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Paul A. Sokoloff

1946 – 2012

Like many amateur entomologists Paul Sokoloff experienced a tension between his entomology and his professional life. During his early career, even though working towards further qualifications, he found time for fieldwork, especially near his home in southeast London. He was interested in all Lepidoptera in Britain, especially the Gelechiidae. He became active in entomological societies, being elected President of the British Entomological & Natural History Society for 1984. He had published an illustrated paper on the genera *Teleiodes* and *Teleiopsis*, he also updated a publication of the Amateur Entomologists' Society *Practical hints for collecting and studying Microlepidoptera* in 1980 and produced a handbook *Breeding the British and European Hawk-moths* in 1984. In 1985 he took over as editor of the *Entomologist's Record*. His interest in literature and his ability with words were put to good use in this role. After ten years he resigned when he took on more demanding professional duties in a leading UK examinations board. In retirement he resumed his entomological activity and became a member of *Nota lepidopterologica*'s editorial team. He met and collaborated with other editors even though he had never managed to attend one of the SEL Congresses. His editorial skill and the effort that he put into improving manuscripts in English published in *Nota* was greatly appreciated by the scientific editors, as well as the numerous authors whom he helped. Regrettably he was diagnosed with cancer in June 2012 and died in November. Our sympathy is extended to his widow Linda and their son and daughter.

David Agassiz

Observations on the preimaginal ecology of *Rhynchina canariensis* Pinker, 1962 (Erebidae: Hypeninae) and *Abrostola canariensis* Hampson, 1913 (Noctuidae: Plusiinae) on the Canary island of La Gomera

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Abstract. In this work some information (including photos) is provided on larvae and preimaginal ecology of two Canarian endemics *Abrostola canariensis* Hampson, 1913 and *Rhynchina canariensis* Pinker, 1962 from La Gomera. Larvae of *R. canariensis* were observed in Vallehermoso on *Lotus emeroides* R. P. Murray (Fabaceae). They inhabit stony, semidry slopes with *Juniperus turbinata* Guss. (Cupressaceae) where there are stands of *L. emeroides* on more or less open ground. The brownish, elongate larvae resemble those of *Zekelita antiqualis* (Hübner, 1809). Eggs and larvae of *Abrostola canariensis* were found on *Parietaria judaica* L. (Urticaceae) on not too dry or partially shaded rocky slopes and especially stone walls made of natural stone in cultivated or abandoned areas. *Parietaria* L. spp. should be the main host plants of this species and *Urtica* L. spp. are likely to be used only occasionally.

Introduction

The Canary Islands are famous for their high rate of endemic plants and insects. While the species composition is relatively well known, the preimaginal stages and bionomics of many species are still in need of detailed study.

Rhynchina canariensis Pinker, 1962 (Erebidae: Hypeninae) and *Abrostola canariensis* Hampson, 1913 (Noctuidae: Plusiinae) are both endemic to the Canary Islands. While the former is known from Tenerife eastwards, the latter inhabits all islands of the archipelago (Baez 1998; Hacker & Schmitz 1996). The larva and relevant life habits were fully unknown in the case of *R. canariensis* and poorly known in that of *A. canariensis*. The latter is said to use *Urtica urens* L. as host plant (e.g., Hacker & Schmitz 1996), but no reliable field observations have been published so far.

During a trip to La Gomera in December 6–19, 2011 the author had the chance to find eggs and larvae of *A. canariensis* and larvae of *R. canariensis*, the latter being new to La Gomera.

Material and methods

Eighteen larvae of *Rhynchina canariensis* were found on December 8 in Vallehermoso (La Gomera, Canary Islands, Spain) at about 400 m above sea level by careful investigation of *Lotus emeroides* R. P. Murray stands. As to *Abrostola canariensis*, five larvae and two eggs were found in several localities (Vallehermoso, Agulo) on La Gomera between December 8–15, 2011 by searching *Parietaria judaica* L. stands. The larvae were successfully reared in small glass containers with perforated caps to avoid

Fig. 1. Imago of *Abrostola canariensis* (La Gomera, Valle Gran Rey, December 2011).

Fig. 2. Larval habitat of *Rhynchina canariensis*: slopes with partially open ground in Vallehermoso (La Gomera, December 2011).

excessive moisture at room temperatures (18–20°C), and taxonomic identifications were confirmed after they attained the imaginal stage.

Additionally, an ex-ovo rearing of *A. canariensis* after oviposition of a female (Fig. 1) from Valle Gran Rey (found at an illuminated building) has been carried out under the same conditions as mentioned above.

Results

Bionomics. Larvae of *Rhynchina canariensis* inhabit dry to semidry, stony or rocky slopes with partially exposed soil (Fig. 2) where procumbent shoots of *Lotus emeroides* grow on mostly open ground in the "succulent" belt between the sea level and approximately 600–700 m above sea level. On La Gomera the species is obviously restricted to the *Juniperus turbinata* Guss. (Cupressaceae) dominated slopes between Vallehermoso and Hermigua where the observed host plant *Lotus emeroides* grows. This plant species is endemic to La Gomera. Larvae of *R. canariensis* had been found already in December 2009 in the same locality, though nearly at the sea level, but rearing had failed so that they could not have been identified. The larvae hide by day, stretching themselves along the lower parts of the procumbent shoots (Fig. 3) of the host plants and in later instars they feed preferentially at night. In captivity the moths emerged after 14 to 18 days of pupal phase.

Larvae of *Abrostola canariensis* were observed on *Parietaria judaica* which grows on walls bordering roads and fields (Fig. 4) or on rocks. The young, whitish green larvae rest on the lower side of the leaves while in the last instar they tend to hide at the base of the plant during daytime. The eggs (Fig. 5) were found singly on the lower side

Fig. 3. Larval habitat of *Rhynchina canariensis*: *Lotus emeroides* on partially open ground at a slope in Vallehermoso (La Gomera, December 2011).

Fig. 4. Larval habitat of *Abrostola canariensis* at Agulo (La Gomera, December 2011): rocks and walls with *Parietaria judaica*.

of the leaves. The occupied plants were mostly growing isolatedly in rock and stone niches on at least partially sunny ground. Pupation took place in captivity between the end of December and January; all pupae (n = 12) entered dormancy and moths did not emerge until late April and May 2012.

Searches for larvae of *A. canariensis* on *Urtica urens* in Fuerteventura (Pico de la Zarza and above Cofete) in February 2011 did not result in any specimens except for those of *Vanessa vulcanica* (Godart, 1819), which is rare on this eastern island. Another examination of *Urtica morifolia* Poir. on La Gomera was also not successful and resulted only in larvae of *Vanessa vulcanica* and *Mniotype schumacheri* (Rebel, 1917).

Habitus. The larvae (Figs 6–11) of *Rhynchina canariensis* are brownish, the first two pairs of prolegs are reduced. They bear a variably broad (viz. not parallel-sided) darker dorsal field which is bordered by a slightly white and then dark area. The ventral side is light coloured, almost whitish. The head shows a darker finely reticulated pattern and especially two large dark spots. The pupa (Fig. 12) is light yellowish to reddish brown.

Young larvae of *Abrostola canariensis* are whitish green (Figs 13–14) and thus well matching the lower sides of *Parietaria* leaves. In the last instar their colour ranges from greenish yellow to light brown (Figs 15–16) with several small whitish marks and speckles. The larva is similar to that of *A. triplasia* (Linnaeus, 1758), but, for example, the dorsal markings on the fourth and fifth segments are different: dark triangles point towards the head in *A. triplasia* whereas there are oppositely oriented subtriangular markings in *A. canariensis*. Additionally, the number of white spots and their size and arrangement is different (e.g., two larger spots at the sides of the triangle of the fourth segment in *A. triplasia*).

Typical traits of *Abrostola* Ochsenheimer, 1816 are well expressed: prolegs on abdominal segments 3–6, transverse, semicircular flecks on the dorsal zone of abdominal segments 1, 2 and 8. The pupa (Fig. 17) is brown and does not differ significantly from those of its European congeners.

Fig. 5. Egg of *Abrostola canariensis* (La Gomera, December 2011).

Fig. 6. Young larva of *Rhynchina canariensis* (La Gomera, Vallehermoso, December 2011)

Fig. 7. Larva of *Rhynchina canariensis* in the last instar (lateral view).

Fig. 8. Larva of *Rhynchina canariensis* in the last instar (dorsal view).

Discussion

Rhynchina canariensis (Fig. 18) is a xerothermophilous species of lower and middle elevations, as shown by the localities where adults have been captured, mainly at light (e.g., Hacker & Schmitz 1998; Pinker 1962). The species is not restricted to slopes, but can also be found in drier coastal plains. On islands other than La Gomera the moth must evidently rely on other *Lotus* spp. such as *Lotus lancerottensis* Webb et Berth., *Lotus glaucus* Dryand. in Aiton, *Lotus glinoides* Delile or *Lotus campylocladus* Webb et Berth., which are locally abundant in biotopes where *R. canariensis* occurs (e.g., in the low hills and valleys around Betancuria on Fuerteventura). It is questionable but it should be examined whether *R. canariensis* is able to develop on other genera of Fabaceae as well. Last instar larvae supplied in captivity with *Onobrychis viciifolia* Scop. (Fabaceae) did not accept this plant. The larvae resemble in both external appearance and behaviour those of *Zekelita antiqualis* (Hübner, 1809) (cf. Beck 1999), which belongs to a closely related genus within the subfamily Hypeninae (Mayerl & Lödl 1997). For example, the larval head markings (Fig. 11) are very similar to each other. Interestingly, larvae of *Rhynchina* (and *Zekelita*) show some characters commonly ob-

Fig. 9. Fully grown (some days prior to pupation) last instar larva of *Rhynchina canariensis* (dorsal view).

Fig. 10. Fully grown last instar larva of *Rhynchina canariensis* (lateral view).

Fig. 11. Head of larva of *Rhynchina canariensis* in the last instar.

Fig. 12. Pupa of *Rhynchina canariensis* (ventral view, cocoon removed)

Fig. 13. Larva of *Abrostola canariensis* in penultimate instar (La Gomera, Vallehermoso, December 2011).

Fig. 14. Larva of *Abrostola canariensis* in penultimate instar, dorsal view (La Gomera, Vallehermoso, December 2011).

served within the subfamily Catocalinae, e.g., the non-parallel sided darker dorsal field, the overall shape, and their behaviour. The higher classification of Noctuoidea has been in great flux recently and the closer affinity of some subfamilies formerly assigned

Fig. 15. Last instar larva of *Abrostola canariensis* (lateral view).

Fig. 16. Last instar Larva of *Abrostola canariensis* (dorsal view).

Fig. 17. Pupa of *Abrostola canariensis* (cocoon removed).

Fig. 18. Adult female of *Rhynchina canariensis*, ex larva, Vallehermoso, December 2011.

to Noctuidae in the old sense such as Hypeninae and Catocalinae is reflected by their placement in the newly established family Erebidae (cf. Lafontaine & Fibiger 2006; Zahiri et al. 2011).

Abrostola canariensis is also an inhabitant of semidry, rocky slopes of the "succulent" belt and cultivated areas, and secondarily of stone walls along roads or between fields. As *Parietaria judaica* is relatively widespread on the islands, it should be the most important host plant for this species. In the literature there are hints and especially presumptions of *Urtica* being the host plant of *A. canariensis*. However, my own examination of *Urtica urens* on Fuerteventura did not yield any larvae, but as the larvae did accept *Urtica dioica* L. in captivity, it is likely that *Urtica urens* is a host plant in nature, too. *Urtica morifolia*, as an endemic member of the genus *Urtica* L., which grows especially in the so called "Laurisilva", is probably not suited because of the cool microclimate prevailing in the humid areas where such wood formations usually occur. Probably the moth also uses other *Parietaria* spp. such as the endemic *Parietaria filamentosa* Webb & Berth. Rearing results indicate that this species is able to survive the dry summer period in pupal dormancy in the same way as its Central

European allies do during the cold winters. Sometimes there are hints about the occurrence of *Abrostola canariensis* on the Ilhas Selvagens which are located between the Canaries and Madeira and belong to Portugal (e.g., the Fauna Europaea project), but the species is not mentioned in the cited paper (Aguiar & Karsholt 2006).

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Objectiu Natura – Associació de Fotògrafs de Natura de Catalunya (ed.) 2012.
Mariposas por la vida. Guía visual de las mariposas ibéricas diurnas. – Objectiu Natura, Barcelona, Spain, 255 pp. ISBN 978-84-616-1072-3. Price: 29.95 € plus shipping costs (order information can be obtained at http://www.mariposasporlavida.org).

Over one hundred, mainly Spanish, photographers have contributed more than 1,000 photos. Like all the other people involved, they have freely created a book that is special in many ways.

With "mariposas por la vida" ("butterflies for life") a field guide based on photos, or simply a "visual guide", was published in November 2012, covering all the butterfly species of the Iberian Peninsula and the Balearic Islands. Two hundred and twenty-nine species of the families Papilionidae, Pieridae, Nymphalidae, Lycaenidae, Riodinidae and Hesperiidae are included. In general, the book dedicates one page to each species, most of them with three coloured photos, usually showing the upper- and the underside of the animals. All photos were taken in the field, showing living specimens in their natural habitat. The information on each species is completed by illustrations on distribution, flight time, butterfly size and degree of threat (according to IUCN) as well as – sometimes a bit sparse – information on the larval food plants. Five additional pages show pictures by photographers whose photos have not been published on the pages dedicated to the species.

Being a "visual guide", as the Spanish subtitle says, supplementary texts were deliberately avoided. The taxonomy is up to date, the photos are of very good quality and aesthetically impressive. For that reason alone the purchase of this book, which is moderately priced, can be recommended. Some readers may regret that the butterflies of the Canary Islands are not included, but this is not a book about Spanish but Iberian butterflies.

Yet another aspect makes this book so special: It is dedicated to Gabino Martín Toral, a Spanish nature photographer and butterfly lover, who died much too early as a victim of the insidious disease amyotrophic lateral sclerosis (ALS), a debilitating motor neuron disease. All sales revenue of this book will be given to the foundation "Fundación Miquel Valls", to benefit the care of ALS patients. So "mariposas por la vida" is a tribute to life, too.

Torsten van der Heyden

Monochroa bronzella sp. n. from the southwestern Alps (Lepidoptera: Gelechiidae)

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Abstract. *Monochroa bronzella* sp. n. is described from the southwestern Alps (France, Italy). It is closely related to *M. nomadella* (Zeller, 1868), with which it was hitherto confused. Literature records of *M. nomadella* from France and northwestern Italy refer to *M. bronzella* sp. n. The two species are most clearly distinguishable in the signa of the female genitalia. Females of both species have reduced wings, most pronounced in *M. nomadella*. The new species is found in mountain areas at altitudes from around 800 to 2000 m. Adults and male and female genitalia of these two species are figured.

Résumé. *Monochroa bronzella* sp. n. est décrit du sud-ouest des Alpes (France, Italie). Il est voisin de *Monochroa nomadella* (Zeller, 1868) avec lequel il a été parfois confondu. Les signalisations de *M. nomadella* de France et du nord-ouest de l'Italie concernent en réalité *M. bronzella* sp. n. Les deux espèces se distinguent facilement par le signum des genitalia femelles. Les femelles des deux espèces ont les ailes réduites, caractère plus prononcé chez *M. nomadella*. La nouvelle espèce vole dans des zones montagneuses entre 800 et 2000 m. Imagos mâles et femelles des deux espèces sont figurés.

Introduction

Monochroa is a species-rich genus of Gelechiidae with altogether 30 species known from Europe, including the Canary Islands (Huemer & Karsholt 2010; Karsholt 2011). Similarly to other genera of the family a complete review on a continental scale is lacking, though Elsner et al. (1999) give an overview of the central European taxa. *Monochroa* species can be divided into species groups based on host-plant relationships and genitalia characters (Gregersen & Karsholt, unpublished). The species dealt with here belongs to the *M. ferrea*-group, which is characterised by having the vinculum of the male genitalia with medial oval sclerotisation and the phallus cylindrical with numerous small spines in the vesica, and larvae (as far as known) feeding on *Carex* (Cyperaceae).

Most species of *Monochroa* are restricted to wetland habitats and only a few taxa occur in mountain areas. Species of the *M. ferrea*-group inhabit sandy or rocky areas from lowlands to high altitudes. Below we describe a new species which was hitherto confused with *M. nomadella* (Zeller, 1868) and compare it with its closest relative.

Abbreviations

BALD	Collection of Giorgio Baldizzone, Asti, Italy
BAS	Collection of Graziano Bassi, Avigliana, Italy
FOUR	Collection of François Fournier, Clermont-Ferrand, France
MHNL	Musée d'Histoire Naturelle de Lyon, France
TLMF	Tiroler Landesmuseum Ferdinandeum, Innsbruck, Austria
VAR	Collection of Thierry Varenne, Nice, France
ZMUC	Zoologisk Museum, Natural History Museum of Denmark, Copenhagen, Denmark

Taxonomic part

Monochroa bronzella sp. n. Figs 1, 2, 5, 7, 9, 11

Material. Holotype ♂, 'route du Col de TENDE Alpes Maritimes 4.viii.2007 uv/vm 1360 m' 'Monochroa bronzella n. sp. ♂ Th. Varenne leg.' 'HOLOTYPE' 'P. Huemer GEL 1176 ♂' (TLMF). – Paratypes: **France**, 2♂, same data as holotype, genitalia slide Nel 21929 (VAR); same data as holotype, 1♂, 16.vii.2009, genitalia slide Fournier 798 (FOUR); Vaucluse, Saint-Christol, 2♂, 8.vii.1992, leg. Moulignier, genitalia slide Nel 1592, 1606 (MHNL, TLFM). **Italy**, Piemonte, Valsusa, Bussoleno, Pian Cervetto, 1400 m, 1♂, 7.vi.1989, leg. Bassi (BAS); ibid, but Rocci Amelone, 1♂, 27.v.1990, leg. Baldizzone, genitalia slide Hendriksen 1404 (ZMUC); ibid, but Mompantero, 1200 m, 3♂, 18.vi.1993, leg. Bassi, genitalia prep. Elsner 882 (in tube) (BAS, ZMUC); ibid, but Mompantero, Mt. Rocciamelone, 800 m, 1♂, 30.v.1998, leg. Bassi (BAS); ibid, but 1100 m, 1♂, 24.v.2011, leg. Baldizzone, genitalia slide Nel 25346 (BALD); Piemonte (CN), Parco Natur. Reg. Alpi Maritime, S. Giacomo di Entracque, Valle della Rovina, 1537–1800 m, 1♂, 14.vii.1996, leg. Baldizzone (BALD); ibid, S. Giacomo di Entracque, sopra Lago della Rovina (Rocca Barbis), 1550–1850 m, 1♂, 20.vii.1997, leg. Baldizzone (BALD); ibid, but 1850–2000 m, 1♂, 26.vii.1997, leg. Baldizzone (BALD); ibid, but Entraque, Trinità, Vallone Grande, 1400 m, 2♂, 15.vii.1996, leg. Baldizzone, genitalia slide Hendriksen 2036 (BALD, ZMUC); ibid, but, Mt. Ray, 1500–1800 m, 16♂, 3♀, 20. & 24.vii.1999, leg. Baldizzone, genitalia slides Hendriksen 2500, 2544, Huemer 12/1330 (BALD, ZMUC); ibid, but 6♂, 3♀, 18. & 20.vii.2000, leg. Baldizzone (BALD); ibid, Entracque, Trinità, Sentiero per Colle della Garbella, 1600–2000 m, 1♂, 16.vii.2000, leg. Baldizzone (BALD); ibid, 2000 m, 2♂, 21.vii.2000, leg. Baldizzone (BALD); Prov. Cuneo, Colle della Lombarda, 1750 m, 6♂, 17.vii.2012, leg. Huemer (TLMF).

Description. Adult (Figs 1, 2). Male (Fig. 1): Wingspan male 13–16 mm. Labial palp slender; segment 2 slightly shorter than segment 3, cream-coloured, overlaid with fuscous on lower and outer surface; segment 3 fuscous. Antenna dark brown; a few paler rings near tip. Head, thorax and tegula shining fuscous. Forewing dark bronze fuscous; an indistinct dark spot at apical part of the cell; fringe grey; no fringe line present. Hindwing grey, with greyish fringe. Female (Fig. 2): Similar to male but smaller (wingspan 9 mm) and with head shining metallic-fuscous and forewings shining bronze-coloured, slightly darker towards apex, without any markings.

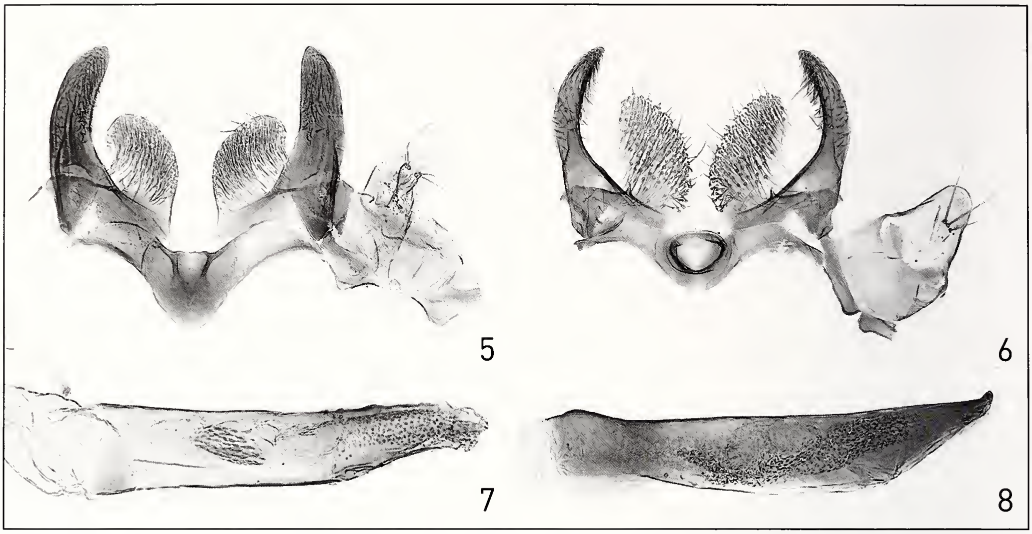
Remarks. The examined specimens show only little variation. Worn specimens become paler, with more metallic shine.

