers. obs.).

Quercus ilex has been cited as a food-plant for *P. etruscaria* (Rebel 1910; Dantart 1990), but this should be treated as doubtful, if one considers the species being floricolous; with *Q. ilex* flowering at the end of April, this would be too early for the larvae of this species, which appear from the end of May (King, pers. obs.).

The inclusion of *Ruta*, as well as *Limonium* as new food-plants for this species, in two different botanical families (Rutaceae; Plumbaginaceae) increases the spectrum of plants utilised.

It is interesting to note that *P. etruscaria* is capable of feeding on both *Ruta montana* (Rutaceae) and *Foeniculum vulgare* (Apiaceae), a behaviour shared only with the Papilionidae whose larvae are able to deal with those plants which contain the compounds; methyl chavicol and anethole (Dethier, 1952).

Microloxia herbaria (Hübner, 1813)

Published records of food-plants: *Teucrium polium capitatum* (Lamiaceae) (Millière 1874; Staudinger 1879; Gómez de Aizpúrua et al. 2003); *Vernonia centaureoides* (Compositae) (Scoble 1999); *Helichrysum stoechas* (Lamiaceae) (Leipnitz *in* Hausmann 2001); *Gypsophila struthium* (Caryophyllaceae) (King 2002); *Limonium dichotomum* (Plumbaginaceae) (King & Romera 2004).

Food-plants recorded from the study area: 64 larvae were collected between 2004 and 2006; 31 in both 2004 and 2005, with 2 being collected in the spring of 2006, four plants are utilised by the larvae, from three botanical families: Labiatae, Plumbaginaceae and Caryophyllaceae. For this reason, the species is, strictly speaking, polyphagous. However, its relationship with each of its food-plants is distinct: for example, with *Teucrium polium* it is not floricolous, and larvae use *Teucrium* throughout the year (25 larvae = 39.1%) In the winter moths the plant also seems to serve as a refuge, as well as a source of food, with larvae in the first two stadia overwintering underneath the plant, becoming fully-grown in April. Nevertheless, in the summer the larva feeds on the flowers of other plants. In October, larvae of the third generation appear to be restricted to the *Teucrium* plants. Although *M. herbaria* maybe floricolous on other plants (*Thymus lacaitae*, *Gypsophila struthium*, *Limonium dichotomum*), it does not feed upon the flowers of *Teucrium*.

Sterrhinae Meyrick, 1892

Idaea incisaria (Staudinger, 1892)

Published records of food-plants: Data available refer to those larvae reared in captivity with larvae showing a marked preference for dead or dying leaves of *Polygonum aviculare*, *Rumex*, *Atriplex halimus*, *Rubia peregrina* and *Galium* (King & Romera 2004; King & Viejo Montesinos 2007). These observations tie in with those larvae reared ex ♀ 7.x.07 (code genit. prep. GK499MA GEK *leg. et det.*) which fed upon *Rumex* and *Polygonum aviculare* (Polygonaceae).

Food-plants recorded from the study area: A wild-caught larva which was collected on 18.vi.2005 (♀ genit. prep. GK115MA GEK *leg. et det.*) on withered leaves of *Antirrhinum majus* (Scophulariaceae) (King & Viejo Montesinos 2007).

Idaea longaria (Herrich-Schäffer, 1852)

Published records of food-plants: Previous papers referred to larvae bred out on withered leaves in captivity (Zerkowitz 1946; Trusch & Müller 2000; King & Romera 2004), however, King & Viejo Montesinos (2007) refer to the capture of a larva in Tres Cantos (Madrid) 7.iv.07 below *Artemisia campestris glutinosa* which fed on the withered leaves and inflorescences of *Rumex* sp. in captivity.

Food-plants recorded from the study area: In the two-and-a-half years of the study a single larva was taken under *Centaurea hyssopifolia* 6.iii.2004 (♂ genit. prep. GK007MA GEK *leg./det.*) which fed on the withered leaves of this composite in captivity (King & Viejo Montesinos 2007).

Idaea cervantaria (Millière, 1869)

Published records of food-plants: Previous papers referred to larvae bred out in captivity on withered leaves (Trusch & Müller 2000; King & Romera 2004).

Food-plants recorded from the study area: A single larva was taken 6.iii.2004 (♂ genit. prep. GK078MA GEK *leg. et det.*) below and between two plants: *Gypsophila struthium* and *Thymus lacaitae* feeding on the withered leaves of these plants in captivity (King & Viejo Montesinos 2007).

Scopula imitaria (Hübner, 1799)

Published records of food-plants: There are no data on this species' food-plant in the Iberian Peninsula, nevertheless, Chrétien (1928) gives *Chaenorhinum origanifolium* (Scrophulariaceae) in the French Pyrenees This observation is of interest given the plant on which larvae were found in Madrid (see below).