Male genitalia (Figs 5, 7). Uncus digitate, short, with four long setae; gnathos absent; valva heavily sclerotised, broad and weakly curved, distal part gradually tapered towards apex, apex with sclerotised wall; sacculus broad, sub-oval, with weakly concave outer and convex inner margin; vinculum with paired posteromedial ridge; saccus short and broad, rounded; phallus massive, straight, distal third tapered; *in situ* apical part of vesica with granular surface, medial part with separate group of about 50 small spines. Segment VIII with pair of short coremata in intersegmental membrane.

Figs 1–4. *Monochroa* spp., adults. **1**. *M. bronzella* sp. n., ♂, holotype; **2**. ibid, ♀, paratype, Italy; **3**. *M. nomadella* (Zeller), ♂, Italy; **4**. ibid, ♀, Russia.

Female genitalia (Figs 9, 11). Papillae anales elongate; apophyses posteriores and anteriores slender, rod-like, about the same length; segment VIII smooth, ventral part largely membranous, sclerotised subgenital plate semi-oval, longitudinal, covered with numerous microtrichia; antrum and posterior part of ductus bursae membranous, posteromedial part with long sclerotised plate; inception of ductus seminalis anteriorly followed by short granular section; corpus bursae oval, covered with microtrichia; signum a large irregularly shaped sub-oval plate, medially slightly constricted, anterior and posterior part with about 4 teeth.

Diagnosis. *M. bronzella* sp. n. resembles the closely related, frequently slightly smaller *M. nomadella* (wingspan of males 12–14 mm, females 8 mm) (Figs 3, 4), which has a black streak in the fold and often also a black spot at 4/5 of the forewing, as well as one at the apical part of the cell. Females of *M. bronzella* have shinier bronze-coloured forewings than the dark greyish brown (and slightly brachypterous) female of *M. nomadella*. The closely related *M. ferrea* (Frey, 1870) has darker, metallic grey forewings with similar markings as in *M. nomadella*, and should not be confused with *M. bronzella* sp. n. Its genitalia are figured by Sattler (1974) and Elsner et al. (1999) (see also remarks). *Eulamprotes unicolorella* (Duponchel, 1843) is similar to females of *M. bronzella* in having unicolorous, metallic shiny forewings, but those, as well as the labial palps, head, thorax and tegulae, are distinctly darker.



Figs 5–8. *Monochroa* spp., ♂-genitalia. **5**. *M. bronzella* sp. n., slide Huemer GEL 1176; **6**. *M. nomadella* (Zeller), slide Huemer GEL 1177; **7**. *M. bronzella* sp. n., phallus, slide Huemer GEL 1176; **8**. *M. nomadella* (Zeller), phallus, slide Huemer GEL 1177.

Figs 9, 10. *Monochroa* spp., ♀-genitalia. **9.** *M. bronzella* sp. n., slide Huemer GU 12/1330; **10.** *M. nomadella* (Zeller), slide Huemer GU 12/1331.

In the male genitalia the new species differs from the most closely related *M. nomadella* and *M. ferrea* by the distinctly broader and not sickle-shaped or apically pointed valva and the shape of the sacculus, and from *M. nomadella* by having a field of spines on the phallus (Figs 5–8; Elsner et al. 1999: pl. 8, Fig. 67). The female genitalia are easily distinguished from all other *Monochroa* by the large signum of unique shape (Figs 9, 11) which is completely different, for example, in the externally similar *M. nomadella* (Figs 10, 12); furthermore the long sclerite of the ductus bursae is characteristic.

Distribution. Only known from the southwestern Alps of France and Italy.

Ecology/Habitat. Larval host plant and early stages are unknown. Adults have been observed from late May to late July and they have been collected during night

Figs 11, 12. *Monochroa* spp., ♀-genitalia, signum enlarged. **11**. *M. bronzella* sp. n., slide Huemer GU 12/1330; **12**. *M. nomadella* (Zeller), slide Huemer GU 12/1331.

at light. It remains unclear if the female is able to fly. Elsner (in litt.) found hundreds of males of *M. nomadella* coming to the UV light, whereas a single female specimen was collected by sweeping grass and various vegetation. The larva of the related *M. ferrea* (Frey, 1870) has been reared from *Carex ericetorum* Pollich. (Cyperaceae) (Kaitila 1996). The habitats of *M. bronzella* sp. n. are steppic and xerothermic slopes. The species seems to be restricted to siliceous soil whereas the related *M. nomadella* prefers calcareous habitats (Elsner et al. 1999).

Etymology. The name of the new species refers to its uniformly bronze-coloured forewings.

General Remarks. Similar to descriptive taxonomy of other genera of Gelechiidae, our description of male genitalia is based "on unrolled" slide preparations (Huemer 1987; Pitkin 1986). According to such slides, the homology of the sacculus in *Monochroa* seems doubtful, since this structure is articulated at the vinculum and should rather be called the vincular process.

Literature records of *M. nomadella* from France (Fournier 2010) and northwestern Italy (Karsholt 2004) refer to *M. bronzella* sp. n. and *M. nomadella* should be deleted from the list of Lepidoptera found in France. Confirmed Italian records exist from South Tyrol to northeastern Italy (Prov. Pordenone). As pointed out by Junnilainen et al. (2010) the figure of the female genitalia of *M. nomadella* in the widely used book on Central European Gelechiidae (Elsner et al. 1999) is erroneous. In fact two figures have been inadvertently transposed on pl. 49 and thus fig. 67 refers to *M. nomadella* whereas fig. 68 depicts *M. ferrea* (Elsner in litt.).

Discussion

Monochroa is one of the morphologically particularly difficult genera of Gelechiidae and identification from external appearance may cause serious problems. Dissection of genitalia is thus often inevitable for a safe identification. Due to the overall similarity of the adults and the frequently hidden living habits, the species inventory of the European fauna is still incomplete. New taxa have been described more or less regularly during the last decades, even from well explored areas such as Great Britain and Scandinavia, but also from the Alps (Huemer & Karsholt 2010; Svensson 1992; Uffen 1991). However, considering the lack of a thorough generic revision, the description of new taxa must be done with due care and is only possible within species-groups with resolved taxonomy. The species group of *M. nomadella* and *M. ferrea* is not yet fully resolved and according to preliminary results of DNA-barcoding may include further cryptic species. However, the genitalia characters of *M. bronzella* sp. n. are unmistakable and it was obviously only by chance that the species was not recognised earlier. As with several other recently described taxa (see Huemer & Karsholt 2010), this record reinforces the importance of the southwestern Alps for overlooked species, most of which are restricted to this part of the Alps.

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Northern boundary of the range of the Clouded Apollo butterfly *Parnassius mnemosyne* (L.) (Papilionidae): climate influence or degradation of larval host plants?

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Abstract. The present paper summarises data on the northern localities of *Parnassius mnemosyne* (L.) (Papilionidae), which are mostly situated in the Russian Federation, and gives a thorough description of the species' northern range location. It is shown that the northernmost populations exist within the karst landscapes in the north of White Sea-Kuloi Plateau (between 65° 35′ and 66° 03′ N) in the lower valleys of the rivers Soyana and Kuloi and in the north of Timan Highland (66° 10′ N) along the shore of Kosminskoe Lake (the Pechora river basin). The northern limits of the Clouded Apollo's range appear to be strongly determined by the distribution of its larval host plants (primarily *Corydalis solida* (L.) Clairv., Papaveraceae) and the role of climate and relief seems to be of minor importance.

Introduction

The Clouded Apollo butterfly *Parnassius mnemosyne* (Linnaeus, 1758) (Papilionidae) is an endangered species in Europe (Van Swaay & Warren 1999; Van Swaay et al. 2010). Its decline has been attributed to the cessation of traditional management, grazing and mowing of semi-natural grasslands and coppicing in woodlands (Luoto et al. 2001; Väisänen & Somerma 1985). The distribution of the species in European countries is known with a high certainty, but it remains less thoroughly known in the Russian Federation (Kudrna et al. 2011; Weiss 1999) due to the less intensive recording in northern Russia. In the meantime, a few individuals from Northern Russia have been described as separate subspecies or other morphological forms (e.g., Eisner & Sedych 1964; Kreuzberg 1989; and others). Some predictive models have been published on the distribution of *P. mnemosyne* which reveal its possible change under biotic (larval host plants) interactions, climate conditions (Araújo & Luoto 2007; Settele et al. 2008), and habitats (Heikkinen et al. 2007), based on West European data.

The habitat preferences of the Clouded Apollo in European countries and the southern regions of European Russia are well studied, but the northern part of Russia has not yet been surveyed (Gorbach & Kabanen 2010; Lyvovsky & Morgun 2007; Weideman 1986; etc.). As populations of this species inhabit heterogeneous environments, their structure generally conforms to the metapopulation model in which a landscape is divided into suitable patches and unsuitable matrix (Gorbach & Kabanen 2010; Luoto et

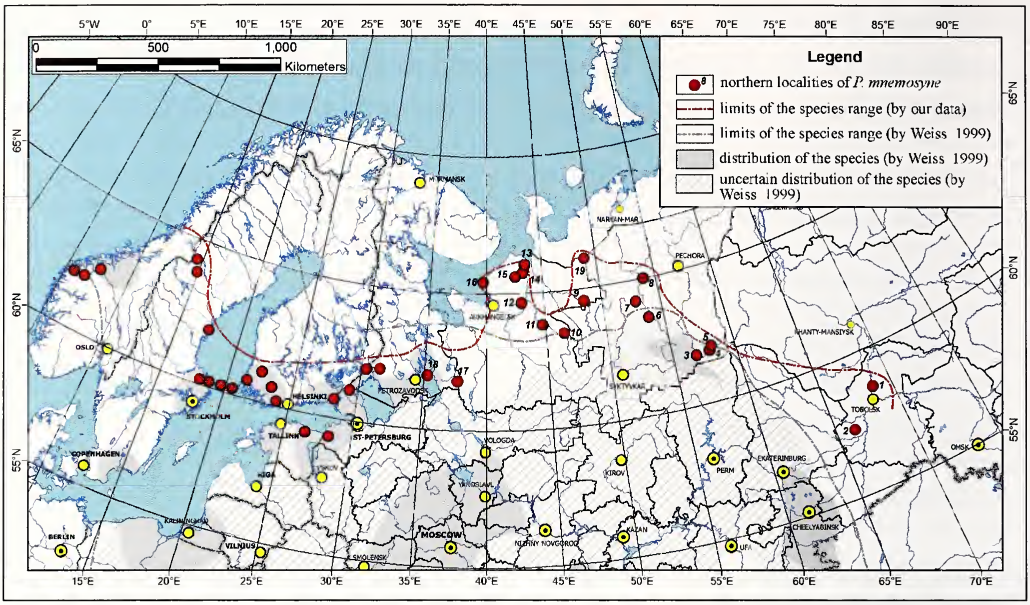


Fig. 1. Distribution of the Clouded Apollo butterfly in Northern Europe and Western Siberia and the northern boundary of the species range. The Russian localities – according to data from Table 1 (locality numbers on the map correspond to numbers in the Table); the Western European localities – according to Settele et al. (2008) and Somerma & Yakovlev (1998).

al. 2001). For example, in Fennoscandia the Clouded Apollo inhabits a dense network of semi-natural grasslands (with mating sites and nectar sources) and deciduous forest patches (with larval food plants) (Heikkinen et al. 2007). Migration routes of individuals can extend onto the meadows and shrubs of open spaces in forests (Gorbach & Kabanen 2010; Konvička et al. 2006; Meier et al. 2005; Valimaki & Itamies 2003).

The Clouded Apollo butterfly is a specific *K*-strategist; females can mate only once and lay about 50 eggs dispersed over a large area (Meglecz et al. 1997; Weideman 1986). *P. mnemosyne* is an oligophagous species and its larvae develop on various plant species of the genus *Corydalis* DC. (Papaveraceae). In the north of Russia, *Corydalis solida* (L.) Clairv. and *C. capnoides* (L.) Pers. have been recorded (Korshunov 2002; Tatarinov & Dolgin 1999). Reports from other countries include *Corydalis solida* for Finland (Luoto et al. 2001; Somerma 1997), *C. intermedia* (L.) Mérat and *C. pumila* (Host) Rchb. for Sweden (Franzén & Imby 2008), and *C. intermedia* for Norway (Aagaard & Hanssen 1989). Knowledge of the host-plant species is important to explain the local and landscape distribution of the Clouded Apollo butterfly (Heikkinen et al. 2005; Luoto et al. 2001). Spatial structure of *P. mnemosyne* metapopulations is determined by the distribution of the *Corydalis* populations (Gorbach & Kabanen 2010).

This paper maps the northern boundary of the *P. mnemosyne*'s range, summarising the information about the peripheral northern localities of this species and discussing the relative influence of climatic factors and host-plant availability upon the limits of the species range.

Materials and methods

The survey of marginal northern *P. mnemosyne* populations was conducted in Arkhangelsk oblast (Russian Federation). A. M. Rykov studied the populations in the Pinega State Nature Reserve annually during 1978–2011. Field studies on the Soyana, Kuloi, Pinega and Yula Rivers were conducted between 2002 and 2007. In 2003, collector L. P. Shoshin (Arkhangelsk) sampled a few specimens of the Clouded Apollo in the Ivovik Stream Valley, located at the Winter Coast of the White Sea. Data on other northern *P. mnemosyne* localities were obtained from different research papers. The arrangement of the localities was digitised and mapped. The species range data in this map were added from Weiss' (1999) book.

The distribution of *Corydalis* plants was obtained from a digitised version of "Atlas Flora Europaeae" (AFE) (Lahti & Lampinen 1999) and from "Flora Sibiriae" (Malyschev & Pechkova 1994). Additional data originated from regional botanic publications (Liden 2001; Puchnina et al. 2000; Schmidt 2005). All botanical data were transferred to the AFE grid map (squares of ca. 50 km × 50 km, the Universal Transverse Mercator (UTM) projection and the Military Grid Reference System (MGRS)) (Jalas & Suominen 1972–1996). Meteorological data were obtained from the website of the World Data Center for Meteorology, Asheville, North Carolina.

Northern localities of the Clouded Apollo butterfly

As shown in Fig. 1, the northern boundary of the range stretches from the Norwegian coast in the West to the Irtysh river headstream in the East, about 4000 km in length. Some northern localities of this species in Fennoscandia are highly populated (Aagaard & Hanssen 1989; Luoto et al. 2001; Opheim 1983; Somerma 1997; Väisänen & Somerma 1985). There is little data on regional expansions (Marttila et al. 2001; Meier et al. 2005). Information about marginal northern localities of *P. mnemosyne* in Russia is compiled in Tab. 1.

Tyumen oblast. In 1987–1988 *P. mnemosyne* populations were discovered in the Irtysh (near the city of Tobolsk) and Iska (Korshunov 2002; Kreuzberg 1989) river valleys. The populations inhabit hay-harvested and grazed floodplain meadows, maintained in river valleys since the 19^{th} century.

Komi Republic. The most northern localities of *P. mnemosyne* were discovered in the valleys of the Pechora river basin at the foothills of the Northern Urals and Timan Highland (Tatarinov & Dolgin 1999, 2001). The cited authors have conducted field studies there since the 1990s. The highest density of populations was detected in the Pechoro-Ilychsky Nature Reserve (Tatarinov & Dolgin 1999). The habitats of the populations were natural humid mixed-herb meadows in river valleys, which are characterised by heterogeneity of species composition and density of vegetation. The dominant species were *Filipendula ulmaria* (L.) Maxim. (Rosaceae), *Crepis sibirica* L. (Asteraceae), *Thalictrum* sp., *Trollius europaeus* L. and *Aconitum septentrionale* Koelle (Ranunculaceae), *Valeriana wolgensis* Kazak. (Valerianaceae), *Geranium sylvaticum* L. (Geraniaceae).

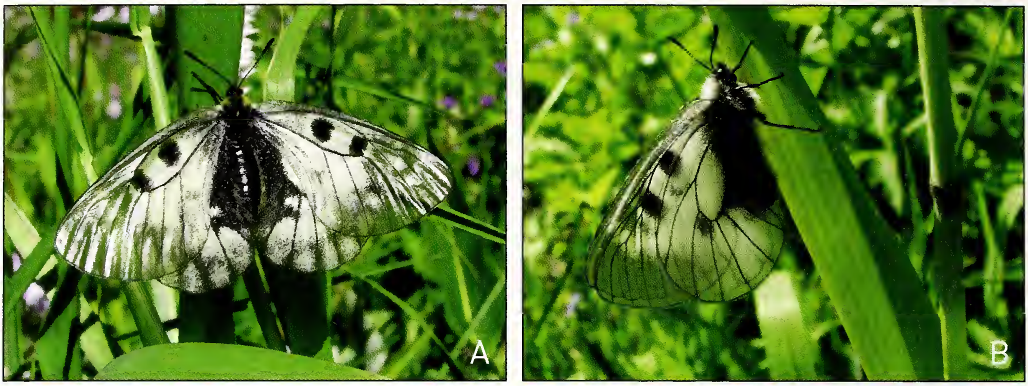
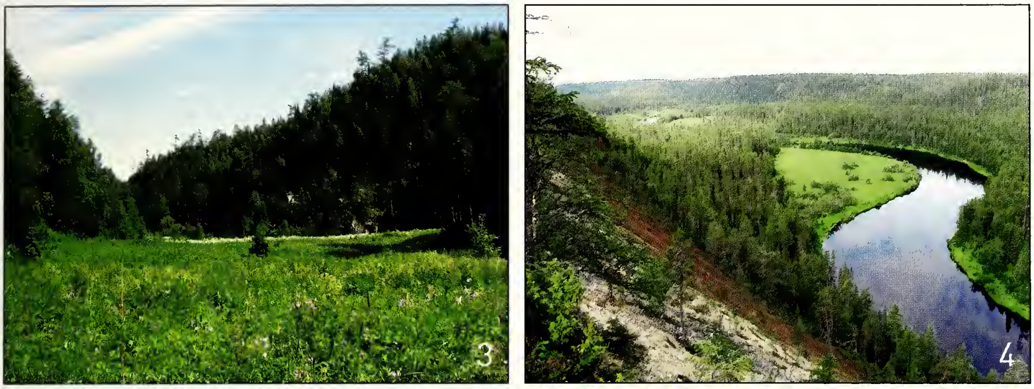


Fig. 2. The Clouded Apollo butterfly specimens from peripheral northern populations inhabited meadows in Moseev Ravine in the White Sea-Kuloi Plateau, Arkhangelsk oblast, Northern European Russia. **A**: upperside; **B**: underside.

Arkhangelsk oblast. The populations are located within the frontiers of the northern part of the Timan Highland (Tatarinov & Dolgin 1999), at the White Sea-Kuloi Plateau (Belomorsko-Kuloiskoe Plato) and in the Pinega river basin. These are probably the largest populations of *P. mnemosyne* among the northern ones. In the Southeast of the White Sea-Kuloi Plateau, in the Pinega State Nature Reserve, observations of *P. mnemosyne* populations have been made since 1978. The populations were discovered in three large karst ravines (Moseev, Vizgunov and Severny), belonging to the Sotka river basin (tributary of the Kuloi river) (Figs 2a, b). The butterfly inhabited small patches of natural humid mixed-herb meadows at the ravine bottoms (Fig. 3). The dominant species of these meadows are *Aconitum septentrionale* Koelle and *Thalictrum* sp. (Ranunculaceae), *Anthriscus sylvestris* (L.) Hoffm. (Apiaceae), *Geranium sylvaticum* L. (Geraniaceae), *Filipendula ulmaria* (L.) Maxim. (Rosaceae), *Cirsium oleraceum* (L.) Scop. (Asteraceae), *Chamerion angustifolium* (L.) Holub (Onagraceae), *Paeonia anomala* L. (Paeoniaceae) and *Elymus caninus* (L.) L. (Poaceae). Here, the ravines are surrounded by Siberian spruce (*Picea abies* ssp. *obovata* (Ledeb.) Domin, Pinaceae) forests, with small inclusions of Siberian larch (*Larix sibirica* Ledeb., Pinaceae). These meadows were formed in karst ravines about 2500–3500 years ago and existed hereafter owing to harsh local microclimates, which prevented forest expansion (Titova et al. 2011). The total area of the Clouded Apollo habitats is ~4 ha within Vizgunov ravine, ~10 ha within Moseev ravine and ~15 ha within Severny ravine. The flight period of adult *P. mnemosyne* continues from mid-June to the beginning of August (13.vi–6.viii), and adult density varies highly from year to year (Bolotov 2004; Rykov 2009). Imagines were observed annually in 1978–2011 in two of the three patches, but in Vizgunov ravine they have not been recorded since 2000.

The *P. mnemosyne* population inhabiting the karst areas of the Soyana river valley was observed in the Northeast of the White Sea-Kuloi Plateau during 2002–2007. Zonal vegetation is represented by spruce and larch forests. The butterflies inhabit a river valley about 50 km long, as well as humid mixed-grass meadows, which are typical of the river valley bottom and which form small patches about 1–3 ha in size,



Figs 3–4. Habitats of the Clouded Apollo butterfly in the White Sea-Kuloi Plateau, Arkhangelsk oblast, Northern European Russia. **3**. Meadow in the Moseev Ravine. **4**. Meadow in the Soyana river valley.

divided by thin forests and shrubs (Fig. 4). The meadows form natural floodplains, and they were used for hay production until the end of the 20th century. The dominant plant species were similar to those of meadows in large karst ravines.

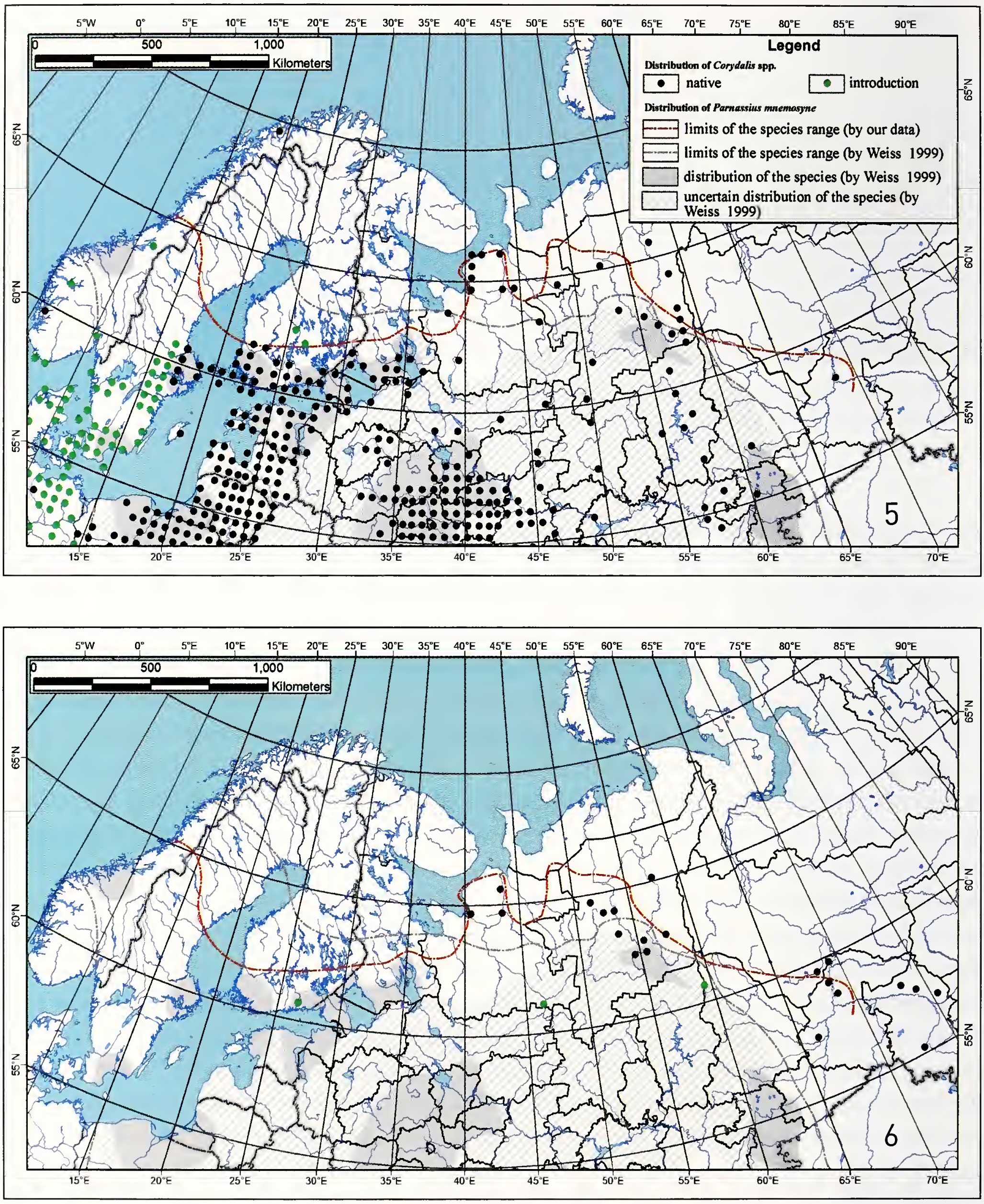
A population of *P. mnemosyne* was found in the Ivovik Stream valley (the northwest of the White Sea-Kuloi Plateau) in 2003. The stream has a deeply scarred valley, restricted to places of Vendian (Ediacara) rocky outcrop on the Winter Coast of the White Sea. The butterflies inhabit small patches of natural humid mixed-herb meadows. This population is isolated from all other localities by continuous stretches of spruce forests.

Nenetsky autonomous district. Only a few specimens of *P. mnemosyne* were discovered on the Kosminskoe Lake shore meadows (northern part of Timan Highlands) (Tatarinov 2006).

Karelia Republic. The distribution of the species is localised around Onega Lake and the eastern part of Ladoga Lake areas (Gorbach & Kabanen 2010; Gorbach & Reznichenko 2009; Kaisila 1947; Somerma & Yakovlev 1998). Localities of *P. mnemosyne* also exist on upland meadows on the islands of Bolyshoy Klimenetskiy and Kizhi in Onega Lake, and at the flood-land meadows along the Koloda river shores in the southeastern part of Russian Karelia (Humala 1998). The meadows were used as hayfields until the beginning of the 21th century. The dominant species of the meadows are *Heracleum sphondylium* ssp. *sibiricum* (L.) Simonk. (Apiaceae), *Rumex acetosa* ssp. *thyrsiflorus* (Fingerh.) Hayek (Polygonaceae), *Centaurea scabiosa* L., *Tanacetum vulgare* L. and *Taraxacum officinale* F.H. Wigg. (Asteraceae), *Barbarea vulgaris* W.T. Aiton (Brassicaceae), *Poa pratensis* L. and *Phleum pratense* L. (Poaceae). In some localities, high abundance of adults was observed (Gorbach & Kabanen 2010).

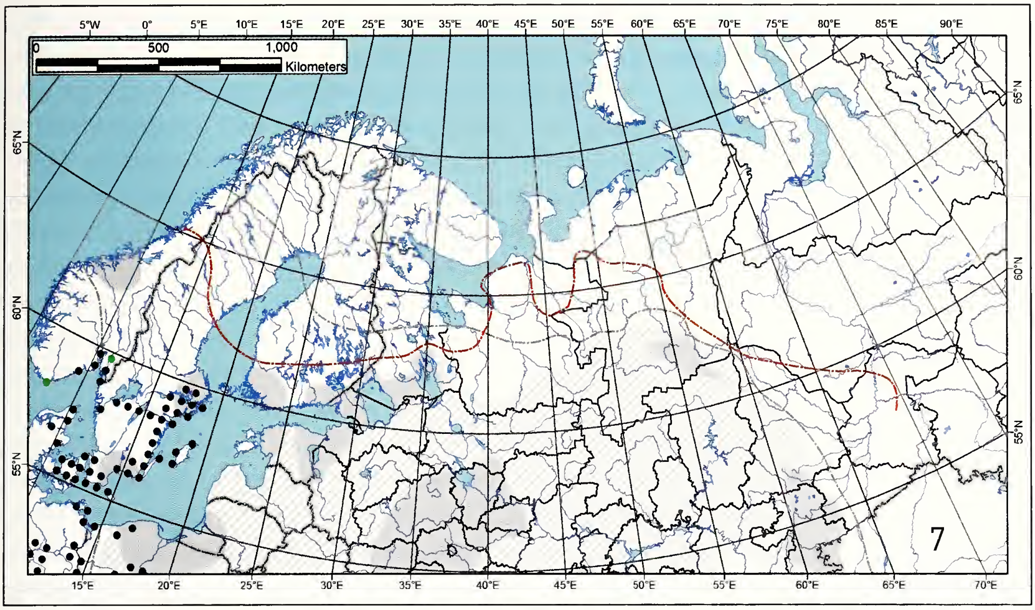
Northern boundary of the species range: the outcome of biotic interactions and climate conditions

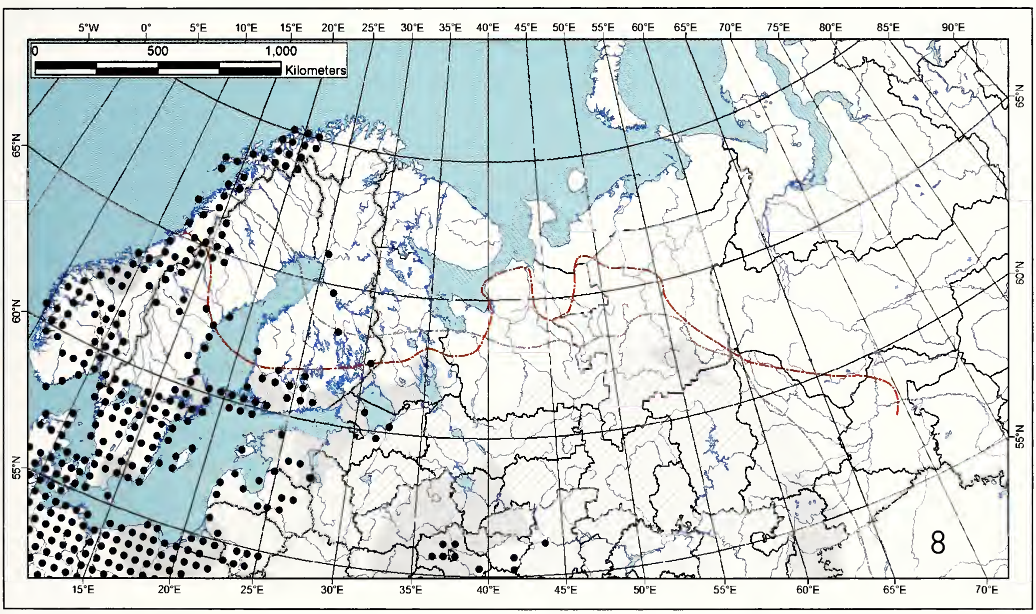
It was mentioned before that *P. mnemosyne* is not usually found farther north than 63–64° N (Kudrna et al. 2011; Lyvovsky & Morgun 2007; Settele et al. 2008; Weiss



Figs 5–6. Distribution of the four species of *Corydalis* spp. and the northern boundary of the Clouded Apollo butterfly range. **5**. *C. solida* (L.) Clairv. **6**. *C. capnoides* (L.) Pers.

1999). New data allow us to specify the northern limits of the species distribution. The world's northernmost populations have been registered at the north of the White Sea-Kuloi Plateau (between 65° 35′ and 66° 03′ N) in the Soyana and Kuloi lower river valleys and in the north of Timan Highland (66°10′ N) at the Kosminskoe Lake shore (the Pechora river basin).





Figs 7–8. Distribution of the four species of *Corydalis* spp. and the northern boundary of the Clouded Apollo butterfly range. **7.** *C. pumila* (Host) Rchb. **8.** *C. intermedia* (L.) Mérat.

Sedimentary Paleozoic bedrock and modern areas of active karst processes form both of these territories (Gofarov et al. 2006; Shvartsman & Bolotov 2008). The karstic rocks are represented by Carboniferous limestone in the Timan Highland and Permian gypsums and anhydrites in the White Sea-Kuloi Plateau. The plateau region is known as a refuge for different animal and plant species, some of which are northern postglacial and some are southern Atlantic relicts. Dryads *Dryas octopetala* L. and *D. o.* ssp. *punctata* (Juz.) Hultén (Rosaceae), osiers *Salix myrsinites* L. and *S. reticulata* L. (Salicaceae) (Puchnina et al. 2000; Simacheva 1986), pond damselflies *Coenagrion glaciale* (Selys, 1872) and *C. hylas* (Trybom, 1899) (Coenagrionidae) (Bernard & Daraż 2010), carabid beetles *Pterostichus brevicornis* (Kirby, 1837) and *Bembidion yukonum* Fall, 1926 (Carabidae) (Mokhnatkin et al. 2010), collembolans *Desoria tshernovi* (Martynova, 1974) and *D. inupikella* Fjellberg, 1978 (Isotomidae) (Babenko 2008) may be considered to be postglacial relict species. In Europe, these postglacial relicts are representatives of a cold-stenothermal fauna that probably colonised the subcontinent during the late Pleistocene and early Holocene in the period of the maximum distribution of birch and pine (Bernard & Daraż 2010; Elina et al. 2005). Other Atlantic relicts, besides *P. mnemosyne,* include its larval host plants *Corydalis solida* and *C. capnoides*, as well as the plants *Stellaria nemorum* L. (Caryophyllaceae), *Cypripedium parviflorum* Salisb. (Orchidaceae), *Paeonia anomala* L. (Paeoniaceae) (Puchnina et al. 2000; Simacheva 1986), the blue butterflies *Cupido alcetas* (Hoffmannsegg, 1803), *C. minimus* (Fuessly, 1775) and *Aricia nicias* (Meigen, 1829) (Lycaenidae) (Bolotov 2004), and the carabid beetles *Calosoma investigator* (Illiger, 1798), *Lebia cruxminor* (Linnaeus, 1758) and *Badister lacertosus* Sturm, 1815 (Carabidae) (Mokhnatkin et al. 2010). They probably migrated to Northern Europe during the Atlantic period of the Holocene. According to the studies of molecular markers, expansion of *P. mnemosyne* northern lineages took place during the postglacial warming period 5000–7000 years ago (Gratton et al. 2008).

During the present period, populations of both groups of relict species remain isolated in the same regions of the European taiga, particularly in karst landscapes (Shvartsman & Bolotov 2008). The coexistence of such different relict species is possible due to the high heterogeneity of karst landscapes. Sites with highly contrasting temperatures exist in such areas: very cold sites near caves with long-term ice alternating with well-heated patches in slopes of south exposure and wide karst ravines. These sites can easily be located near each other. For example, upland herb meadows grow at the bottom of Moseev ravine (inhabited by the Clouded Apollo and other southern relicts), whereas small patches of mountain dryads tundra with *Salix myrsinites* and *S. reticulata* occur on the nearby gypsums and anhydrites outcrops.

The altitude range of the northern localities of *P. mnemosyne* is very broad (Tab. 1). Here populations exist under different climatic conditions (Tab. 2). Therefore, climate and relief cannot be considered as major limiting factors for the expansion of the Clouded Apollo northward. Dot maps of the distribution area of different *Corydalis* species (Figs 5–8) reveal that the northern boundary of *P. mnemosyne*'s range almost fully correlates with the distribution of only one larval food species – *Corydalis solida. Corydalis intermedia* is widespread in Western Fennoscandia, but *P. mnemosyne* is found only in a few localities. However, Fennoscandian populations of *P. mnemosyne* mostly prefer *Corydalis solida*, which is represented usually by introduced individuals (Liden 2001). These differ from native populations in flower and bract constitution details. This plant species is widely cultivated in parks and gardens and escapes from cultivation frequently. Many naturalised populations of *Corydalis solida* exist in the south of Norway (primarily along the seacoast), southern Sweden and central Finland (AFE Secretariat, A. Sennikov, pers. comm.).

Studies of regional differences in the Clouded Apollo larval food preference may be enlightening. For example, in the European part of Russia (Penza oblast), *P. mnemosyne* larvae were registered feeding only on *Corydalis solida*, although *C. cava* (L.) Schweigg. & Körte and *C. cava* ssp. *marschalliana* (Willd.) Hayek occur in the same biotopes (Polumordvinov & Shibaev 2007). Also, models using larval host plants as a predictor of variability of the studied species predicted the presence of the Clouded Apollo when *Corydalis solida* was present and the absence of the Clouded Apollo when *C. solida* was also absent; this was true even when other *Corydalis* species were present (Araújo & Luoto 2007).

Given that the distribution of *P. mnemosyne* in the north mostly correlates with the presence of *Corydalis* populations, and populations of the butterfly inhabit natural meadows, it is difficult to forecast significant future changes in the northern boundary of the species range. Geographically, the majority of peripheral northern localities of this species is concentrated in sparsely populated areas in the Russian Federation, in predominantly non-disturbed taiga landscapes with difficult access, which do not seem to be threatened by human activities. Many Russian populations inhabit the state nature reserve territories: "Kizgi Scerries" Reserve (Karelia Republic), Pinega and Soyansky Reserves (Arkhangelsk oblast), Pechoro-Ilychsky and "Belaja Kedva" Reserves (Komi Republic).

P. mnemosyne occupies habitats with optimal ecological conditions in different biomes, therefore this species has a zonal replacement of habitat preferences (Bei-Bienko 1966; Chernov 2008). In the north, it behaves like a typical mesophilous species, which prefers open intrazonal habitats with medium humidity and solar heat (in different types of open meadows). Southern populations prefer mostly humid and less warm habitats. In Central Europe, including southern regions of European Russia, the Clouded Apollo is a woodland species and inhabits forest steppes, sparse deciduous forests and forest clearings where the larval host plants grow (Konvička & Kuras 1999; Konvička et al. 2006; Meglecz et al. 1997; Polumordvinov & Shibaev 2007; Weidemann 1986). In the south of Europe, its populations avoid lowlands, where the environment is too hot and dry, and reside primarily in the humid and cool habitats of mountain-subalpine belts (Descimon & Napolitano 1993; Lyvovsky & Morgun 2007; Napolitano et al. 1988; Napolitano & Descimon 1994). Hence, the distribution of the Clouded Apollo in the North is limited principally by the distribution of its larval food plants. However, it should be stated that the latitudinal change of landscape-habitat occupancy also depends on regional climatic conditions (temperature and humidity). The results of this paper agree with the importance of biotic interactions for modelling individual species distribution at the macroecological scale under climate change (Araújo & Luoto 2007).

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Tab. 1. Peripheral northern localities of *Parnassius mnemosyne* in Russia. * – see Fig. 1.

No.*	Coordinates	Altitude, m.a.s.l.	Locality	Administrative region	Geographic region	Information source
1	58° 37′ 44″ N 68° 34′ 00″ E	40	Irtysh river valley (near Nadzy village); other locality nearby: Ingair railway station (58°37'N, 68°46'E)	Tyumen oblast	Western Siberian Plain, Irtysh River basin	Korshunov 2002
2	57° 23′ 07″ N 66° 14′ 50″ E	60	Iska river valley, Irtysh river basin (near Shapkul village)	--//--	--//--	--//--
3	61° 49′ 14″ N 56° 51′ 02″ E	140	Pechora river valley (near Yaksha village)	Komi Republic	Northern Ural	Tatarinov & Dolgin 1999, 2001; A. G. Tatarinov & O. I. Kulakova, pers. comm.
4	61° 52′ 32″ N 57° 56′ 31″ E	200	Garevka river valley, Pechora river basin, Pechora-Ilychsky State Nature Reserve	--//--	--//--	--//--
5	62° 01′ 43″ N 58° 10′ 28″ E	170	Yany-Pupu-Nier mountain range, Pechora-Ilychsky State Nature Reserve	--//--	--//--	--//--
6	63° 33′ 07″ N 53° 29′ 33″ E	120	Ukhta river valley (near city of Ukhta), Izhma river basin	--//--	Foothills of Timan Highland	--//--
7	64° 13′ 07″ N 52° 53′ 44″ E	110	Belaya Kedva river valley, Pechora river basin	--//--	Timan Highland	--//--
8	64° 55′ 34″ N 53° 46′ 37″ E	30	Izhma river valley (near Izhma village)	--//--	--//--	--//--
9	64° 32′ 59″ N 48° 26′ 57″ E	140	Mezen river valley (near Vozhgora village)	Arkhangelsk oblast	--//--	--//--
10	63° 25′ 57″ N 46° 30′ 19″ E	80	Pinega river valley (near Nyukhcha village)	--//--	Northern Dvina-Mezen Plain	Our observations
11	63° 48′ 34″ N 44° 44′ 24″ E	50	Yula river valley, Pinega river basin	--//--	--//--	--//--
12	64° 38′ 29″ N 43° 03′ 39″ E	60	Moseev karst ravine, Pinega State Nature Reserve; two other localities nearby: Vizgunov karst ravine (64°39'N; 43°02'E) and Severny karst ravine (64°32'N; 43°07'E)	--//--	White Sea-Kuloi Plateau	--//--

Table 1 continued.

No.*	Coordinates	Altitude, m.a.s.l.	Locality	Administrative region	Geographic region	Information source
13	66°02′43″ N 43°28′13″ E	20	Mouth of the Kuloi river (near Dolgoschelye village)	--//--	--//--	--//--
14	65°44′32″ N 43°15′12″ E	20	Lower course of the Soyana river, Kuloi river basin	--//--	--//--	--//--
15	65°36′33″ N 42°32′31″ E	30	Soyana river valley, Kuloi river basin; many other localities along the river valley were also recorded here (see Rykov 2009)	--//--	--//--	--//--
16	65°27′00″ N 39°42′34″ E	40	Ivovik stream valley	--//--	Winter Coast Mountains, shore of the White Sea	--//--
17	61°47′30″ N 37°43′03″ E	110	Koloda river valley (near Ust-Reka village)	Karelia Republic	Onega lake area	Humala 1998
18	62°05′00″ N 35°13′00″ E	40	Kizhi Island; other locality nearby: Bolshoy Klimenetsky Island (61°58’N, 35°15’E)	--//--	--//--	Gorbach & Kabanen 2010; Humala 1998
19	66°10′00″ N 48°57′00″ E	110	Kosminskoe Lake, Pechora river basin	Nenetsky autonomous district	Timan Highland	Tatarinov 2006

Tab. 2. Climatic conditions of northern localities of the Clouded Apollo butterfly.