Food-plants recorded from the study area: Only two larvae were collected in Ciempozuelos (14.iii.2004; 3.iv.2005) both of these specimens on the same plant, *Antirrhinum majus* (Scrophulariaceae). It remains to be seen, but it is highly probable, that the species is oligophagous on plants of this family, rather than polyphagous as suggested by Hausmann (2004).

Scopula (*Glossotrophia*) *rufomixtaria* (Graslin, 1863)

Published records of food-plants: Chrétien (1928) gives *Silene* and *Dianthus* (Caryophyllaceae); whilst King (2000) gives *Gypsophila struthium* (Caryophyllaceae). King & Romera (2004) describe the refusal of newly eclosed larvae of this species to accept leaves of a species of *Silene* sp. common in the area where a female was taken 2.x.03 in Tres Cantos (Madrid) (♀ genit. prep. GK124MA GEK *leg. et det.*).

Food-plants recorded from the study area: There were only four larvae collected in the years 2004–2006 (19.iii.2005, 3.iv.2005, 26.iii.2006) on *Gypsophila struthium,* the recognised food-plant (King 2000).

Scopula (*Glossotrophia*) *asellaria dentatolineata* (Wehrli, 1926)

Published records of food-plants: *Linaria, Antirrhinum* (Scophulariaceae) (Millière

1869–1874); *Fagonia cretica* (Zygophyllaceae), *Anarrhinum brevifolium* (Scrophulariaceae), *Salvia aegyptiaca* (Lamiaceae) (Chrétien, 1917); leaves of herbaceous plants (Forster & Wohlfahrt, 1981); King & Romera (2004) cite *Scopula* (*Glossotrophia) asellaria dentatolineata* in *Antirrhinum majus*; the use of *Gypsophila struthium* is still to be confirmed, as although a larva was collected from this plant on 23.xi.07, there is no evidence that the larva actually fed on it (King pers. com.).

Food-plants recorded from the study area: A total of 335 larvae were taken in the two-and-a-half years of the study on *Antirrhinum majus* mainly feeding on the shrivelled-up leaves of this plant, especially in the summer months.

Casilda consecraria (Staudinger, 1871)

Published records of food-plants: A monophagous species on plants of the genus *Limonium* (Hausmann 2004); Leipnitz in Hausmann (2004) gives the flowers and leaves of *L. sinuatum* and *L. gmelini/augustifolium* in Cyprus; in Spain, *L. dichotomum* is recorded (King 2002; King & Romera 2004; Gómez de Aizpúrua et al. 2005).

Food-plants recorded from the study area: There were 158 larvae collected over the two-and-a-half years of the study on the recognised food-plant, *L. dichotomum* (Plumbaginaceae). The larva is floricolous, but the finding of specimens in May, before the plant flowers, would indicate that the larva also consume the leaves. In any case, the moth also flies as early as February, well before flowering, and also before the leaves are completely available (King 2002).

Larentiinae Duponchel, 1845

Xanthorhoe fluctuata (Linnaeus, 1758)

Published records of food-plants: Monophagous on the flowers and the leaves, of *Lepidium subulatum* (Cruciferae) King (2005).

Food-plants recorded from the study area: There were 121 larvae taken over the years 2004–2006 on *Lepidium subulatum*.

Camptogramma bilineata (Linnaeus, 1758)

Published records of food-plants: *Rumex* (Polygonaceae) *Urtica*, (Urticaceae), *Digitalis* (Scrophulariceae), *Viola* (Violaceae), *Verbascum* (Scrophulariceae) (Gómez de Aizpúrua 1989); *Rumex thyrsiflorus*, *Ononis repens*, *Helianthemum* sp. (Ebert 2001); *Urtica urens* (Gómez de Aizpúrua et al. 2006).

Larva collected from *Asphodelus ramosus* L (Liliaceae) (La Ponderosa, Chinchón, Madrid, 600 m) 24.iii.2001 (♂ genit. prep. GK159MA GEK *leg. det.*), but this cannot be confirmed as a larval food-plant, as probably the larva was only resting on this plant; larva also collected from *Taraxacum*, but in the vicinity of *Rumex* sp. (Tres Cantos (Madrid) 1.iv.2007), feeding on this latter plant in captivity.

Food-plants recorded from the study area: Only four larvae were taken between 2004–2006 (21.ii.2004, 6.iii.2004, 6.iii.2005, 8.i.2006) under *Thymus lacaitae*, but this cannot be confirmed as the food-plant, as the larvae did not thrive on this plant in captivity. It is probable that the plant serves only as a refuge. The specimen taken in January 2006 was found under moss growing in the vicinity of this thyme species.

Nebula ibericata (Treitschke, 1871)

Published records of food-plants: Monophagous on *Galium fructicesens* (Cav.) (Rubiaceae) (King 2005).
Food-plants recorded from the study area: Only two larvae were collected between 2004–2006 (24.iv.2004, 11.iii.2006), both examples were taken beneath other plants, for example, *Thymus lacaitae*, but in the vicinity of *Galium fructicesens*, which only develops in the cooler months, as it dessicates with the arrival of heat in May. With the field study completed, three other examples were found (6.xii.2006, 17.xii.2006, 25.ii.2007) amongst the tiny specimens of this rubiaceaous plant.

Antilurga alhambrata (Staudinger, 1859)

Published records of food-plants: King & Romera (2004) cite the larva on *Helianthemum apenninum*, but the plant was misidentified and is actually *H. hirtum* which belongs to the plant association *Gypsophilo-Centaureetum hypssopifoliae* (Bellot 1952) (Rivas Martínez 1970) a typical gypsophilous plant. In the winter of 2006–2007 (30.xii.2006, 7.i.2007, 14.i.2007) 21 larvae were found underneath *H. hirtum* in an area of gypsym soils in the metropolitan area of Madrid (Cerros de Vallecas, 600 m).
Food-plants recorded from the study area: A total of 16 larvae were taken between the years 2004–2006 on the recognised food-plant, *H. hirtum*, on which it is monophagous.

Hospitalia flavolineata (Staudinger, 1883)

Published records of food-plants: There are no published data on food-plants.
Food-plants recorded from the study area: One larva was taken (8.ii.2004; ♂ genit. prep. GK150MA GEK *leg*/LR *det.*) underneath *Thymus lacaitae*. However, whether this labiate is indeed the host-plant, is still to be confirmed, given that the larva pupated four days later. It should be emphasised that the moth did not emerge successfully and was identified by dissecting the specimen within the pupal exuvium.

Gymnoscelis rufifasciata (Haworth, 1809)

Published records of food-plants: Despite being recognised as a polyphagous species (Mironov 2003) there are few food-plant records for the Iberian Peninsula, except *Salvia lavandulifolia, Lavandula pedunculata* (Lamiaceae) (Gómez de Aizpúrua et al.

2005), and for the Canary Islands in *Adenocarpus viscosus* (Papilionaceae) (Viejo & Cifuentes 1995).

Food-plants recorded from the study area: There was only one larva taken between 2004 and 2006, despite being common as an imago (King per. obs.); on *Gypsophila struthium* 22.vii.2004 (♂ genit. prep.GK182MA). With the field study over, a further larva was taken 13.x.07 on *Limonium dichotomum*. There are no previous records of larvae of this species in plants of either of these botanic families (Caryophyllaceae; Plumbaginaceae).

Eupithecia gemellata **Herrich-Schäffer, 1861**

Published records of food-plants: Carrara (1928) cites *Tunica saxifraga* (Caryophyllaceae) as the food-plant in Trieste (Italy); King & Romera (2004) include *Gypsophila struthium* and *Limonium dichotomum* from larvae collected in Madrid.

Food-plants recorded from the study area: Of the 12 larvae collected (2004–2005) most were noted on the flowers of one plant only: *Gypsophila struthium* (10 = 83.3%), however, with the two specimens taken in 2005 (17.ix.2005, 1.x.2005) these were found on two different plants of two distinct plant families: *Limonium dichotomum* (Plumbaginaceae) and *Reseda stricta* (Resedaceae) this would suggest that the species is not monophagous as indicated by Mironov (2003).

The following specimens were identified by examination of the genitalia: ♂ ex larva 18.ix.2004 GK181MA; ♀ ex larva 1.x.2004 GK180MA; ♂ ex larva 1.x.2004 GK185MA; ♀ ex larva 9.x.2004 GK184MA; ♂ ex larva 24.x.2004 GK176MA; ♀ ex larva 6.xi.2004 GK179MA; ♂ ex larva 1.x.2005 GK379MA; all specimens GEK/leg. et det. Of the 12 larvae, eight survived to produce moths, of which seven were dissected, one ♀ ex larva 17.ix.2005 emerged eleven months later: 23.viii.2006.

Eupithecia centaureata **(Denis & Schiffermüller, 1775)**

Published records of food-plants: Polyphagous on the leaves, flowers and seeds of various herbaceous plants (Mironov 2003; Ratzel 2003).