Position of the northern localities	No. of the Russian localities (see Table 1 & Fig. 1)	Weather station	July mean temperature, °C	January mean temperature, °C	Summarised daily means above 10°C	Length of the period with summarised daily means above 10°C [days]
Western Siberia	1, 2	Tobolsk	18.8	–16.9	2090	127
Northern Ural	3, 4, 5	Troitzko-Pechorskoje	16.6	–16.6	1499	91
Eastern Timan	6, 7, 8	Izgma	15.7	–18.4	958	61
Western Timan	9	Koinas	16.3	–15.5	1327	86
Pinega river	10, 11	Sura	16.7	–14.2	1342	86
Southeast of the White Sea-Kuloi Plateau	12	Pinega	15.5	–15.0	1216	85
Northeast of the White Sea-Kuloi Plateau and Northern Timan	13, 14, 15, 19	Mezen	14.8	–13.2	1036	75
Winter Coast Mountains, shore of the White Sea	16	Zimnegorskij	14.7	–9.8	746	50
Southern Karelia	17, 18	Petrozavodsk	16.8	–8.0	1773	118
Northern Estonia	—	Tallin-Toravere	18.3	–3.6	2137	117
Southern Finland	—	Helsinki-Vantaa	17.7	–3.4	2001	131
Central Sweden	—	Ostersund-Froson	14.5	–4.8	1327	94
Southern Norway	—	Trondheim-Vernes	17.4	–2.9	1936	128

The genetics of *Luperina nickerlii* Freyer, 1845 in Europe (Noctuidae)

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Abstract. We use mitochondrial markers to examine the genetic status of European subpopulations of *Luperina nickerlii* Freyer, 1845 (Noctuidae) in Britain, Ireland, Spain and the Czech Republic. We show that all the populations sampled belong to the same species *Luperina nickerlii*, despite considerable differences in appearance, ecology and population isolation. Neighbour-joining tree based on mitochondrial markers showed only three populations as separate clusters: *gueneei*, *nickerlii* and *knilli*. We show that subspecies *leechi*, *albarracina* and *demuthi* are genetically close to each other and that both *leechi* and *gueneei* show significantly lower heterozygosity than the other subspecies sampled. *L. n. albarracina* and *knilli* show high genetic variability. Isolation by distance was not supported in this study, suggesting populations were probably linked to each other in the recent past.

Introduction

Luperina nickerlii Freyer, 1845 (Noctuidae) is widespread in mainland Europe occurring on xerothermic slopes where the larvae feed on different grasses (Ganev 1982; Hacker 1989; Karsholt & Razowski 1996; Robineau 2007; Steiner & Ebert 1998), although in Britain and Ireland they are entirely coastal and certain subspecies are of conservation concern (Goater & Skinner 1995). Eight subspecies of this moth have been described (Tab. 1), based largely on phenotypes such as wing colouration, although the taxonomy of the genus is in constant flux. Thus, *L. n. leechi* was described as a new subspecies in 1976 (Goater 1976), whereas *L. n. graslini* and *L. n. tardenota* were originally described as separate species but have since been synonymised and are now regarded as subspecies of *L. nickerlii* (Zilli et al. 2005). *L. n. knilli* has also been proposed to warrant full species status (De Worms 1978; Haggett 1980) but is now considered a subspecies (Skinner 2008). *L. n. albarracina* was described as a new subspecies in 1962 (von Zerny 1962) on wing colour and shape, but some authorities now consider it merely a form (Zilli et al. 2005). *L. n. graslini* is similar in appearance to *L. n. gueneei* but otherwise the subspecies all look different from each other in wing colour and are generally easy to distinguish by eye. *L. n. demuthi* is the most variable of all the subspecies and occasional specimens may look similar to those of subspecies *L. n. leechi*, *L. n. knilli* and *L. n. gueneei*, but the majority of specimens are readily separated from the other subspecies.

The European mainland subspecies all have similar ecologies, feeding on the same food plants and occupying similar biotopes. However, the subspecies in Britain show dramatic differences in their ecology and life styles and are prone to producing small isolated colonies (Tab. 1). In Britain at least, the sparse fragmented distribution of this moth over a large area may reflect a collapse in a former larger range size following an initial increase at the end of the last glacial maximum when temperatures attained levels similar to those of today, and as a result leaving behind small refuge populations, or alternatively multiple post-glacial colonisation events from continental populations or recent changes in habitat preference or behaviour (e.g., a host-plant switch or a reluctance to fly). The populations of the British and Irish subspecies are at least 300 km apart from each other and a minimum of 320 km from the nearest known mainland population near Paris (which is very small and possibly endangered), 850 km from Spanish populations and 950 km from populations at Prague, with little possibility of regular interchange. However, in captivity, *L. n. gueneei* and *L. n. leechi* (which have similar ecologies) can pair and produce moths similar to *L. n. leechi* (Haggett 1980; A. Myers, personal communication). These, at least, are the same species (Mayr 1942) and have similar ecologies. The definition of a subspecies (Lincoln et al. 1985) as isolated natural populations differing taxonomically and genetically from other groups within the species supports the splitting of *L. nickerlii* into subspecies as differing taxonomically.

The single isolated population of *L. n. leechi* has perhaps been studied in more detail than the other subspecies (e.g., Spalding 1991a, b). It is restricted to a small area of a shingle beach, 500 metres × 240 metres, where its larval food plant *Elytrigia juncea* (L.) Nevski (Poaceae) occurs (Spalding 1997; Spalding et al. 2012). It is listed in a Biodiversity Action Plan listing as a unique subspecies currently under threat and declining, and is thus of high conservation value (JNCC 2007). The population has been studied by one of us (AS) since 1987. The population size of this iconic species is very small, with the annual Index of Abundance (the sum of the weekly means based on transect counts) between 1994 and 2009 ranging between 5 to 78 adult moths (mean 18.99) (Spalding 1997; Spalding & Young 2011a).

Here we use mitochondrial DNA markers to ask several questions fundamental to the origin and conservation of *L. nickerlii* subspecies. First, given the different ecologies and appearance of the UK and Irish subspecies, do they belong to the same species as the mainland populations? Secondly, we investigate the genetic variation of these subspecies. Thirdly, we ask which populations should be the focus of conservation concern.

Material and Methods

Sampling. Adult specimens of *Luperina nickerlii* from four different populations in UK and Ireland and four mainland populations from the Czech Republic and Spain were sampled (Tab. 2 and Fig. 1). Actinic light traps with chloroform were used to collect the moths except for *L. n. leechi*, which was collected using torch light. Specimens were kept alive until either snap frozen in liquid nitrogen (*L. n. leechi*, *L. n. gueneei*, *L. n. knilli* and *L. n. demuthi*) or preserved in pure ethanol (Czech populations of *L. nickerlii*) for genomic DNA extraction except for pinned and dried specimens (Spanish populations of *L. n. albarracina*).

Tab. 1. *Luperina nickerlii* subspecies in Europe and their food plants and habitat

Subspecies	Habitat	Food plant	Countries	Number of sites	Within site abundance
demuthi Goater & Skinner, 1995	Saltmarsh	*Puccinellia maritima* (Huds.) Parl.	England	Few	Abundant
graslini Oberthür, 1908	Hot dry slopes	*Festuca ovina* L. and other grasses	France (south)	Many	Abundant
gueneei Doubleday, 1864	Sand dune	*Elytrigia juncea* (Viviani) Runemark ex Melderis	England; Wales	Few	Abundant
knilli Boursin, 1964	Coastal cliff	*Festuca rubra* L.	Ireland	Few	Rare
leechi Goater, 1976	Shingle beach	*Elytrigia juncea* (Viviani) Runemark ex Melderis	England	One	Rare
nickerlii Freyer, 1845	Sparse open grassland; sandy heaths	*Festuca ovina* L. and other grasses	Germany; Czech Republic; Bulgaria	Many	Abundant
tardenota Joannis, 1925	Hot dry slopes	*Festuca ovina* L.and other grasses	France (central)	Few	Rare
albarracina Schwingen-schuss, 1962	Hot dry slopes	*Festuca ovina* L. and other grasses	Spain; Portugal	Many	Abundant

Tab. 2. *Luperina nickerlii* sampling locations and mitochondrial COI haplotypes

Date	Subspecies	Locality	Coordinates	COI*	Sample size**
11–14 Sep 2008	*leechi*	Loe Bar, UK	50°04′12.98″ N 5°17′40.14″ W	A	22
8 Sep 2008	*demuthi*	Strood, UK	51°47′51.53″ N 0°55′09.23″ E	A, B, C	10
27–28 Aug 2008	*gueneei*	Gronant, UK	53°21′01.30″ N 3°22′20.77″ W	D	12
19 Aug 2008	*knilli*	Inch, Ireland	52°08′37.41″ N 9°59′14.65″ W	A, F, G	4
19–20 Aug 2008		Trabeg, Ireland	52°07′16.44″ N 10°12′25.82″ W	E	10
5 Sep 2009	*nickerlii*	Máslovice, CR	50°12′23.80″ N 14°23′16.85″ E	H, I, J	6
5 Sep 2009		Praha, CR	50°02′53.11″ N 14°24′16.68″ E	H, I	14
15 Sep 2009	*albarracina*	Amavida, Spain	40°33′38.97″ N 5°5′7.13″ W	A, K, O	4
16 Sep 2009		Páramos, Spain	42°35′17.95″ N 3°43′56.36″ W	A, K, L, M, N	9

* cytochrome c oxidase subunit I gene (COI) haplotypes sampled in the *L. nickerlii* populations.
** Number of specimens collected.

Genomic DNA isolation. Genomic DNA was extracted from the thorax or abdomen of preserved individuals using either standard phenol/chloroform method (Blin & Stafford 1976) or a Genomic DNA Purification Kit (Fermentas, Burlington, Canada) according to the manufacturer's instructions. DNA concentration was estimated by NanoVue (GE Healthcare, Buckinghamshire, UK) and adjusted to 500 ng/μl.

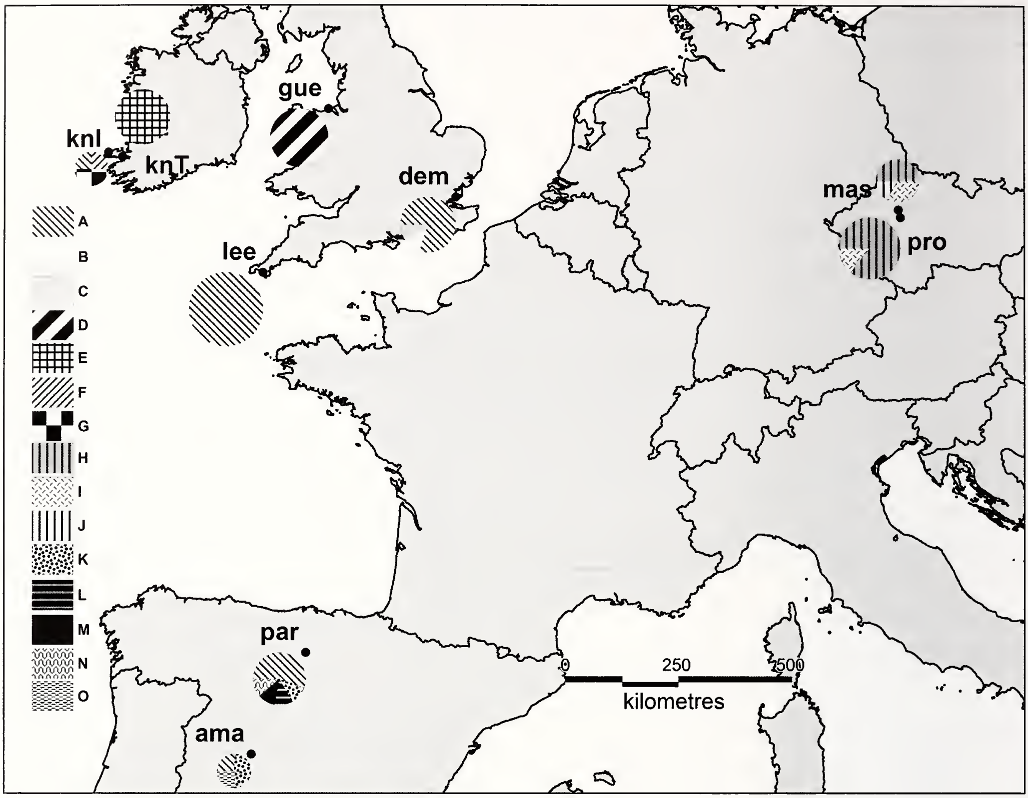

Fig. 1. Map of *Luperina nickerlii* sampling localities and haplotype structure of each sampled population based on the sequence of mitochondrial cytochrome c oxidase subunit I gene (COI). Each population is represented by a circle which is proportional to the number of specimens used for the analysis. Regions within each circle correspond to the proportion of individual COI haplotypes. Abbreviations: **dem**, *L. n. demuthi*, Strood, UK; **gue**, *L. n. gueneei*, Gronant, UK; **knl**, *L. n. knilli*, Inch, Ireland; **knT**, *L. n. knilli*, Trabeg, Ireland; **lee**, *L. n. leechi*, Loe Bar, UK; **mas**, *L. n. nickerlii*, Máslovice, Czech Republic; **pro**, *L. n. nickerlii*, Praha, Czech Republic; **par**, *L. n. albarracina* Páramos de Masa, Spain; and **ama**, *L. n. albarracina*, Amavida, Spain. Sample sizes are given in Table 2. *L. n nickerlii* also occurs elsewhere, e.g., in France and Portgual, but was not sampled there.

Genetic marker sequencing. In order to characterise the genetic distance and variability of different populations of *L. nickerlii* we selected hybrid primers for mitochondrial cytochrome c oxidase subunit I gene (COI). PCR was set up using a commercially available master mix provided by Qiagen (Hilden, Germany) containing the reagents 12.5 µl dH_2O, 2 µl 10x buffer, 2 µl $MgCl_2$, Primer F & R 2 x 1 µl, 0.4 µl l dNTP, 0.1 µl Taq polymerase, 1 µl of DNA extracts, for a total of 20 µl PCR reactions, following the manufacturer's recommendations.

An initial denaturation at 94°C for 3 min was followed by 35 cycles of 30 sec at 94°C, 30 sec at the annealing temperature of 50°C, and 1 min 30 sec at 72°C, and by a final extension step of 7 min at 72°C. Quality and amount of PCR products were checked on a 1% agarose gel. In total 1,212 bp of mitochondrial sequence were obtained. Sequences can be retrieved from GenBank under the following accession numbers: GU903504–582 and HM068967–79.

Tab. 3. Population pairwise F_{ST} values. The calculations were based on mitochondial COI sequences.

	demuthi	*gueneei*	*knilli* Inch	*knilli* Trabeg	*leechi*	*nickerlii* Máslovice	*nickerlii* Praha	*albarracina* Amavida
gueneei	0.69***	—						
knilli Inch	0.61 **	0.90**	—					
knilli Trabeg	0.77***	1.00***	0.63 NS	—				
leechi	0.13**	0.93***	0.92***	1.00***	—			
nickerlii Máslovice	0.47 ***	0.74***	0.57 *	0.74**	0.72***	—		
nickerlii Praha	0.65 ***	0.83***	0.77 **	0.85***	0.81***	0.04 NS	—	
albarracina Amavida	0.38*	0.80**	0.51*	0.80**	0.74**	0.46*	0.69***	—
albarracina Páramos	0.04 NS	0.54***	0.44**	0.63***	0.12**	0.35***	0.57***	0.10 NS

Significance level: NS = not significant; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

Sequence analyses. Mitochondrial sequences were aligned using the program MUSCLE (Edgar 2004) implemented in Geneious (Biomatters Ltd., Auckland, New Zealand). Heterozygotes were detected by Heterozygote plug-in in Geneious and manually corrected. Out of 1,212 bp of mitochondrial sequence, 12 sites were informative. Neighbor-joining trees were constructed by Geneious under Jukes-Cantor genetic distance model (Jukes & Cantor 1969; Saitou & Nei 1987). Bootstrap was performed with 1,000 replicates and branches with less than 50% support were collapsed.

Population structure analysis. Analysis of Molecular Variance (AMOVA), F-statistics (fixation indices) and population pairwise differences (Excoffier et al. 1992; Weir 1996; Weir & Cockerham 1984) were calculated using Arlequin version 3.1 (Excoffier et al. 2005). Heterozygosity was computed as described in Nei (1987). Correlation of genetic and geographic distance was tested by Mantel test performed on matrices of pairwise geographic distances (given as ln km) and linearised pairwise F_{ST} values ($F_{ST}/(1-F_{ST})$) (Mantel 1967; Slatkin 1995). Hardy-Weinberg equilibrium (Guo & Thompson 1992; Levene 1949) and exact test of differentiation (Goudet et al. 1996; Raymond & Rousset 1995) were computed as implemented in Arlequin v3.1. Statistical parsimony network (Templeton et al. 1992) was constructed using TCS v1.21 (Clement et al. 2000).

Results

F_{ST} values are summarised in Tab. 3. Despite our expectations and although the habitat and phenotype of *L. n. leechi* is closest to *L. n. gueneei,* this subspecies is genetically closer to *L. n. demuthi* and *L. n. albarracina*. Pairwise F_{ST} value between *L. n. leechi* and *L. n. gueneei* was 0.93 compared to the F_{ST} between *L. n. leechi* and *L. n. demuthi* which was 0.13. High genetic differentiation was shown between *L. n. gueneei* and *L. n. knilli.*

Neighbour-joining tree based on mitochondrial marker showed only three populations as separate clusters: the population of *L. n. gueneei* was well separated (Fig. 2); *L. n. nickerlii*, *L. n. knilli* and *L. n. albarracina* individuals formed three separate

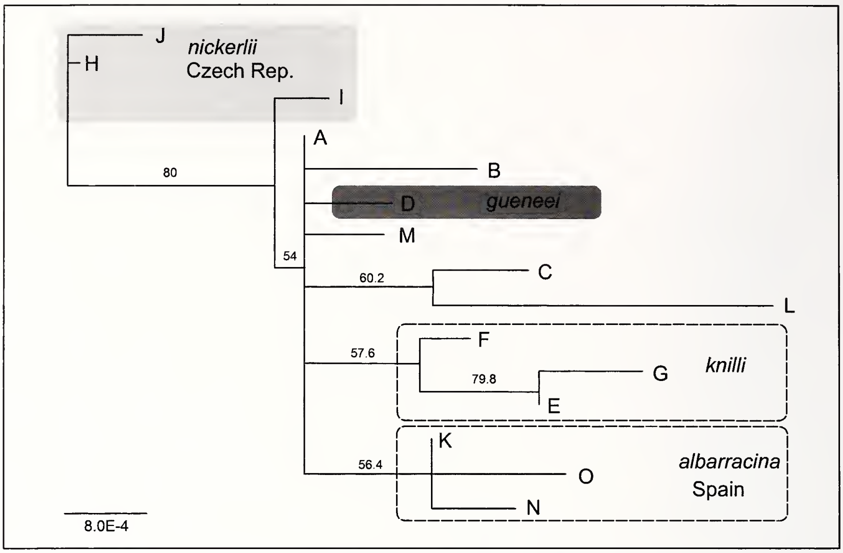

Fig. 2. Unrooted neighbor-joining tree calculated from mitochondrial COI haplotypes sampled among 91 *L. nickerlii* individuals from 9 populations. Each haplotype is represented by a letter code (for distribution and frequency see Tab. 1 and Fig. 1). Numbers above branches indicate percentage of bootstrap support out of 1,000 repetitions. Shaded rectangles mark unique haplotypes belonging to a particular population. Both *L. n. knilli* and *L. n. albarracina* (Spain) marked by an empty rectangle and dashed line contain haplotype A beside the enclosed ones.

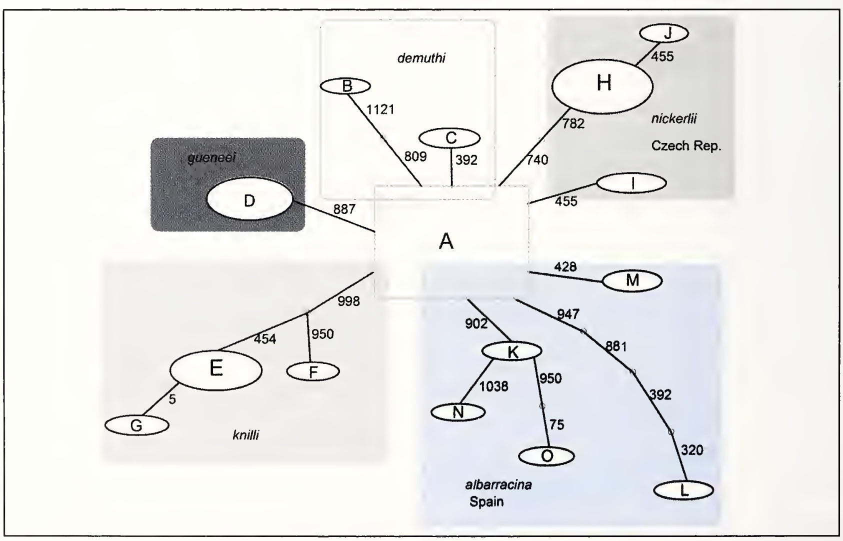

Fig. 3. Parsimony network constructed from sequence of mitochondrial cytochrome c oxidase subunit I gene (COI) of 91 *L. nickerlii* individuals from 9 populations. (*L. nickerlii* occurs elsewhere in Europe but these populations were not sampled). Total number of 15 different haplotypes were sampled (A–O listed in Tab. 2; for their prevalence see Fig. 1). Elipse areas are proportional to the haplotype frequencies. Haplotype connections were parsimonious at the 95% level. Haplotype with the highest outgroup probability is displayed as a square (A). *L. nickerlii* subspecies are marked with shaded rounded squares. Shape overlaps denote sharing of the haplotype A between different populations. Subspecies *leechi* consists of a single haplotype (A) and is not highlighted in the figure. Numbers along lines are the nucleotide positions in the sequence that changed. Empty nodes represent missing unsampled intermediate haplotypes.