Food-plants recorded from the study area: Although the species is regarded as being polyphagous, the data recorded here are the first host-plant records for the Iberian Peninsula. In Ciempozuelos larvae are floricolous on two plants: *Gypsophila struthium* and *Foeniculum vulgare* (Apiaceae); with 18 larvae from *Gypsophila* (81.8%) and four from *Foeniculum* (18.2%). This species is not known from these plants, although it is recorded from other caryophyllaceous plants e.g. *Silene vulgaris* (Mironov 2003); however, records from other umbelliferous (Apiaceae) plants are quite numerous e.g. *Angelica sylvestris*, *Peucedanum oreoselinum*, *P. palustre*, *Selinum carvifolia*, *Daucus carota*, *Pastinaca sativa*, *Heracleum sphondylium*, *Seseli annuum*, *Bunium bulbocastanum*, *Torilis japonica*, *Cicuta virosa*, *Eryngium* sp., *Ferulago* sp. (Mironov 2003). The importance that the umbells play in the early stages of *E. centaureata*, can be emphasised by the finding of two larvae once the study had finished (16.vi.2007) in a species of *Torilis*. This attraction for the Apiaceae has been also commented on by Ratzel

(2003). In this way, the species can be regarded as oligophagous rather than polyphagous, as it tends to utilise plants in the same botanical family.

Lithostege castiliaria Staudinger, 1877

Published records of food-plants: *Lepidium subulatum* (King 2002, 2005).
Food-plants recorded from the study area: 24 larvae collected in May in the years 2004–2006 (30.v.2004, 5.vi.2004, 14.v.2005, 13.v.2006) were found in the flowers of *Lepidium subulatum* (King 2005), affirming its status as a monophagous species, which synchronises larval development with the flowering period of *Lepidium.*

Ennominae Duponchel, 1845

Petrophora convergata (Villers, 1789)

Published records of food-plants: *Ephedra nebrodensis* (Ephedraceae), *Rosmarinus officinalis, Teucrium polium capitatum* (Labiatae) (Gómez de Aizpúrua et al. 2003).
Data from the field in Madrid (localities situated 710–730 m) confirms the following food-plants *Thymus lacaitae* (6.v.2000; Ciempozuelos); *Lavendula stoechas* (14.iv.2006; Tres Cantos), 5.v.2007 El Goloso, 13.v.2007 Tres Cantos; *Thymus* sp. (29.iv.2007 El Goloso).
Food-plants recorded from the study area: This species would appear to be restricted to *Thymus lacaitae* with 282 larvae collected only from this labiate.

Petrophora narbonea (Linnaeus, 1758)

Published records of food-plants: *Teucrium chamaedrys, T. scorodonia* (Lamiaceae) (Chapaleon 1992). Data from the field in Madrid (all from Ciempozuelos) indicate the following food-plant: *Teucrium polium* (larvae collected: 18.iii.2001, 9.ii.2002, 9.iii.2002).
Food-plants recorded from the study area: The only plant that the larvae were collected from was *Teucrium polium* with 85 larvae being found.

Dasypteroma thaumasia (Staudinger, 1892)

Published records of food-plants: *Lepidium subulatum* (Gómez de Aizpúrua et al. 2003; King & Romera 2004).
In the winter and spring of 2007 the following food-plant observations in Madrid were made: *Helianthemum hirtum* (Cerros de Vallecas; 7.i.2007); *Artemisia campestris glutinosa* (Compositae) (El Goloso; 4.iii.2007, 22.iv.2007; Tres Cantos; 18.iii.2007; 1.iv.07, 7.iv.2007); *Thymus lacaitae* (3.iv.2007, Barrancos de la Fuente de la Jonquera, Zaragoza, 200 m).

Food-plants recorded from the study area: 46 larvae were collected over the period 2004–2006 from a total of seven plants of five plant families. These were: *Thymus lacaitae, Teucrium polium* (Labiatae), *Centaurea hyssopifolia* (Asteraceae), *Antirrhinum majus* (Scrophulariaceae), *Helianthemum squamatum, H. hirtum* (Cistaceae) and *Lepidium subulatum* (Cruciferae). However, there were differences in the preferences shown for these plants: for example, 29 larvae (63%) were collected from just one plant species, *Thymus lacaitae*, which suggests that the larvae browses on different low plants as it develops; in captivity the larvae were not always reared on the plant on which they were found, but on the plants which last better in captive conditions e.g. *Teucrium polium*.

***Calamodes occitanaria* (Duponchel, 1829)**

Published records of food-plants: *Dorycnium pentaphyllum* (Fabaceae (Leguminosae)) (Gómez de Aizpúrua, *at al* 2006). The following observations were made of larvae collected in the field in Madrid and Guadalajara: *Thymus lacaitae* (18.ii.2001, 25.ii.2001; La Ponderosa, Chinchón), (27.i.2002; Barajas), (30.xii.2006; Cerros de Vallecas), *Thymus* sp. (29.iii.2002; Iriépal (prov. Guadalajara)]; *Santolina rosmarinifolia* (El Goloso; 4.ii.2007, 11.ii.2007, 4.iii.2007; Tres Cantos 18.iii.2007), *Artemisia campestris glutinosa* (4.iii.2007; El Goloso, Tres Cantos; 18.iii.2007).
Food-plants recorded from the study area: The species is monophagous on *Thymus lacaitae*, with all 73 larvae collected from this plant. It is interesting to note that the larvae are to be found in the winter months, probably when the leaves of its sclerophyllous food-plant are in a suitable condition to be consumed.

***Aspitates ochrearia* (Rossi, 1794)**

Published records of food-plants: *Artemisia campestris glutinosa* (Gómez de Aizpúrua et al. 2003). The following observations were made of larvae collected in the field in Madrid, Valladolid and Zaragoza: *Artemisia campestris glutinosa* (3.ii.2002 Madrid; Barajas), (4.iii.2007, 11.iii.2007, 18.iii.2007, 7.iv.2007; Tres Cantos); *Centaurea hyssopifolia* (9.iii.2002; Ciempozuelos), *Carlina corymbosa* (1.ix.2002; Tres Cantos) although it is likely that the larva was only resting on this plant. *Thymus* sp. (1.ix.2002; Tres Cantos), *Dorycnium* sp. (21.iii.2004; Valladolid), *Bupleurum* sp (3.iv.2007; Montes de Torrero, Zaragoza) . It is likely that the larva was only resting on this plant, as in captivity it fed on *Rumex* sp.
Food-plants recorded from the study area: Although only 6 larvae were collected over the years 2004–2006 (25.i.2004, 22.ii.2004, 6.iii.2004, 5.xii.2004, 1.iv.2006) the larva was polyphagous on five plant species each in a different family: *Centaurea hyssopifolia* (Compositae) (2 larvae), *Lepidium subulatum* (Cruciferae) (1 larva), *Thymus lacaitae* (Labiatae) (1 larva), *Helianthemum hirtum* (Cistaceae) (1 larva) and *Gypsophila struthium* (Caprifoliaceae) (1 larva).

Dyscia distinctaria (Bang-Haas, 1910)

Published records of food-plants: *Helianthemum guttatum* (Cistaceae), *Cistus ledon* (Fabaceae), *C. albus* (Zerkowitz 1946).
Food-plants recorded from the study area: The only larva found was a fully-grown specimen under *Helianthemum hirtum* (Cistaceae) (5.xii.2004) which produced a female in February 2005 (genit. prep. GK165MA GEK *leg et det.*)

Compsoptera jourdanaria (Serres, 1826)

Published records of food-plants: *Santolina rosmarinifolia* (Gómez de Aizpúrua 1987); *Salsola vermiculata, Artemisia herba-alba* (Redondo et al. 2001); *Artemisia campestris glutinosa, Artemisia herba-alba* (Compositae) (Gómez de Aizpúrua et al. 2003).
The following food-plant records are from Madrid and Zaragoza: *Thymus lacaitae* (30.xii.2006; Cerros de Vallecas), *Helianthemum hirtum* (30.xii.2006; 7.i.2007 Cerros de Vallecas), *Artemisia campestris glutinosa* (Tres Cantos 4.i.2007, 6.i.2007, 20.i.2007, 11.iii.2007, 22.iv.2007; El Goloso 4.ii.2007, 4.iii.2007), *Artemisia herba-alba* (Ciempozuelos 25.ii.2007; Montes de Torrero, Zaragoza 3.iv.2007), *Santolina rosmarinifolia* (El Goloso 4.ii.2007, 11.ii.2007, 4.iii.2007, 11.iii.2007).
Food-plants recorded from the study area: The species seems to be monophagous on *Artemisia herba-alba*, with 10 larvae collected from this plant in March 2005 (19 and 22.iii.2005). Although, there are two records from *Helianthemum hirtum*, a characteristic gypsophite, in the area of Vallecas, this plant was not used in Ciempozuelos. The host-plant is a new record for this species; an interesting observation was that the parenchyma was scraped away by the young larvae, rather than the leaf being consumed at the margins, as is usually the case with geometrid larvae. In localities in north-central Madrid, the larva feeds on three species of plant (*Thymus lacaitae*, *Artemisia campestris glutinosa*, *Santolina rosmarinifolia*) in two botanic families (Labiadae and Compositae).

Discussion

Hering (1950) and Huemer (1988) describe three strategies related to larval feeding: monophagy (which can be divided into three groups according to whether the species uses only one species of plant, or all plants in a single genus); Oligophagy (when the plants utilised belong to genera in the same family, or related families; disjunctive Oligophagy includes those species who utilise plants that are not related, or whose relationship with the plant varies according to generation. Lastly, polyphagy, involves those species feeding on plants families across a wide botanic spectrum (more than two plant families). Another strategy within the range of feeding possibilities is that of detriphagy, characteristic of the genus *Idaea* (Ryrholm, 1989). This enables the larvae to cope with the hydrological deficit in the Mediterranean basin, especially, but not only, in the summer months.