Tab. 4. Genetic diversity indices based on mt COI gene.

Population	**mt COI**	
	Gene diversity (*h*)	Average no. of pairwise differences (π)
demuthi	0.49 +/– 0.18	1.02 +/– 0.74
gueneei	0.22 +/– 0.17	0.22 +/– 0.29
knilli Inch	0.67 +/– 0.31	1.33 +/– 1.10
knilli Trabeg	0.00 +/– 0.00	0.00 +/– 0.00
leechi	0.00 +/– 0.00	0.00 +/– 0.00
nickerlii Máslovice	0.73 +/– 0.16	1.80 +/– 1.20
nickerlii Praha	0.26 +/– 0.14	0.79 +/– 0.61
albarracina Amavida	0.83 +/– 0.22	1.50 +/– 1.12
albarracina Páramos	0.72 +/– 0.16	1.72 +/– 1.10

Tab. 5. Analysis of molecular variance (AMOVA). Mitochondrial sequence (COI) was used for the analysis. For abbreviations see legend to Fig. 1.

Population structure	**Variance**	**% total**	**p**	**F-statistics**
Each population independently				
– among populations	0.6373	63.09	0	
– within populations	0.3728	36.91		F_{ST} = 0.6309
Subspecies grouped				
– among groups	0.5177	49.96	0.0113	F_{CT} = 0.4996
– among populations within groups	0.1458	14.07	0.0432	F_{SC} = 0.2811
– within populations	0.3728	35.98	0	F_{ST} = 0.6402
(dem+lee)(gue)(knI+knT)(mas+pro)(ama+par)				
– among groups	0.6270	57.62	0.0011	F_{CT} = 0.5762
– among populations within groups	0.0884	8.12	0	F_{SC} = 0.1916
– within populations	0.3728	34.26	0	F_{ST} = 0.6574
(dem+lee+ama+par)(gue)(knI+knT)(mas+pro)				
– among groups	0.7286	60.54	0.0004	F_{CT} = 0.6054
– among populations within groups	0.1020	8.48	0	F_{SC} = 0.2149
– within populations	0.3728	30.98	0	F_{ST} = 0.6902

clusters (Fig. 1). Topology of the remaining samples was not resolved. The populations of *L. n. leechi* and *L. n. gueneei* were very homogeneous. On the other hand, high variability was revealed between populations of *L. n. albarracina* and *L. n. knilli* (Fig. 1). Values of expected heterozygosity in populations sampled are low when compared with published results in other species of Lepidoptera (Nève 2009). The estimates, however, strongly depend on the markers used (e.g., microsatellites, allozymes) and many of the studies listed by Nève (2009) have used allozymes. Among populations studied here, *L. n. leechi* showed significantly lower heterozygosity (Tab. 4). Finer structure of population genealogy was achieved by haplotype network construction (Fig. 3).

The AMOVA analysis showed the populations are structured but in contrast to our prior expectations, *L. n. leechi* is genetically closer to *L. n. demuthi*, *L. n. knilli* and *L. n. albarracina* (they widely share one haplotype) rather than to *L. n. gueneei* (Tab. 5). The Mantel test for isolation by distance was not significant (r^2 = 0.014; p = 0.78).

Discussion

We used mitochondrial markers to look at the current genetic composition of *L. nickerlii* moths in Britain and Ireland in order to understand where they came from and in particular why they are prone to splitting-off genetically identifiable groups that are isolated from other groups. Taken together the genetic markers support the null hypothesis that all the populations sampled belong to the same species *Luperina nickerlii*, despite differences in appearance and population isolation – and some differences in ecology between UK, Irish and mainland populations, although the alternative hypothesis that evolutionary divergence is too recent to be fully reflected genetically could also be considered.

More detailed analyses of the subspecies populations reveals a complex pattern of within species population differentiation. Population structure for Lepidoptera depends on the spatial distance of habitats, the dispersal abilities of the species (Nève 2009) and population origin (e.g., Hewitt 1996). *Luperina nickerlii* appears to show low dispersal abilities, perhaps due to population isolation (Spalding & Young 2011b), although occasionally singletons are found at some distance from known populations (Goater 1974; Wedd 1991), indicating dispersal activity. Results from the COI data indicate that there may have been some historical gene flow between the subspecies as isolation by distance was not supported in this study, suggesting populations were probably linked to each other in the recent past, either reflecting a collapse in a former larger pre-glacial range size or multiple post-glacial colonisation events; the degree of genetic differentiation between the British populations may suggest the second hypothesis as otherwise greater similarity between populations might be expected (e.g., Dapporto et al. 2011). Movement is likely between continental populations, e.g., in Spain and the Czech Republic, where several populations occur in close proximity, and also in Wales and south-east England where *L. n. gueneei* and *L. n. demuthi* exist in extensive dune (for *L. n. gueneei*) and saltmarsh (for *L. n.* d*emuthi*) habitat. In contrast, the results for *L. n. knilli* indicate little interchange between populations despite occupying the same extended coastal cliff habitat in south-west Ireland and *L. n. leechi* is isolated by at least 300 km from known *L. nickerlii* populations.

The origin of the British subspecies is unclear. Those occurring on the western fringes may be part of an Atlantic Arc species assemblage that includes species such as the Quimper Snail *Elona quimperiana* (Férussac) (de Beaulieu & Le Moigne 1991) and Killarney Fern *Trichomanes speciosum* Willd (Page 1997). *L. n. leechi* shows some genetic similarity to *L. n. albarracina, L. n. knilli* and *L. n. demuthi*, but not (despite our expectations) *L. n. gueneei*. It is possible that *L. n. leechi* is a population founded by a single stray *L. n. demuthi* or *L. n. albarracina*. If so, *L. n. leechi* would be more likely to feed as larvae on *Festuca rubra* L. or *Puccinellia maritima* (Huds.) Parl. (Poaceae). However, it would appear that *L. n. leechi* may have been present on or near Loe Bar long enough to adapt to a different habitat and transfer from former food plants to *Elytrigia juncea*; in fact *Festuca rubra* is abundant in that locality. Rapid changes in larval host-plant preferences have been reported in butterflies (e.g., Asher et al. 2001; Pratt 1986–1987; Thomas et al. 2001) and moths, e.g., *Lithophane leautieri* (Boisduval, 1829) (Noctuidae) (Young 1997). Further research, perhaps involving *L. nickerlii* specimens from France and Portugal, may reveal additional linkages between the subspecies.

The origin of the extensive populations of *L. n. gueneei* remains a mystery; this subspecies appears to show significantly lower heterozygosity despite forming extensive populations on the north coast of Wales and the west coast of Lancashire, with at least some linkage between populations. Despite similarities in ecology to *L. n. leechi* (both species occurring on coastal dunes and beaches and both feeding on *Elytrigia juncea*), there is no indication that these two species have a common origin.

Genetic factors are important when assessing threatening processes and devising conservation plans for threatened species (Frankham & Ralls 1998). From a genetics perspective, the primary conservation goals are to preserve as much genetic diversity and variability as possible as well as the evolutionary processes responsible for this diversity (Clarke & O'Dwyer 2000; Coates 2000; Crandall et al. 2000). It is perhaps useful to rank populations on patch size, habitat quality and land tenure (Clarke & O'Dwyer 2000), variation in phenotype (Crandall et al. 2000) and host-plant performance (Legge et al. 1996) in addition to genetic diversity. The continental subspecies appear to have similar ecologies although there are some phenotypic and genetic differences; the British and Irish subspecies show phenotypic and genetic differences as well as having different host plants and habitats. Populations of *L. n. tardenota*, *L. n. gueneei*, *L. n. leechi* and *L. n. knilli* appear to be small and possibly declining; we provisionally suggest that key conservation effort should be directed to these subspecies.

However, not all subspecies should be considered equal (Ryder 1986). It is important to take account of the evolutionary processes associated with current levels of species diversity at the approriate geographical scale (e.g., Coates 2000). Low heterozygosity combined with increased levels of inbreeding associated with a limited number of individuals and a distorted sex ratio have been shown to decrease survival rates (e.g., Gerber 2006; Saccheri et al. 1998) and the small isolated population of *L. n. leechi* may not survive for long. The phenotypic characters that have been used to differentiate *L. n. leechi* as a subspecies are perhaps subject to environmental plasticity and may not be under genetic control. In this case this population would no longer be considered of conservation importance as *L. n. leechi* contains a single haplotype that is widely shared with other subspecies (e.g., *L. n. demuthi* and *L. n. albarracina*). The lack of genetic diversity possibly as a result of its recent origin and the small population size suggests that this isolated subspecies may be less worthy of conservation than some of the other subspecies. The case for *L. n. gueneei* is less clear as this subspecies possesses a unique haplotype and forms extensive populations on the north coasts of Wales and north-east Lancashire.

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The status of *Satyrus abramovi* var. *korlana* Staudinger, 1901 (Nymphalidae)

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Abstract. A new status for *Satyrus abramovi* var. *korlana* Staudinger, 1901 as a subspecies of *Karanasa regeli* (Alphéraky, 1881) is proposed. The diagnostic characters of *K. abramovi* (Erschoff, 1884) and *K. regeli* (Alphéraky, 1881) in male genitalia are discussed. Lectotypes are designated for *Satyrus abramovi* var. *korlana* Staudinger, 1901 and *Satyrus regeli* var. *regulus* Staudinger, 1887.

Резюме. Установлено, что таксон *Satyrus abramovi* var. *korlana* Staudinger, 1901 является подвидом *Karanasa regeli* (Alphéraky, 1881). Выделены диагностические признаки *K. abramovi* (Erschoff, 1884) и *K. regeli* (Alphéraky, 1881) в гениталиях самцов. Обозначены лектотипы *Satyrus abramovi* var. *korlana* Staudinger, 1901 и *Satyrus regeli* var. *regulus* Staudinger, 1887.

Introduction

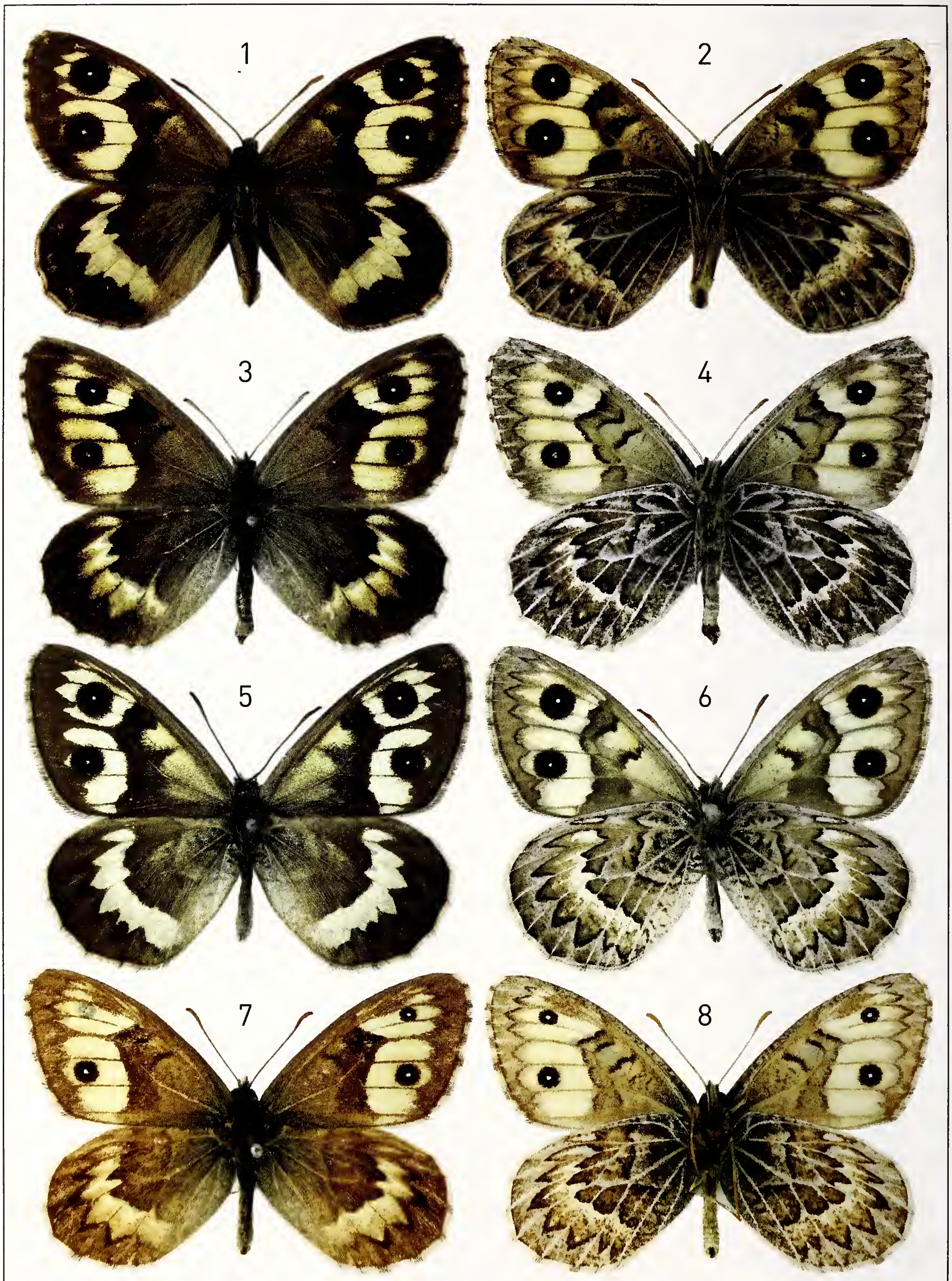
The taxonomy of some of the taxa of the genus *Karanasa* Moore, 1893 inhabiting high mountainous Central Asia remains unclear. One of these taxonomic problems is the status of the species-group taxon *Satyrus abramovi* var. *korlana*, described by O. Staudinger from "Korla" (eastern extensions of Tian-Shan in China near the city of Korla). A. Avinoff & W. R. Sweadner (1951) listed this taxon as the separate species *Karanasa korlana* (op. cit.: 101) and also as a subspecies of *K. regeli* (Alphéraky, 1881) (op. cit.: 191, 195). These two authors have been the last who revised the genus *Karanasa*, but they did not use genitalia features in their revision. For clarification of this problem, to resolve the status of the taxon *korlana*, I revised its type material as well as the type material of other closely related taxa.

Abbreviations

SK	S. K. Korb collection, housed in Nizhny Novgorod, Russia
ZMMU	Zoological Museum of the Moscow University, Moscow, Russia
ZMHB	Museum für Naturkunde an der Humboldt-Universität, Berlin, Germany

Material and methods

The following name-bearing types have been studied: syntypes of *Satyrus abramovi* var. *korlana*; lectotype of *Satyrus regeli* Alphéraky, 1881 (lectotype designated by Korb 2012: 46); syntypes of *Satyrus regeli* var. *regulus* Staudinger, 1887 (all three taxa are currently classified in *Karanasa*).



Figs 1–8. *Karanasa* Moore, 1893. **1**, **2**. topotype male, upperside (1) and underside (2), 12.viii.2006, Kyrgyzstan, Chatyr-Kul Lake environs, 2800 m. **3**, **4**. *Karanasa regeli korlana* (Staudinger, 1901), lectotype male, upperside (3), underside (4), Korla. **5**, **6**. *Karanasa abramovi regulus* (Staudinger, 1887), lectotype male, upperside (5), underside (6), Transalai. **7**, **8**. *Karanasa regeli* (Alphéraky, 1881), lectotype male, upperside (7), underside (8), Tian Shan.

Figs 9, 10. Lectotype labels. **9.** *Karanasa regeli korlana* (Staudinger, 1901). **10.** *Karanasa abramovi regulus* (Staudinger, 1887).

For nomenclatural stability and to fix the exact type locality I designate here the lectotype of *Satyrus abramovi* var. *korlana*. For the same reason I designate here the lectotype of *Satyrus regeli* var. *regulus*. Lectotypes are preserved in ZMHB.

Satyrus abramovi var. *korlana* — Figs 3, 4, 9, 12, 15

Material. Lectotype ♂, 'Origin.'; 'v. Korlana Stgr.'; 'Korla'; 'Abramovi | v.'; printed on red paper 'LECTOTYPUS ♂| korlana | Stgr. | S. K. Korb design. 17.04.2012'. Paralectotype 1♀.

Satyrus regeli var. *regulus* — Figs 5, 6, 10, 13, 16

Material. Lectotype ♂, 'Transalai | Pamir ? | 88 Maur.'; 'Abramovi | Ersch. | Regulus | Stgr.'; 'LECTOTYPUS ♂ | regulus | Stgr. | S. K. Korb design. 17.04.2012'. Paralectotypes 3♂, 1♀.

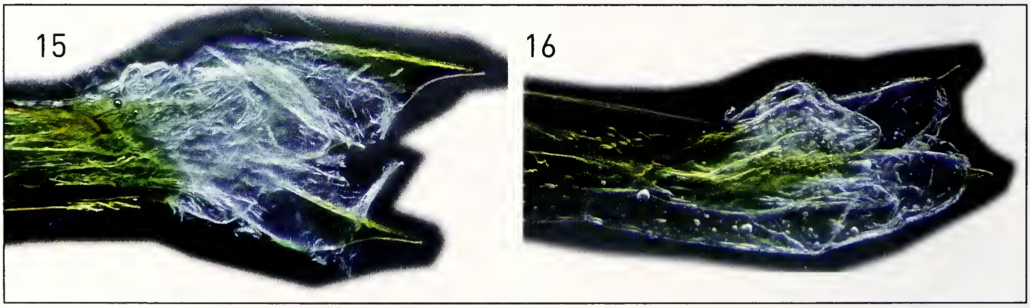
Karanasa regeli (Alphéraky, 1881) — Figs 7–10, 12, 14, 15

Material. **Kazakhstan**: 12♂, 3♀, Transilian Alatau Mts, Assy valley, 24.vii.2010, leg. P. Egorov, SK; 2♂, Transilian Alatau Mts, Koram, 2200 m, 14.viii.1957, Panfilov leg., ZMMU. **Kyrgyzstan**: 2♂, 1♀, Kungey Ala-Too Mts, Grigoryevskoye valley, 2500 m, 12.viii.2003, leg. S. K. Korb, SK; 1♂, Kungey Ala-Too Mts, Temirovka, viii.2010, local collector, SK; 1♂, 1♀, Kungey Ala-Too Mts, Toguzbulak, 2000 m, 7.viii.2003, leg. S. K. Korb, SK.

Karanasa abramovi (Erschoff, 1884) — Figs 1–8, 11, 13, 16

Material. **Kyrgyzstan**: 2♂, Chatyr-Kul Lake environs, 2800 m, 12.viii.2006, leg. S. K. Korb, SK; 2♂, Kyrgyz Mts, Ala-Archa Nature Reserve, upper course of Ala-Archa river, 3000 m, 02.viii.2003, leg. S. K. Korb, SK; 6♂, 2♀, West Tian-Shan <sic!>, Dolon Pass, 3000 m, 9.viii.1967, leg. A. Tsvetaev, ZMMU; 2♂, Transalai Mts, Aram-Kungei, unknown collector, SK.

Figs 11–14. Male genitalia. **11**. *Karanasa abramovi* (Erschoff, 1884), topotype. 12.viii.2006, Kyrgyzstan, Chatyr-Kul Lake environs, 2800 m. **12**. *Karanasa regeli korlana* (Staudinger, 1901), lectotype. **13**. *Karanasa abramovi regulus* (Staudinger, 1887), lectotype. **14**. *Karanasa regeli* (Alphéraky, 1881), paralectotype, Tian Shan.



Figs 15, 16. Vesica and distal part of phallus. **15**. *Karanasa regeli korlana* (Staudinger, 1901), lectotype. **16**. *Karanasa abramovi regulus* (Staudinger, 1887), lectotype.