Tab. 2 categorises the 25 species found as larvae in terms of their apparent feeding strategies, with the majority of species (13 = 55%) being monophagous, whilst 10 species are polyphagous (45%) (this would include the detrivores, as technically, they utilise plants from more than two plant families, although the mechanisms they employ to deal with the plant are distinctive, feeding on dead, decaying or dessicated leaves; the larvae in this way are perhaps in a better position to circumvent ostensible plant defence mechanisms). These detrivores would be: *I. incisaria*, *I. longaria*, and *I. cervantaria*, a strategy recognised as being common in the genus; *Idaea* (Covell 1983; Hausmann 2004, King & Romera 2004; King & Viejo Montesinos 2007). *Scopula* (*Glossotrophia*) *asellaria dentatolineata* is an interesting case, as although it is a monophagous species (at least in the area under study), it has been observed as being a detrivore, both in the wild state and in captivity, feeding on the dried-up leaves of its food-plant *Anthirrhinum majus* on which it monophagous. The *Idaea* feed on the withered leaves of various low plants offered to them in captivity, and probably in the wild state too: In April/May 2008, thirty-four larvae of *Idaea ochrata albida* Zerny, 1936 were found in Madrid (El Goloso, Tres Cantos) from amongst the leaf litter to be found at the base of *Artemisia campestre* plants, as well as from amongst other low plants, including grasses.

It was not clear which food-plant was being used by two species: *C bilineata* and *H. flavolineata*, because the larvae did not feed in captivity on the plant upon which they were found in the wild.

The diversity of geometrid species hosted by an individual plant species can vary considerably. For example, *Teucrium polium* was examined on 95 of the 130 visits (73.7%), nevertheless, it supports a mere three species namely; *M. herbaria, P. narbonae* and *D. thaumasia*. Another plant which was examined frequently, on 56 visits (43.8%), was *Limonium dichotomum*, but it supports only four species (*P. etruscaria*, *M. herbaria*, *C. consecraria*, *E. gemellata*) all of these species being floricolous, although *C. consecraria* would use the leaves as well, as the larvae are to be found before flowering. *Lepidium subulatum* was examined on 64 occasions (49. 2%) but does not support more than four species (*X. fluctuata*, *L. castiliaria D. thaumasia*, *A. ochrearia*). In contrast, *Gypsophila struthum* (especially the flowers) and *Thymus lacaitae* (only the leaves) support at least twelve species each (including species not identified); *P. etruscaria*, *M. herbaria*, *I. cervantaria*, *G. rufomixtaria*, *G. rufifasciata*, *E. centaureata*, *E. gemellata* and *A. ochrearia* (3 species unidentified). On *Gypsophila struthum*, all species except *S. Rufomixtaria* are generalists, whilst *Thymus lacaitae* provides food for *M. herbaria*, *C. bilineata*, *H. flavolineata*, *P. convergata*, *D. thaumasia*, *C. occitanaria* and *A. ochrearia* (5 species unidentified). *Thymus lacaitae* is interesting in that the plant is used in the winter and spring, but not in the summer, as the leaves are presumably too tough for larvae to eat. In fact, in this latter plant, only two species are specialists on it (*P. convergata*, *C. occitanaria*), at least in Ciempozuelos. With regard to *C. bilineata* and *H. flavolineata*, it was not possible to establish the relationship that they maintain with this plant: was it nutritional or merely structural? The case of *M. herbaria* was interesting as it was the only species which was found on its flowers (1 larva 12.vi.2004) despite it being an established floricolous species in the summer months (see species results), as well as the fact that this thyme species was examined on 73 times out of the 130 visits to the field study site.

Tab. 2. The 25 species taken as larvae in Ciempozuelos 2004–2006 and their feeding strategies. N = number.

Species	N plant species utilised	N plant families utilised	mono-phagous	oligo-phagous	poly-phagous	detrivore
Phaiogramma etruscaria	4	4			+	
Microloxia herbaria	4	3			+	
Idaea incisaria						+
Idaea longaria						+
Idaea cervantaria						+
Scopula imitaria	1	1	+			
Scopula rufomixtaria	1	1	+			
Scopula asellaria dentatolineata	1	1	+			+
Casilda consecraria	1	1	+			
Xanthorhoe fluctuata	1	1	+			
Camptogramma bilineata			?	?	?	
Nebula ibericata	1	1	+			
Antilurga alhambrata	1	1	+			
Hospitalia flavolineata			?	?	?	
Gymnoscelis rufifasciata	2	2			+	
Eupithecia gemellata	3	3			+	
Eupithecia centaureata	2	2			+	
Lithostege castiliaria	1	1	+			
Petrophora convergata	1	1	+			
Petrophora narbonea	1	1	+			
Dasypteroma thaumasia	7	5			+	
Calamodes occitanaria	1	1	+			
Aspitates ochrearia	5	5			+	
Dyscia distinctaria	1	1	+			
Compsoptera jourdanaria	1	1	+			

There are two species of *Helianthemum* in the study area: *H. hirtum* and *H. squamatum*, but they have a very restricted geometrid association; *H. hirtum* harbours two monophagous species in the winter months (*A. alhambrata, D. distinctaria*) and two other generalist species (*D. thaumasia*, *A. ochrearia*). In contrast, *H. squamatum* appears to have no geometrid species associated with it, except two records of *D. thaumasia* (27.ii.2005, 13.iii.2005), where the larvae were just found underneath the plant and not on the leaves or flowers (see species' results). In terms of the attraction of this cistaceous plant for other Lepidoptera, there are two species in Ciempozuelos: *Dipluriella loti* (Ochsenheimer, 1810) (Lasiocampidae) which utilises both the leaves and the flowers of this plant and *Anacampsis scintillella* (Fischer von Röslerstamm, 1841) (Gelechiidae) seems to be a specialist on the leaves (M. F. C. Corley pers. com.).

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Appendix 1:

Plants cited in the study which formed part of the transect, or otherwise cited (not literature references). (Not all of these plants belong to the *Thymo-Teucrion verticillati* botanic alliance).

Cistaceae
- *Helianthemum hirtum* (L.) Mill.
- *H. squamatum* (L.) Dum

Rutaceae
- *Ruta montana* (L.) L.

Brassicaceae (Cruciferae)
- *Lepidium subulatum* L.

Resedaceae
- *Reseda stricta* Pers.

Plumbaginaceae
- *Limonium dichotomum* (Cav.) Kuntze

Scrophulariaceae
- *Antirrhinum majus* L.

Rubiaceae
- *Galium fructicesens* Cav.

Lamiaceae (Labiatae):
- *Teucrium polium* L. *subesp. capitatum* Briq.
- *Thymus lacaitae* Pau.

Caryophyllaceae
- *Gypsophila struthium* L. in Loefl.

Apiaceae
- *Foeniculum vulgare* Mill. subsp. *vulgare*

Asteraceae
- *Centaurea hyssopifolia* Vahl.
- *Artemisia herba-alba* Asso. subsp. *herba-alba*
- *Artemisia campestris glutinosa* (J. Gay ex Besser).

Łukasz Przybyłowicz 2009. Thyretini of Africa. An Illustrated Catalogue of the Thyretini (Lepidoptera: Arctiidae: Syntominae) of the Afrotropical Region. – Entomological Volume 16. A series facing global biodiversity in insects. – Apollo Books, Stenstrup. 170 pp., 6 (colour) + 37 pls. Hard cover, format 175 × 255 mm.

I first became acquainted with African Thyretini in 1989 when Vladimir Dubatolov brought a couple of these moths to St Petersburg for identification. Externally, the moths look like unusual Syntomidae or Lasiocampidae / Limacodidae. However, despite spending some time on them and consulting a number of standard references, unambiguous identification proved impossible. This was not a surprise, as most African moths have been poorly studied. Moreover, the Thyretini were not well defined until very recently and the group has been variously treated as a family or as a subgroup of the Arctiidae or Syntomidae. Thus, this monograph, by Dr Łukasz Przybyłowicz from Cracow, is particularly welcome.

The book states that it is the first comprehensive tool for the identification of thyretines, a unique group of large arctiids (Arctiidae: Syntominae) restricted almost exclusively to the Afrotropical Region. The 194 currently recognized species are catalogued and illustrated. Information on the original descriptions, type locality and type depositions for each of 333 species-group names is given. Five genus-group names and 62 species-group names are synonymized. Three genus-group names and seven species-group names are excluded from the Thyretini and transferred to other groups of arctiids. The diagnostic features of each species are presented, as well as brief details on early stages, biology and known distribution. The male and female genitalia are illustrated by half-tone photographs and the whole moths by colour photographs. Where possible the types are illustrated rather than other specimens. Finally, a complete bibliography treating various aspects of the nomenclature, taxonomy, faunistics, biology and other information concerning Thyretini is included.