Discussion and Conclusions

During the examination of the type material and additional specimens the following differences between *K. regeli* and *K. abramovi* were found in the male genitalia (Figs 11–16). In *K. abramovi* the valva is elongated, with no extension in its distal part; in *K. regeli* it is more massive, with an extension in its distal part. In *K. abramovi* the dorsal

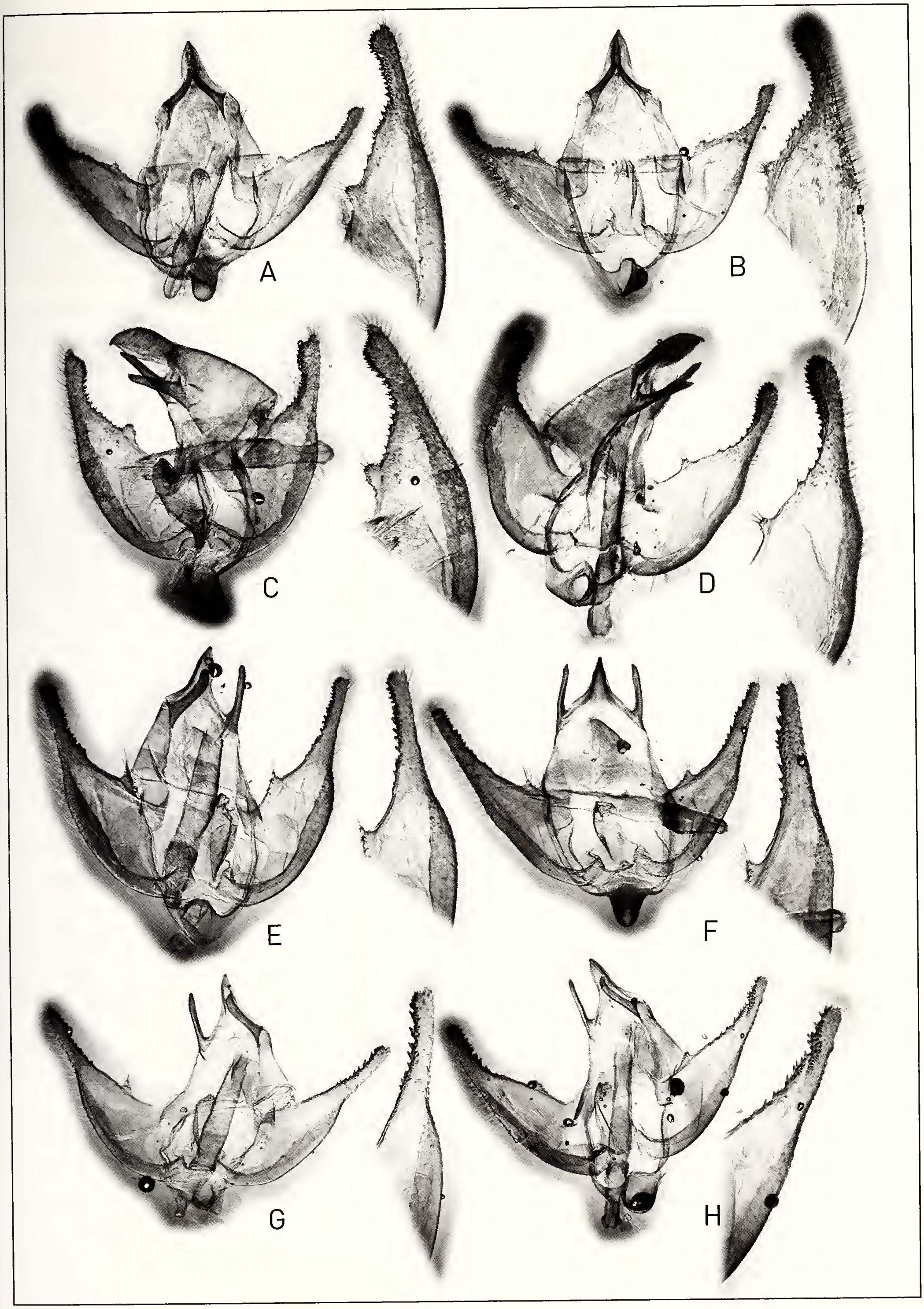


Fig. 17. Variability of genitalia in *Karanasa* species. **A–D**. *K. regeli* (Alphéraky, 1881), Transili Alatau Mts, Assy valley (**A**, **B**), Terskey Ala-Too Mts, Pokrovka environs (**C**, **D**). **E–H**. *K. abramovi* (Erschoff, 1884), Akshiyrak Mts, Dolon Pass.

side of the valva continues towards the apex in a more or less smooth line, whereas in *K. regeli* it forms a bend at about one quarter from the apex. In *K. abramovi* the outgrowth on the dorsal side of the valva at about one third from the base is always pointed and can be divided into two or three parts, whereas in *K. regeli* it is always somewhat rounded and forms one whole. In *K. abramovi* the dorsal teeth on the valva, mostly present apically, are always separated from this outgrowth with an area without teeth; in *K. regeli* they start almost immediately after the outgrowth. In *K. abramovi* the vesica has two small spine-like cornuti; in *K. regeli* it has two quite large scale-like cornuti.

Due to the fact that genitalia features of the taxon *korlana* match much more closely those of *K. regeli* than those of *K. abramovi*, *korlana* is now considered a subspecies of *K. regeli*. It is its most widely distributed subspecies, distributed in Khalyktau, Borokhotan, Narat, Borto-Ula, Kuruktag, Avral-Ula and the Uken Mountains in northwestern China. Both species (*K. abramovi* and *K. regeli*) are similar in wing pattern but significantly different in genitalia (as described above).

Only one infrasubspecific taxon for this group is currently established: *K. abramovi* ab. *erschovi* Avinov, 1910 (a yellow aberration of the female). Individual variation in both taxa is only present in the colour and width of the light-coloured band on the upperside of the wing and in the size of the eyespots. Wing pattern variability in both species is very large. Very high variation in genitalia structures is also present, but this does not obscure the specific features as the variation only occurs in smaller details. This variation should be studied in more detail in the future (Fig. 17).

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The "Omnivorous Leafroller", *Platynota stultana* Walsingham, 1884 (Tortricidae: Sparganothini), a new moth for Europe

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Abstract. *Platynota stultana* Walsingham, 1884, a polyphagous tortricid and economically important species, is formally recorded for the first time for Europe.

Introduction

Platynota stultana Walsingham, 1884 is an invasive species of Tortricidae native to Mexico and the southwestern United States, accidentally introduced to the Hawaiian Islands (Miller 1995). Known in the entomological literature as the "omnivorous leafroller", its potential range of food plants includes more than 20 plant families including relevant ornamental plants, agricultural crops, and even forest species (Powell & Brown 2012).

Its presence in Europe was first detected in 2009 by pest control services of the provinces of Murcia and Almeria in Spain during routine monitoring of agricultural areas, mostly on pepper crops (*Capsicum* sp., Solanaceae). Although there has been no reaction in the entomological literature, several popular electronic agricultural journals and leaflets have included information on this pest and provided details on its distribution and potential control in Spain (Hymenoptera 2011).

Parallel field work developed in Spain in the period 2005–2008 in the provinces of Almeria, Alicante, and Granada by A. Cox and M. Delnoye rendered a good series of specimens of an unknown Sparganothini species that was finally identified by A. Schreurs and the first author of this paper as belonging to *P. stultana*. Because of the economic importance of the species and the limited attention that the entomological literature has paid to this new pest introduction, it seems appropriate to publish this note to formally record its presence in Spain.

Platynota stultana is a small moth, the wingspan of the male is 10–15 mm and of the female 14–19 mm. As in most members of the tribe Sparganothini, the labial palpi are long and frontally projected. This character is not found in the European fauna except in the few species of the genus *Sparganothis* Hübner, reducing potential mistakes in identification. Male forewings possess a small costal fold. The general upperside ground colour is brown in the approximately basal half and golden brown in the distal half (Fig. 1A). In the female the markings are less distinct (Fig. 1B). Some colour variation is common. Male and female genitalia include unmistakable features (Figs 1C, D).

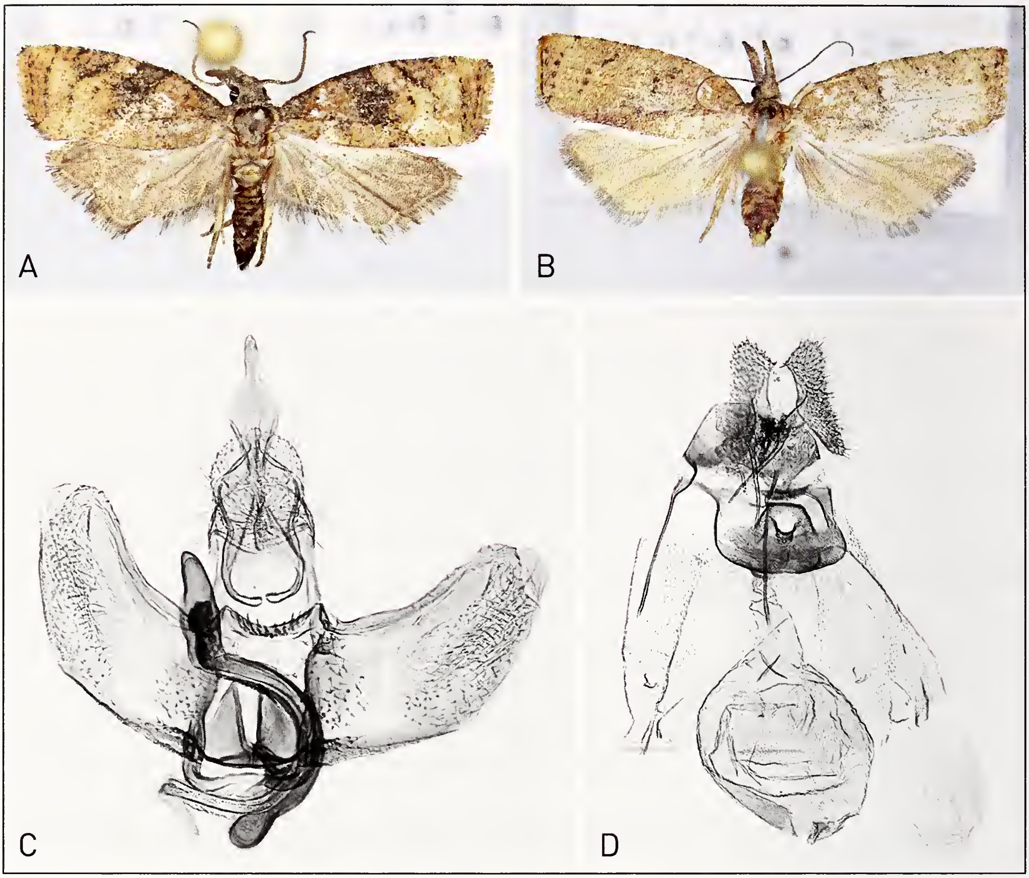

Fig. 1. *Platynota stultana.* **A**: Male (Cabo de Gata, Almería, Spain). **B**: Female (Granada, Spain). **C**: Male genitalia (GS: FG2409). **D**: Female genitalia (GS: FG2408).

Detailed information on its morphology and biology is compiled by Powell & Brown (2012).

In the United States the moth has 4–6 generations a year. The female lays a patch of about 100 eggs. After hatching the larvae move to the top of the plant and feed within a bud or between the two leaves. In greenhouse conditions the larvae are fully grown within a period of 20–30 days. They hibernate between the third and fifth instar in webbed nests. Pupation takes place in a rolled leaf.

Material. **Spain**, 29 specimens, Almeria, Aqua Dulce, x.2005, leg. AC; 3 specimens, Alicante, La Marina, leg. MD; 18 specimens, Almeria, Cabo de Gata, vi.2007; 5 specimens, same locality but dated x.2007; 82 specimens, Granada, Castillio de Banos, x.2008, genitalia slides FG2138♂, FG2354♀, FG2355♂; 10 specimens, same locality but dated vi.2010; 1 specimen, xi.2011 [GNL, AS, AC].

Abbreviations

AS	Collection A. Schreurs, Kerkrade, The Netherlands
AC	Collection A. Cox, Mook, The Netherlands
GNL	Collection F. Groenen, Luyksgestel, The Netherlands
MD	Collection M. Delnoye, Susteren, The Netherlands

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Habitat preferences of butterflies (Papilionoidea) in the Karpaz Peninsula, Cyprus

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Abstract. The Mediterranean region comprises of some of the world's unique and biogeographically important areas, harbouring high levels of biological diversity. On the other hand, anthropogenic disturbances are causing degradation of diverse ecosystems within the region. The aim of this study was to determine the habitat preferences of butterfly species and the potential threats they may face within the Karpaz Peninsula of Cyprus. To understand the importance of local vegetation characteristics of butterflies in the Karpaz Peninsula, 'Pollard Walk' transect counts were used to assess the abundance and species richness of butterflies. Butterflies resting on plants and those in flight were counted and identified. Preferred plant species and habitat types (EUNIS and EU Habitats) of the butterflies are also identified. During the surveys in 2006, eleven butterfly species were recorded. Two of them (*Glaucopsyche paphos* and *Maniola cypricola*) are endemic to Cyprus. Construction developments and road improvements were recorded within the region and have resulted in habitat loss and degradation. Our results provide valuable knowledge about important habitats for Cypriot butterflies within the Karpaz Peninsula and additionally highlight the need for their conservation in the face of large infrastructure developments and unregulated construction.

Introduction

The Mediterranean Basin is rich in biodiversity and in need of conservation (Myers 1990). Cyprus is the third largest island within the Mediterranean Basin, after Sicily and Sardinia. It harbours a variety of ecosystems including pine forests, garrigue, maquis, rocky areas, coastal rocky areas, coastal dunes, wetlands, and agricultural areas together with a high number of threatened and endemic plant and animal species (Baier et al. 2009; Flint & Stewart 1992; Makris 2003; Tsintides 1998; USAID 2006). The northern part of the island has been politically isolated for many years and as a result, development has been relatively slow compared with similar regions in the Mediterranean. In general, the northern part of the island offers a range of varied terrestrial habitats, such as pine forests (both lowland and mountain), juniper shrubs, garrigue, phrygana, limestone pavements and dune vegetations (Tsintides 1998; Viney 1994).

The Karpaz Peninsula is biologically one of the most important areas in Cyprus. It is situated at the easterly point of the Five Finger Mountain Range (Beşparmak Sıra Dağları). It consists of hill-like formations covered with maquis, pine forests, olive and carob plantations, plains containing arable lands, semi-dry stream beds and a coastal zone. The Karpaz Peninsula is particularly known for its unspoilt landscapes and its interesting wildlife; therefore it is an important ecotourism area. The area has recently received official legal protection as an important natural resource for the northern part of the island and was declared a "Special Environmentally Protected Area" according to Environment Law (21/97) article 11 by the Turkish Cypriot authorities. The Karpaz

Special Environmentally Protected Area has been selected due to the occurrence of internationally important habitats and species, including marine turtles *Chelonia mydas* (Linnaeus, 1758), *Caretta caretta* (Linnaeus, 1758), Audouin's Gull *Larus audouinii* Payraudeau, 1826, and Mediterranean Monk Seal *Monachus monachus* (Hermann, 1779) (Godley & Broderick 1992; Haigh 2004; Iris & Gucel 2008). Karpaz is not only known for important animal species; it also harbours many endemic and rare plant species such as Cyprus Orchid (*Ophrys kotschyi* H. Fleischm. & Soó) which is listed under EU Annex II plant species (European Commission 2007a; Kreutz 2004).

Although the peninsula is declared as a "Special Environmentally Protected Area" by local authorities, herbicide and pesticide use in agricultural fields is still allowed. Agricultural cereal fields in the area are mainly wheat and barley production areas and are open monocultures. These areas are not irrigated and farmers apply shallow ploughing in these monoculture fields. The field margins between the grassland fields are not more than 1.5 m wide.

It is known that about one third (31%) of European butterflies has declined over the last 10 years (van Swaay et al. 2010). There are many documented threats to butterflies in Europe, including the increasing use of agricultural herbicides and pesticides, habitat loss, climate change, land management, agricultural conversion and fragmentation (Grill et al. 2005, Stefanescu et al. 2005; Wilson & Maclean 2011). Building and infrastructure developments such as roads, quarries and housing are also strong drivers of population declines affecting 80% of the threatened butterfly species within Europe (van Swaay et al. 2009).

So far in Cyprus, 53 species and subspecies of butterflies have been recorded. They include three endemic species (*Maniola cypricola* (Graves, 1928), *Hipparchia cypriensis* Holik, 1949 and *Glaucopsyche paphos* Chapman, 1920) (Makris 2003). Two of the endemic species, *M. cypricola* and *G. paphos*, are of European Conservation Concern (van Swaay & Warren 1999). Here we used a case study of butterfly abundance and behaviour within the Karpaz Peninsula in different habitat types. We compared the butterfly abundance/activity and species richness between different habitat types during the spring season. Understanding the response of different butterfly species to different habitats is essential in order to design conservation management, especially in Mediterranean mosaic landscapes (Pe'er et al. 2011). The aim of this study was to determine the habitat preferences of butterfly species and the potential threats that they may face within the Karpaz Peninsula of Cyprus.

Materials and Methods

This study was carried out in the Karpaz Peninsula of Cyprus between the beginning of April until the end of May 2006. The vegetation in the area is mainly dominated by *Juniperus phoenicea* L. (Cupressaceae), *Olea europaea* Linnaeus (Oleaceae), *Ceratonia siliqua* L. (Fabaceae), *Pistacia lentiscus* L. (Anacardiaceae), *Thymus capitatus* (L.) Hoffmanns. & Link (Lamiaceae), *Sarcopoterium spinosum* (L.) Spach (Rosaceae) and *Genista sphacelata* Spach (Fabaceae). During the spring there are many wild flowers in the area including several endemic plant species such as *Anthemis tricolor* Boiss.

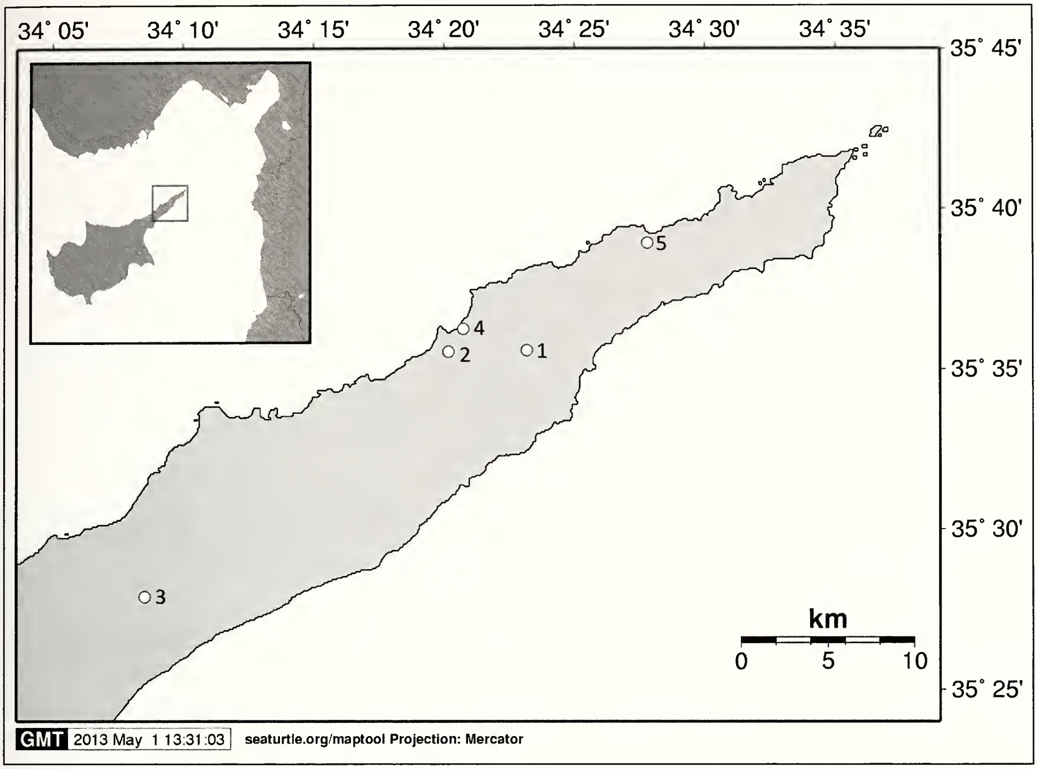

Fig. 1. Numbered open circles (○) provide the location points for each butterfly-survey transect within the Karpaz Peninsula.

(Asteraceae), *Helianthemum obtusifolium* Dunal (Cistaceae) and *Ophrys kotschyi* (Orchidaceae).

According to local records, the average annual rainfall in the area is 455–506 mm. The highest rainfall occurs during December–January. The average temperature is 20°C in the region (Yeni Erenkoy Meterological Station).

The census procedure used for this research was the Pollard Walk method, as described by Pollard (1977) and Royer et al. (1998). Five Pollard walk transects were established across the Karpaz Peninsula during this project (Fig. 1.). Transects of a fixed length (1 km) were walked and adult butterflies recorded. All transects were carried out at the optimum time of the day for seeing butterflies (11.00–13.00 hours), on warm sunny days at temperatures of 24–28°C, with little or no wind (Beaufort force 0–2) and all transects were below 130 metres elevation. Transects were chosen to cover a range of habitat types. Plant identifications were carried out during transect selection. Butterflies nectaring on plants and those in flight were counted and identified. If the exact identification of the species was not possible, a butterfly net was used to capture those butterflies in question, in order to facilitate field identification using the available literature (Makris 2003; Tolman & Lewington 1997). After identification, captured butterflies were released at their point of capture. In addition, butterflies nectaring on plants were recorded together with the plant species.