The book is divided into 14 (but really into 15) chapters; their status and rank is different, the numeration is lost in the text of the book and numerated headlines are also often lost from the text. The chapters are as following: 1. Acknowledgements, 2. Summary (only 6 lines), 3. Introduction – half a page, briefly considering the placement of the Thyretini among arctioid moths, without discussing taxonomy, and a history of their study. A short note explains that ”in the present catalogue the traditional classification is still applied” (p. 7), but it remains unclear what ”the traditional classification” is. 4. Arrangement of the book – an explanation of the structure of the systematic account of species. 5. List of abbreviations of institutions. 6. Catalogue (nomenclatorial list of names, catalogued alphabetically). 7. Unavailable names. 8. Taxa excluded from the Thyretini. 9. Taxonomic changes and comments to the generic level (with some remarks on taxonomy for five genera). 10. Descriptions of species (which is more an annotated list of species). 11. References. 12. Colour plates with adult habits. 13. Plates with male genitalia. 14. Plates with female genitalia. 15. Index of scientific names. The numeration of the chapters is wrong from the 7. (given “6.” erroneously twice) that results in the book in 14 but not 15 chapters.

It is not necessary to consider each of the chapters, but three are worthy of discussion. These are the Catalogue, the annotated list of species and figures.

Nomenclatorial Catalogue (pp. 10–29, although not headlined in the text of the book), without doubts is a corner-stone of the monograph. It consists of complete nomenclatorial data (such as original descriptions, type localities, deposition of the types, synonymy and designation of a lectotype) for all 194 currently recognized species-group names. Unfortunately, the number of species associated with each genus differs from that given earlier in the catalogue (see below). A large number of infrasubspecific names (mostly described originally as aberrations) are considered in a separate section "Unavailable names". Otherwise, there is little to criticize in the catalogue, which is certainly comprehensive. This part will be especially helpful for curators arranging collections although genera and their species are arranged alphabetically, rather than in any systematic order.

For identification of thyretines, the annotated list of species and figures is the most important part of the book. I read carefully the numerous specific accounts, but in the end it left me with more questions than answers.

1. Unfortunately, by separating the catalogue from the systematic account of species and listing of colour variations and aberrations given under "Unavailable names", the individual variability of particular species is not clearly shown and there are many duplications and large, blank gaps in the text. This together with rather poor layout, such as extra lines for plate numbers only, occupies at least 15 pages of wasted space and make the information provided confusing to follow. The space lost here could have been used for other information, such as maps of distribution.
2. Diagnostic characters are provided for only a few of the similar species. For a number of species, only very short descriptions are given and for others the only diagnostic characters used are for the male genitalia. For most other species, comments such as "lacking contrast", "females are indistinguishable", and "smaller than previous species", provide little diagnostic help and really should have been augmented by figures of genitalia and adults.
3. Similarly, identification keys are not provided.
4. In some complex cases where there is an uncertain or controversial status of a taxon, the author fails to discuss these matters and simply refers to his own works (only three are listed in the references).
5. The author's point of view is not always clear. For example, seven species are listed in *Pseudothyretes* Dufrane, 1945 (p. 93–94), and are also numbered in the catalogue, but, for example, the text for some species reads: "160. *Pseudothyretes carnea* (Hampson, 1898) ... One of the two species in the genus described from a female. It certainly is conspecific with one of the other species but it is impossible now to match females with males" or "163. *Pseudothyretes mariae* Dufrane, 1945 ... The holotype is in fact a female ... For taxonomic interpretation see remarks for *P. carnea*".

Such ambiguous notes can also be found in other parts of the book, and suggest that the number of "currently recognized species" is undoubtedly an underestimate. Also, the absence of new descriptions is surprising as it is hard to believe that the Thyretini of the

African continent are so well studied. In other groups of moths, more than 50% of the species are often still undescribed.

The illustrations should be a key feature of a book such as this, as thyretini moths are often brightly colored and many have wings with transparent windows. However, the colour quality of the plates is very poor with the plates being dark and colours poorly represented e.g. red colour is almost absent, being replaced by brownish or dark crimson. Even very bright moths with characteristic wing pattern elements can only be recognized with difficulty or in some cases are indistinguishable from others. Additionally, some of the specimens displayed are poorly preserved or badly set. Finely prepared moths of different sexes, from different locations and various patterning and colouration are absent!

In contrast, the half-tone plates are highly professional, made to the best quality, with easily recognizable illustrations. Here, it would have been advantageous to see some additional marks like arrows pointing to characteristic features of similar species.

The publication has been needed for a long time and I hoped it would be a perfect example, a jewel in any library. However, there is insufficient coverage of the subject. It can not be described as a tool "facilitating the identification of thyretines". It is valuable as a nomenclatorial Catalogue, although it is not comprehensive in the remaining parts, completely lacking morphological descriptions for moths and larvae, their biology and additional data. Nevertheless, I wish Dr Przybyłowicz well in his studies and hope for improvements in futures publications on Thyretini and really would like to see a comprehensive revision of this group in the future.

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SOCIETAS EUROPAEA LEPIDOPTEROLOGICA e.V.

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