Tab. 1. Transects and habitat classifications for each transect

Transect number	coordinates	EU habitat type	EUNIS habitat type	Common flowering plants	Habitat definition
1	35,59293 N 34,38642 E	0	J2 Low density buildings	*Onopordum cyprium*, *Chrysanthemum crononarium*	Village Area
2	35,59206 N 34,33646 E	5210 Arborescent matorral with *Juniperus* spp.	0	*Cistus* spp., *Thymus capitatus*	Arborescent matorral
3	35,46469 N 34,14230 E	0	E 2.6 Agriculturally-improved, re-seeded and heavily fertilized grassland, including sports fields and grass lawns	*Centaurea hyalolepis*, *Onopordum cyprium*	Agricultural area
4	35,60391 N 34,34566 E	5420 *Sarcopterium spinosum* phryganas	C2 Surface running waters	Few *Cistus* spp. and *Onopordum cyprium*	Phrygana
5	35,64884 N 34,46318 E	5210 Arborescent matorral with *Juniperus* spp.	0	*Cistus* spp.	Arborescent matorral

Transect 1 was established within the Dipkarpaz village, and the transect was walked along the house garden edges which were mainly dominated by *Onopordum cyprium* Eig (Asteraceae), *Chrysanthemum coronarium* L. (Asteraceae), *Cistus creticus* L. (Cistaceae) and grassy patches. Transect 2 was established in the arborescent matorral with *Juniperus* habitat. The habitat was dominated by *Pistacia lentiscus*, *Juniperus phoenicea* and *Cistus salviifolius* L. (Cistaceae) with small grassland patches. Transect 3 was established along the edge of the field crop (wheat and barley) growing area. The vegetation was dominated by *Centaurea hyalolepis* Boiss. (Asteraceae) and *Onopordum cyprium*. Transect 4 was established along the Ronnas River and vegetation was dominated by *Pistacia lentiscus*. Transect 5 was established within the arborescent matorral with *Juniperus* habitat. The habitat was dominated by *Juniperus phoenicea*, *Pistacia lentiscus* and *Calicotome villosa* (Poir.) Link (Fabaceae) (Tab. 1, Fig. 1).

The plant species were identified using Viney (1994) as a reference. In addition, for each transect site the existing habitat type was also identified according to the Interpretation Manual of European Union Habitats and EUNIS habitat classification (Tab. 1) (Davies et al. 2004; European Commission 2007b).

Results and Discussion

Butterfly abundance and species richness were studied in different habitat types within the Karpaz Peninsula. During the surveys, a total of 169 individual butterflies from

Tab. 2. Butterfly species and their total abundance observed in different habitats. T = Transect.

Species Name	**Village area (T 1)**	**Arborescent matorral (T 2 and T 5)**	**Agricultural area (T 3)**	**Phrygana (T 4)**	**Total number**
Pieris rapae	0	0	8	0	8
Colias crocea	0	0	3	2	5
Gegenes pumilio	2	0	0	0	2
Glaucopsyche paphos	4	9	0	5	18
Gonepteryx cleopatra	1	0	1	5	7
Maniola cypricola	0	11	39	10	60
Papilio machaon	1	0	0	3	4
Pieris brassicae	7	5	4	1	17
Thymelicus acteon	0	0	15	12	27
Vanessa cardui	1	3	16	0	20
Vanessa atalanta	1	0	0	0	1
Total Abundance	17	28	86	38	169
Total Species	7	4	7	7	11

11 species were recorded across the five transects in the Karpaz Peninsula region of Cyprus. Surprisingly, the highest number of butterflies (86) was recorded from agricultural habitat, especially high abundance of the endemic species *Maniola cypricola*. Most of the individuals recorded from farmland habitat were nectaring on *Centaurea hyalolepis* along the field margins. Flower-rich field margins may be crucial for spring-flying butterflies (Dover 1989), as nectar feeding increases individual longevity, female fecundity and patterns of oviposition in local populations (Erhardt & Mevi-Schütz 2009; Stefanescu & Traveset 2009). An important factor behind butterfly losses is the loss of flower-rich habitats from open farmlands (Nilsson et al. 2008).

The second highest number of butterflies (38) was recorded from *Sarcopoterium spinosum* phrygana habitat (EU Annex I 5420) from the Ronnas River area. *Sarcopoterium* phryganas are low thorny shrub-like formations within the thermo-Mediterranean zone of Aegean islands, Greece, Coastal Anatolia and Cyprus. This habitat type harbours many flowering and aromatic plant species such as *Thymus capitatus*, *Cistus creticus*, *Cistus salviifolius* and *Teucrium* spp. (Lamiaceae) (EC 2007b). In particular *Cistus* spp. and *Teucrium* spp. are important butterfly nectar sources in Cyprus (Özden & Hodgson 2011). Species richness of butterflies was similar within four transects apart from the species-poor arborescent matorral habitat transect (Tab. 2).

Maniola cypricola (60), *Thymelicus acteon* (Rottemburg, 1775) (27) and *Vanessa cardui* (Linnaeus, 1758) (20) were the three most abundant species observed from different transects. The endemic *M. cypricola* was recorded from arborescent matorral, phrygana habitats and agricultural farmlands but not from the village area. This observation was interesting, because *M. cypricola* is a very common species across Cyprus (Özden et al. 2008; Özden & Hodgson 2011). Natural habitats and field margins may provide suitable habitat for this species; however, this limited data cannot be considered conclusive. As expected, the generalist *Pieris brassicae* (Linneaus, 1758) was recorded from all types of habitats (Tab. 2).

Tab. 3. Number of butterflies recorded while nectaring on different plant species. * – A total of 32 *Maniola cypricola* was recorded on *C. hyalolepis* from agricultural area. ** – A total of 14 (all) *Thymelicus acteon* was recorded on *C. hyalolepis* from agricultural area. *** – A total of 16 *Vanessa cardui* was recorded on *C. hyalolepis* from agricultural area.

Species Name	*Onopordum cyprium*	*Cistus creticus*	*Centaurea hyalolepis*	*Genista sphaceleata*
Pieris rapae	0	0	8	0
Colias crocea	0	0	3	0
Gegenes pumilio	2	0	0	0
Glaucopsyche paphos	0	2	4	5
Gonepteryx cleopatra	0	0	0	0
Maniola cypricola	2	3	33 *	0
Papilio machaon	1	0	0	0
Pieris brassicae	1	0	3	0
Thymelicus acteon	0	2	14**	0
Vanessa cardui	0	0	17***	0
Vanessa atalanta	0	1	0	0
Total Numbers	6	8	82	5

Regarding nectaring records, the highest number of butterflies utilised *Centaurea hyalolepis* (82 individuals) as a source of nectar. *Thymelicus acteon* was also recorded nectaring on *Centaurea hyalolepis* (Tab. 3). *T. acteon* is considered as a Near Threatened species at the European level (van Swaay et al. 2010). Plants of the genus *Centaurea* are widely regarded as providing a good source of nectar. The high nectar yield of plants in this genus makes it very attractive to insects, especially butterflies (Wackers et al. 2005). *Centaurea hyalolepis* is spreading annually or biennially reaching a height of 60 cm and is much-branched; it is a common plant throughout northern Cyprus, flowering from April to July.

Conclusion

In conclusion, the results presented in this paper provide valuable information on Cypriot butterflies and their close relationship with different habitat types within the Karpaz Peninsula. Further research is needed in order to discover which plant species are preferred sources of nectar for butterflies over a longer time frame.

Observations of butterfly behaviour have revealed that the flora of the field margins provides rich nectar sources for butterflies in Karpaz. Therefore, local authorities should be made aware of the importance of field margins in cereal farmlands and this information should be used when implementing the management plans of the EU Habitats Directive within the agricultural farmland ecosystems of Karpaz Special Protected Area. Also, for the future protection of special biodiversity-rich habitats, unnecessary road improvements along with uncontrolled building constructions should be excluded from this area.

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Occurrence of *Borearctia menetriesii* (Eversmann, 1846) (Erebidae: Arctiinae) in Northern European Russia: a new locality in a disjunct species range

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Abstract. Disjunctive distribution is typical for the transpalaearctic tiger moth *Borearctia menetriesii* (Eversmann, 1846) (Erebidae: Arctiinae) at the present time. The new discovery at the East European (Russian) Plain modifies the previously known distribution pattern of this species. A specimen of this moth was recorded on a small patch of a humid mixed-herb meadow on the forest karst landscape of the White Sea-Kuloi Plateau. Its location is in the upper part of the Sotka River Valley and is surrounded by northern primary forest of spruce with inclusions of larch patches. It is characterised by a cold microclimate. This paper summarises data on previously known localities of *B. menetriesii* that are situated mainly within the Russian Federation and analyses the species distribution using Bailey's Ecoregions system.

Introduction

The Menetries's Tiger Moth *Borearctia menetriesii* (Eversmann, 1846) (Erebidae: Arctiinae) is one of the rarest species of Palaearctic tiger moths and disjunctive distribution is typical for it (Dubatolov 1984, 2010; Kurentzov 1965, 1973). Contemporary data include the following areas in this species range: Europe: Middle-Finland; European Russia: Karelia and Ural Mountains; Siberia: lower Ob river, the Altai and Sayan Mountains, Baikal, Transbaikalia, Evenkia and Yakutia; Kazakhstan: northeastern region; Far Eastern Russia: northern region of Amur basin, Sikhote-Alin Mountains and Sakhalin Island (Dubatolov 1996, 2010; Dubatolov & Gordeeva 2005; Ermakov 2006; Nupponen & Fibiger 2012; Saarenmaa 2012).

Single specimens were found in most of the listed localities (Dubatolov 1984, 2009, 2010; Koshkin 2010; Krogerus 1944; Marttila et al. 1996; Shodotova et al. 2007; Silvonen 2010). Sometimes, the records are separated from each other by decades, for example in Finland (Fabritius 1914; Krogerus 1944; Marttila et al. 1996; Lappi et al. 2004; Silvonen 2010) and Sakhalin Island (Hori 1926; Klitin 2009). In recent times (i.e. 21st century) species records are known for Finland (Lappi et al. 2004; Silvonen 2010) and Russia: Yamal-Nenets District (Gorbunov & Olschwang 2012), North Ural Mountains (Ermakov 2006; Nupponen & Fibiger 2012), Kuznetsky Alatau Mountains (Sutchev & Skalon 2012), Transbaikalia (Saarenmaa 2012), Sikhote-Alin Mountains (Silvonen 2010) and Sakhalin Island (Klitin 2009).

The largest gap in the species range is situated in the territory of north-eastern Europe: in the West there are only a few localities in East Fennoscandia and in the East we know only of North Ural and Western Siberian records (Dubatolov 2004, 2010; Ermakov 2006; Nupponen & Fibiger 2012).

Larval development of *B. menetriesii* was described for the first time by Krogerus (1944) and was recently illustrated in detail via in vitro observations (Saarenmaa 2012). The aim of the present paper is to analyse the distribution range of *B. menetriesii* in the light of the first species record from the White Sea-Kuloi Plateau, Northern European Russia.

Material and methods

The White Sea-Kuloi plateau is the largest karst region of Northern European Russia, with an area of approximately 24,000 km^2. The average plateau altitude varies from 70 to 140 m.a.s.l. (Gofarov et al. 2006). Lower Permian gypsum and anhydrite rocks form the eastern part of the plateau and intensive karst processes occur in this area.

The karst landscape environment on White Sea-Kuloi Plateau has specific ecological conditions and the most important are the following: (1) high relief heterogeneity: alternating karst craters and ravines, deep incised river valleys, rock outcrops, sliderocks and caves with perennial subterranean ice; (2) high levels of stream flow and low levels of waterlogging; (3) significant microclimate variability, from very cold to warm conditions, which is determined by a high complexity of vegetation cover; (4) high mineralisation of ground waters and domination by carbonate-rich soils in the soil coverage; (5) high activity of exogenous geological processes (karst formation) and soil erosion (Puchnina et al. 2000; Shvartsman & Bolotov 2008).

Siberian spruce (*Picea abies* ssp. *obovata* (Ledeb.) Domin, Pinaceae) and larch (*Larix sibirica* Ledeb., Pinaceae) primary forests dominate the vegetation cover. According to data from Pinega meteorological station (for the period 1903–2003), the annual mean air temperature is 0.1°C, annual precipitation is 554 mm, the mean air temperature of the coldest month (January) is –15.0°C and of the warmest month (July) is 15.5°C; the summarised daily means above 10°C equal 1216°C.

We were conducting our entomological research on the Sotka River shore (Kuloi River drainage) during the periods 7–17.vi.2000, 13–20.vii.2000, 21–28.viii.2000, 26.vii.2001, 26–31.viii.2004, 8–11.vii.2005, 21–22.vii.2007. We collected mainly butterflies (Papilionoidea), but several individual moths were caught selectively. Butterfly nets were used for collecting.

Data on other *B. menetriesii* localities were obtained from different studies (see Appendix). We included only reliable references where species identification was verified by specialists; for the majority of Russian localities identification was performed by Dr. V. V. Dubatolov (Siberian Zoological Museum of the Institute of Animal Systematics and Ecology, Siberian Branch of the Russian Academy of Science, Novosibirsk city). The arrangement of the localities was digitised and mapped using ESRI ArcGIS 10. We mapped only those data pertaining to collected specimens in order to avoid including several visual and non-specific records (Appendix). The presumed error of determination of the locality coordinates is around ± 1–2 km, because published records of moths are usually ascribed to approximate locations (for example, near a certain vil-

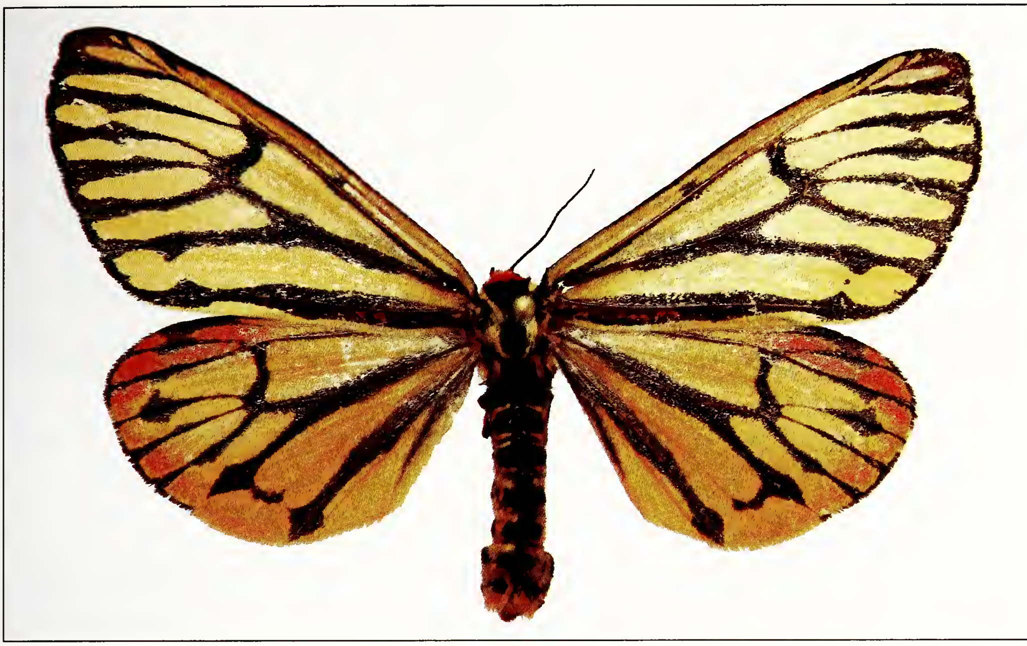

Fig. 1. *Borearctia menetriesii* specimen (female) from the Sotka River valley, Arkhangelsk Oblast, Northern European Russia (photo by Yu. Kolosova).

lage). Two localities were digitised from the general range map by Dubatolov (2010) and the obtained coordinates are highly approximated, probably by around ± 5 km. We used Bailey's Ecoregions Map of the Continents (Bailey 1989) for generalised estimation of the species preferences for ecosystem types. On this map, ecosystem units of regional extent (ecoregions) are marked by climate and vegetation. An Arcview shapefile containing ecoregions map data was obtained from the Global Ecosystem Data Base of NOAAs National Geophysical Data Center, Boulder, Colorado, USA.

Results

The record of a female specimen of *B. menetriesii* was made on 9.vii.2005 (Fig. 1). The moth flew at the top of tall mixed-herb vegetation and was caught during the flight (I. N. Bolotov leg.). This specimen is deposited in the collection of the Biological Museum of the Institute of Ecological Problems of the North, Ural Branch of the Russian Academy of Sciences (Arkhangelsk city).

Locality description: Upper part of the Sotka River valley; 64°38′59″ N, 43°04′08″ E; altitude 37 m.a.s.l; 16 km WSW from the Pinega settlement; karst landscape; a small patch of natural humid mixed-herb meadow (Figs 2a, b). The dominant species of the meadow were *Aconitum septentrionale* Koelle and *Thalictrum* sp. (Ranunculaceae), *Geranium sylvaticum* L. (Geraniaceae), *Filipendula ulmaria* (L.) Maxim. (Rosaceae), *Cirsium oleraceum* (L.) Scop. (Asteraceae), *Chamerion angustifolium* (L.) Holub (Onagraceae), *Paeonia anomala* L. (Paeoniaceae) and *Elymus caninus* (L.) L. (Poaceae). The meadow is surrounded by the primary Siberian spruce forest on gypsum soils with

Fig. 2. Habitat of *Borearctia menetriesii*. **A**, the Sotka River valley with karst gypsum outcrop, Pinega region, Arkhangelsk Oblast, Northern European Russia. **B**, forest humid mixed-herb meadow where specimen was collected (photos by Yu. Kolosova).

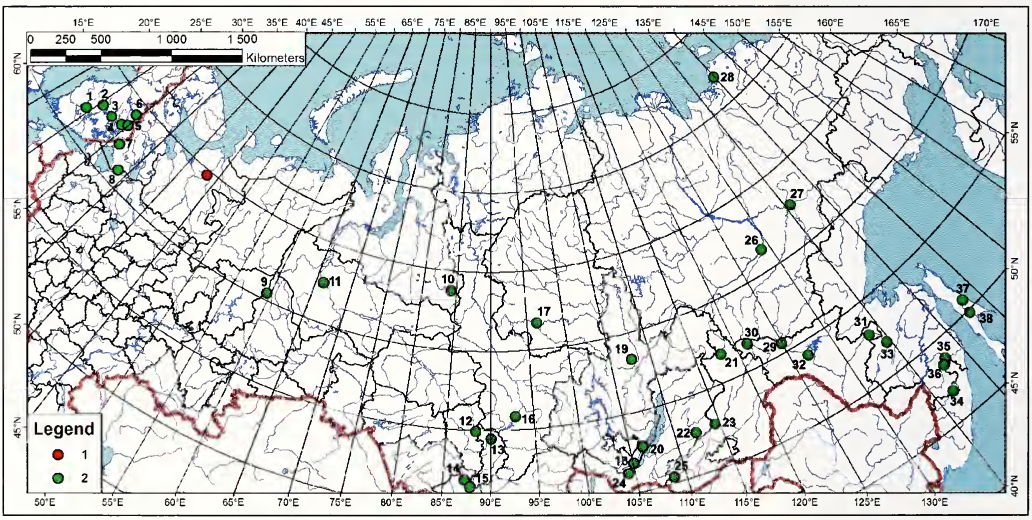

Fig. 3. Distribution range of *Borearctia menetriesii*. Species localities: 1 – our record, 2 – previously published records (see Appendix). Species locality numbers on the map correspond to numbers in the appendix.

inclusions of larch (*Larix sibirica*) patches. Large gypsum outcrops (20–30 m high) are found near the location where the specimen was collected (Fig. 2a). Subterranean solution cavities, caves with cold microclimate and perennial ice are situated in these outcrops. Sparse larch forests and tundra communities with numerous Arctic and Arctic-Alpine vascular plants occur in the outcrops: *Dryas octopetala* L. and *D. o.* ssp. *punctata* (Juz.) Hultén (Rosaceae), *Arctostaphylos alpina* (L.) Spreng. (Ericaceae), *Hedysarum arcticum* B. Fedtsch., *Astragalus norvegicus* Grauer and *Oxytropis campestris* ssp. *sordida* (Willd.) C. Hartm. (Fabaceae), *Salix myrsinites* L., *S. arbuscula* L., *S. recurvigemmis* A. Skvorts. and *S. reticulata* L. (Salicaceae); etc. The study area is situated in the centre of a large primary taiga forest massif, belonging to Pinega State

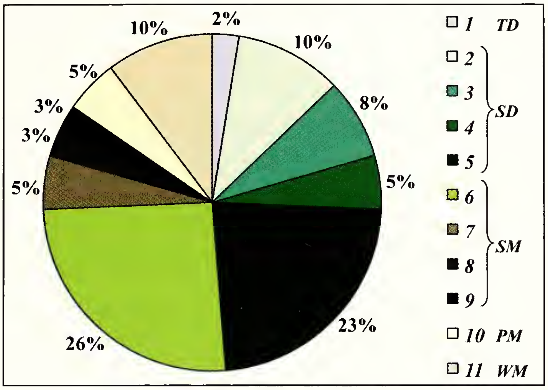

Fig. 4. Proportions of numbers of *Borearctia menetriesii* localities situated in different Bailey's Ecoregions (Bailey 1989). A total data of 39 localities was used (published data in the appendix and our own record). Ecoregions divisions: *TD* – tundra division, *SD* – Subarctic division, *SM* – Subarctic regime mountains, *PM* – prairie regime mountains, *WM* – warm continental regime mountains. Ecoregions provinces: *1* – Arctic tundra, *2* – continental and extreme continental light deciduous taiga, *3* – continental dark evergreen needle-leaf taiga, *4* – eastern oceanic taiga, *5* – moderate continental dark evergreen needle-leaf taiga, *6* – forest-creeping trees-tundra of extreme continental climate, *7* – forest-tundra of moderately and continental climate, *8* – open woodland-creeping trees-tundra, *9* – open woodland-tundra, *10* – continental steppe-forest-tundra and steppe-forest-meadows, 11 – oceanic forest-creeping trees.

Nature Reserve. Anthropogenic activity on the reserve territory has been totally prohibited since 1976 and works are allowed only for reserve staff and several authorised scientists.

Discussion

The new record of *B. menetriesii* in north-eastern Europe significantly reduces the gap between two *Borearctia* derivatives (Fig. 3). In the upper part of the Sotka River valley the karst landscape produces cold microclimate (Puchnina et al. 2000; Shvartsman & Bolotov 2008) by the action of two factors: the cold influence of karst groundwater outpouring and the refrigerant effect of ice caves on the air of the river valley. Boreal karst areas have a more continental climate in comparison to neighbouring territories (Puchnina et al. 2000; Shvartsman & Bolotov 2008). This fact confirms the opinion about the relative continentality of *B. menetriesii* (Kaisila 1947). Another important fact is that larch forest patches are common in the karst landscapes of the White-Sea Kuloi plateau, including the Sotka River valley (Puchnina et al. 2000; Shvartsman & Bolotov 2008), because the *Larix* species are significant food plants in the majority of the *B. menetriesii* range (Saarenmaa 2012).

Collected specimens of *B. menetriesii* inhabited only a few ecoregion types in spite of very broad species range (Fig. 4 and Appendix). Most of the localities (19 sites, 49% of the total known) were situated in two ecoregion provinces: 1) subarctic mountains with forest-creeping trees-tundra of extreme continental climate (Transbaikalia and the Russian Far East); 2) moderate-continental dark evergreen needle-leaf taiga (all northern European localities). The northernmost species record was made at 71° 52′ N in

Arctic tundra of the Yana-Indigirka Lowland of the Northern Yakutia (Appendix), but scarce larch forests in the tundra of Yana-Indigirka can advance very far northwards in the river valleys (including the Muksunuokha River valley where this specimen was collected) and it is possible that *B. menetriesii* ranges as far north as larch forests. The height of the Arsenyeva Mountain (1860 m, the Sikhote-Alin Mountains of the Russian Far East) is the maximum altitude where a specimen of this species has been collected.

According to the aforementioned, one can conclude that the distribution pattern of *B. menetriesii* is primarily connected with ecosystems of primary taiga forests and mountain forest-creeping trees-tundra with elfin forms of coniferous trees. These ecosystem types play the main role in vegetation cover of Northern Eurasia. In spite of the exceptionally low abundance of *B. menetriesii*, we can assume that the scattered transcontinental distribution of this species is determined by preference for specific biomes.

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Appendix

List of published localities of *Borearctia menetriesii*. * – The presumable error of determination of the locality coordinates is around ± 1–2 km for most sites excluding localities No. 35 and No. 36 for which the error is around ± 5 km; ** – see categories of the Bailey's Ecoregion system in legend to Fig. 4.

No.	Country	Region	Locality and sample data	Coordinates*		Bailey's Ecoregions**		Reference
				N	E	Division	Province	
1	Finland	Hame	Juupajoki, vi.1920, 1 larva, Carpelan leg.	61°52′04″	24°25′51″	SD	5	Krogerus 1944
2	Finland	Keski-Soumi	Saarijärvi, Pyhä-Häkki National Park, 29.vi.1943, 1♀, Stockmann, Krogerus and Stenius leg.	62°49′27″	25°27′55″	SD	5	Krogerus 1944
3	Finland	Kuopio	Kuopio, Haminanlahti, 8.vii.1913, 1♀, Fabritius leg.	62°50′47″	27°32′11″	SD	5	Fabritius 1914
4	Finland	Pohjois-Karjala	Polvijärvi, Martonvaara, old dark spruce forest, 29.vi.1921, 1♀, Sandström leg.	63°01′36″	29°15′31″	SD	5	Krogerus 1944
5	Finland	Pohjois-Karjala	Lieksa, Kevätniemi, 26.vi–4.vii.2003, 1♀, Hilkkonen leg. [the collecting year was erroneously published as 2002]	63°19′42″	29°58′54″	SD	5	Silvonen 2010
6	Finland	Oulu	Kuhmo, a Natura 2000 site, 6.vii.2009, half-open bog surrounded by coniferous forest, 1♀ (dead)	64°07′48″	29°31′12″	SD	5	Silvonen 2010
7	Russia	Karelia Republic	Salmi, Hiisjärvi, northward from the Ladoga Lake, 8.vii.1939, 1 ex., Valleala leg.	62°08′01″	31°16′25″	SD	5	Krogerus 1944
8	Russia	Karelia Republic	Kuujärvi [recent name is Mikhailovskoe village], 3.5 km SE from Mäkrätjärvi, northward from the Svir River, 3.vii.1943, 1 ex., Grönroos leg.	61°00′43″	33°44′39″	SD	5	Krogerus 1944
9	Russia	Sverdlovsk oblast	North Ural, northern slope of Denezhkin Kamen Mt., 20.vii.2005, taiga forest, 1♀ (dead), Ermakov leg.	60°28′00“	59°40′00“	SM	9	Ermakov 2006; Nupponen & Fibiger 2012
10	Russia	Jamal-Nenets district	Northern boundary of Verkhne-Tazovsky Nature Reserve, 2003, 1 ex. [probably this specimen was cited by Silvonen (2010) as record «Polar Urals near the Jamal Peninsula in 2003»]	63°43′00″	84°14′00″	SD	3	Gorbunov & Olschwang 2012

List of published localities of *Borearctia menetriesii* – continued.

No.	Country	Region	Locality and sample data	Coordinates*		Bailey's Ecoregions**		Reference
				N	E	Division	Province	
10	Russia	Khanty-Mansiysk district	Near Oktjabryskoe village, 12.vii.1964, 1♀, Shubina leg.	62°27′38″	66°01′59″	SD	3	Dubatolov 1984, 1996
12	Russia	Kemerovo oblast	Kuznetsky Alatau Mts., Nature Reserve, Bezyimaynka River, 12.vii.2010, 1 ex., Budaev leg.	54°56′00″	88°22′00″	SD	3	Sutchev & Skalon 2012
13	Russia	Khakassia Republic	Itkul Lake	54°27′42″	90°05′13″	SM	7	Kozhanchikov 1923 (cited from Dubatolov 1985)
14	Russia	Altay Republic	Altay Mts., Teletskoye Lake, near Artybash village, 20.vi.1969, 1♀	51°47′26″	87°15′30″	PM	10	Dubatolov 1985
15	Russia	Altay Republic	Altay Mts., near Chiry village, 2.vii.1964, 1♀, Korshunov leg.	51°21′41″	87°50′19″	PM	10	Dubatolov 1985
16	Russia	Krasnoyarsk district	East Sayan Mts.,"Stolby" Nature Reserve, 15.vii.1966, 1♀, Korshunov leg.	55°49′48″	92°51′19″	SD	2	Dubatolov 1985
17	Russia	Krasnoyarsk district	Podkamennaya Tunguska River, near Baykit village, 9.vii.1929, 1♀	61°40′48″	96°22′48″	SD	2	Dubatolov 1984
18	Russia	Irkutsk oblast	Baikal Lake, Bolshie Koty Gulf, 13.vii.1970, 1♀, Drakin leg.	51°53′55″	105°04′58″	SM	6	Dubatolov 1985
19	Russia	Irkutsk oblast	Near Kirensk city, Chechui River near Rassokha River, 22.vii.1969, 1 ex., Pleshanov leg.	58°19′25″	107°37′15″	SD	2	Berlov & Berlov 2012
20	Russia	Irkutsk oblast	Near Elantsy village, Aya bay, vii.1971, 1 ex., Berlov leg.	52°47′14″	106°22′53″	SM	6	Berlov & Berlov 2012
21	Russia	Transbaikalia district	Ingamakit Stream mouth, near Chara settlement, open and light larch forest, 3.vii.2011, 1♂, Korsun leg.	56°43′57″	118°02′05″	SM	6	Saarenmaa 2012
22	Russia	Transbaikalia district	Yabloneviy Mt. Ridge, Saranakan Mt., 21.vi.1951, 1♀ and 2.vii.1955, 1♀, Kurentzov leg.	52°40′35″	112°15′58″	SM	6	Dubatolov 1990

List of published localities of *Borearctia menetriesii* – continued.

No.	Country	Region	Locality and sample data	Coordinates*		Bailey's Ecoregions**		Reference
				N	E	Division	Province	
23	Russia	Trans-baikalia district	Yabloneviy Mt. Ridge, Chingikan Mt., 1 ex.	52°46′12″	114°29′32″	SM	6	Dubatolov & Gordeev 2000
24	Russia	Buryatia Republic	Khamar-Daban Mt. Ridge, 1 ex.	51°17′26″	104°19′11″	SM	6	Dubatolov & Gordeeva 2005
25	Russia	Trans-baikalia district	Malkhanskiy Mt. Ridge, near Krasniy Chikoy village, cedar forest, 1 ex.	50°22′12″	108°44′60″	SM	6	Dubatolov & Gordeev 2000
26	Russia	Sakha-Yakutia Republic	Near Bestyah village, 24.vi.1907, 1♀, Naumov leg.	61°22′06″	128°52′04″	SD	2	Dubatolov 1984
27	Russia	Sakha-Yakutia Republic	Suntar-Khayata Mt. Ridge, East Khandyga River headstream, vii.1986, 1 ex.	62°33′04″	135°41′50″	SM	8	Dubatolov & Kaymuk 2003
28	Russia	Sakha-Yakutia Republic	Yana-Indigirka Lowland (Muksunuokha River), 1 ex.	71°52′00″	139°52′00″	TD	1	Dubatolov & Kaymuk 2003
29	Russia	Amur oblast	Near Mogot village, 25.vi.1975, 1♀, Bogdanova leg.	55°36′14″	124°55′14″	SM	6	Dubatolov 1985
30	Russia	Amur oblast	Near Mostovoy village, 1 ex.	56°36′00″	121°24′00″	SM	6	Dubatolov 2009
31	Russia	Amur oblast	Near Zlatoustovsk settlement, 1 ex., Streltzov leg.	52°57′50″	133°35′48″	SM	7	Dubatolov 2009
32	Russia	Amur oblast	Zeya Nature Reserve, Bolshaya Erakingra River, cordon "52 km", 11.vii.1979, 1♀, Murzin leg.; Bolshaya Erakingra River, 9–14. vii.1977, 2♀ & 1♂, Sviridov and Murzin leg.; Motovaya River, 14–18.vii.1977, 1♀, Sviridov leg.	54°05′15″	126°52′14″	SM	6	Dubatolov 1984
33	Russia		Bureya Nature Reserve; the middle course of Levaya Bureya River, 15.vii.1984, 1♀, Nebaykin leg.; Verkhne-Bureya Region, vii.1984, 1♀, Nebaykin leg.	51°55′46″	134°35′44″	SD	4	Koshkin 2010

List of published localities of *Borearctia menetriesii* – continued.

No.	Country	Region	Locality and sample data	Coordinates*		Bailey's Ecoregions**		Reference
				N	E	Division	Province	
34	Russia	Primorye district	Sikhote-Alin Mts., Arsenyeva Mt., at height of the mountain, rocky alpine tundra, 1860 m.a.s.l., 20.vii.1948, 1 ex., Kononov and Kurentzov leg.	46°50′41″	136°42′13″	WM	11	Kurentzov 1973
35	Russia	Primorye district	Sikhote-Alin Mts.	48°45′46″	138°07′22″	WM	11	Dubatolov 2010
36	Russia	Primorye district	Sikhote-Alin Mts.	48°30′20″	137°36′26″	WM	11	Dubatolov 2010
37	Russia	Sakhalin Island	East slope of Nabilskiy Mt. Ridge, 850 m.a.s.l., karst landscape, mountain slope with high-herb sprouts and shrubs, 22.vii.2002, 1 ex., Klitin leg.	50°42′27″	143°18′01″	SD	4	Klitin 2009
38	Russia	Sakhalin Island	Poronay River valley, peat bog, in the early 1920s, 1 ex.	49°50′27″	142°57′45″	WM	11	Hori 1926
—	Finland	Pohjois-Karjala	Juuka, Polvela-Petrovaara, 21.vi.1961, a flying specimen seen by a M. Kononen	63°09′14″	29°39′16″	SD	5	Silvonen 2010
—	Finland	Oulu	Kuhmo, Kuusijärvi, Havukka, 22.vii.1939, one specimen seen and drawn by maiden	63°53′47″	30°13′53″	SD	5	Silvonen 2010
—	Russia	Irkutsk oblast	Baikal Lake, 3.vii.1958, 1♀	No data	No data	No data	No data	Dubatolov 1985
—	China	Heilongjiang	V. V. Dubatolov noted that *Callimorpha principalis* Fang (1982) might belong to *B. menetriesii*	No data	No data	No data	No data	Dubatolov 1996, 2010
—	Kazakhstan	East Kazakhstan Region	"Songoria", 1♀ (holotype)	No data	No data	No data	No data	Dubatolov 1996; Krogerus 1944

Two little-known species of Gelechiidae in the European fauna

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Abstract. The identities of *Doryphora orthogonella* Staudinger, 1871 and *Anacampsis azosterella* Herrich-Schäffer, 1854 are discussed and they are confirmed as belonging to the genera *Stomopteryx* Heinemann, 1870 and *Syncopacma* Meyrick, 1925, respectively. Both species are redescribed based on types and additional new material. The adults and the male genitalia of both species are illustrated. A lectotype of *Doryphora orthogonella* is designated. Both species are new to the fauna of Ukraine, and *Syncopacma azosterella* is shown to be relatively widely distributed in southern parts of central and eastern Europe and in the Mediterranean.

Introduction

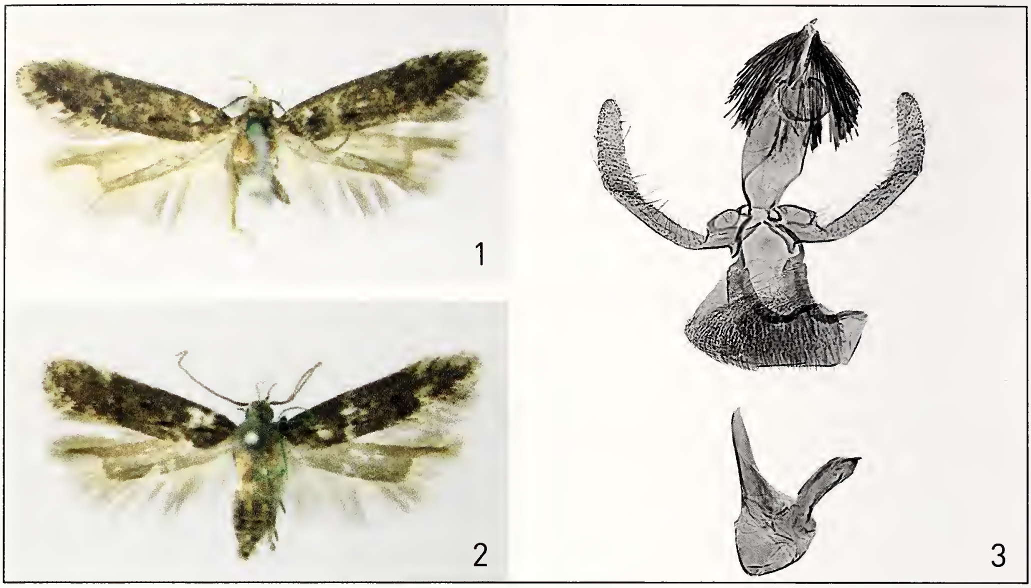
Gelechiidae is among the least known lepidopteran families in Europe (Bidzilya & Karsholt 2008). Although some progress has been made (e.g., Huemer & Karsholt 2010), there are still numerous taxa awaiting revision. Here we deal with two such taxa. As a result of study of material deposited at ZMKU two doubtful species of Gelechiidae belonging to the genera *Stomopteryx* Heinemann, 1870 and *Syncopacma* Meyrick, 1925, currently in the subfamily Anacampsinae (Karsholt et al. 2013), were found. Their identification appeared problematic, and we therefore considered them worthy of detailed examination.

The first species, *Stomopteryx orthogonella* (Staudinger, 1871), was known only from the type-series collected in Sarepta in Russia (nowadays a district of Volgograd) in 1871 and has not been recorded since its description. The discovery of two additional males of this species from Ukraine encouraged us to re-examine the type material deposited in the collection of ZMHU. As a result, *S. orthogonella* is redescribed here and its male genitalia are described and illustrated for the first time.

The second species, *Syncopacma azosterella* (Herrich-Schäffer, 1854), has for a long time been confused with other species of the genus *Syncopacma*. This was due to the fact that its type material had not been previously revised. Recently the holotype of *S. azosterella* was found by the second author, and this allowed us to clarify the status of this taxon and link a number of regional records with this name.

Abbreviations of institutions

BMNH	The Natural History Museum, London, U.K.
ZMHU	Zoological Museum, Humboldt University, Berlin, Germany
ZMKU	Zoological Museum, Kiev National Taras Shevchenko University, Kiev, Ukraine
ZMUC	Zoological Museum, Natural History Museum of Denmark, Copenhagen, Denmark



Figs 1–3. *Stomopteryx orthogonella* (Staudinger). **1**. Lectotype, Sarepta, wingspan 14.0 mm. **2**. Paralectotype, Sarepta, wingspan 13.1 mm. **3**. Male genitalia, lectotype.

Stomopteryx orthogonella (Staudinger, 1871) **Figs 1–3**

Doryphora orthogonella Staudinger, 1871: 307.
Aristotelia orthogonella (Staudinger); Meyrick, 1925: 42.
Stomopteryx orthogonella (Staudinger); Karsholt & Riedl, 1996: 118, 311.

Material. Lectotype by present designation ♂, "Origin" | "Sarepta" | *Stomopteryx orthogonella* Stdgr., O. Karsholt det. | Gen. Præp. nr. 3025, ♂, O. Karsholt | Zool. Mus. Berlin | ex. coll. Staudinger (here designated). – Paralectotype: ♂, "Origin" | "Sarepta" (ZMHU). **Russia**: Sarepta, 2♂ 25–30.v.1864 (Christoph), 1♂ 1867, 1♂ 6.viii.1869, 1♂ 8.viii.1875 (all BMNH); Volgograd, 1♂ 18–24.v.1967, leg. V. Zouhar, genitalia slide Karsholt 4076 (ZMUC). **Ukraine**, Dnepropetrovsk reg., Pavlograd distr., Bulakhovka, estuary, saline: 2♂ 15.vii.2011, leg. V. Afans'eva (ZMKU).

Redescription. Adult (Figs 1, 2). Wingspan 12.5–14.5 mm. Head grey to light brown; frons and lateral margins paler; labial palpus strongly upcurved, brown, inner surface pale grey to cream; segment 3 paler, 1.5 times narrower and nearly as long as segment 2, pointed; scapus brown, flagellum brown with white basal rings; thorax and tegula as forewing. Forewing brown; a narrow black streak from the base along fold to nearly half length of wing, with a few orange-brown scales; a diffuse black spot in middle of cell; a black dot in the cell corner; creamy spots at 3/4 of costa and dorsum; subapical area mottled with grey scales; fringe grey, brown-tipped. Hindwing grey; a narrow yellow-white line at border to grey fringe.

Variation. The black streak at the base of the forewing may be divided into two elongated spots; the costal and dorsal cream-coloured spots may in some specimens be reduced to a few scales or obsolete.

Male genitalia (Fig. 3). Uncus 3 times as long as broad, densely covered with long strong setae, tip pointed, curved; gnathos weak, ring-shaped; tegumen prolonged, lateral

folds curved inwards; pedunculi short, tapered; valva evenly curved, slightly broadened in middle, apex rounded, about as long as tegumen and uncus, covered with setae in distal 2/3; sacculus subtriangular, densely covered with hairs; phallus basally swollen, distal portion straight, gradually narrowed and pointed apically; lateral projection about as broad as distal portion of the phallus at its base, with a prominent pointed tip.
Female genitalia. Unknown.
Biology. Early stages unknown. Adults have been collected in May, July and August, and the species may thus be bivoltine. The habitat in Ukraine is a saline estuary.
Distribution. Russia: Lower Volga; Ukraine (new record).
Remarks. *Doryphora orthogonella* was described from two males collected at Sarepta (now Krasnoarmeysk near Volgograd, 48°31'N, 44°34'E) by H. Christoph (Staudinger 1871). Although Staudinger compared it to *Scrobipalpa acuminatella* (Sircom, 1850) he noted that its hindwings were similar to those of *Gelechia detersella* Zeller, 1847, the type species of the genus *Stomopteryx* Heinemann, 1870. It was, however, only combined with *Stomopteryx* in 1996 by Karsholt & Riedl.

The five specimens held in the collection of the BMNH have also most likely been collected at the type locality, although they are not part of the type series. The few specimens of *S. orthogonella* available from the type locality and two specimens collected in Ukraine are identical both externally and in the male genitalia.

Externally *S. orthogonella* may resemble *S. hungaricella* Gozmány, 1957, but the latter is usually nearly uniformly black rather than brown, and without any trace of streaks or spots. The lateral projection that is placed near the right angle of the phallus is the most prominent character; it separates *S. orthogonella* from most other species of *Stomopteryx*, although a similar structure is found in *S. basalis* (Staudinger, 1876) and related species, which are easily separated by the reddish-brown base of the forewing.

S. orthogonella is apparently a rare species. Since its description in 1871 it has not been dealt with in the literature apart from checklists and catalogues (e.g., Meyrick 1925) until now. Anikin et al. (1999) considered it to be extinct from its type locality.

Syncopacma azosterella (Herrich-Schäffer, 1854) Figs 4–8

Anacampsis azosterella Herrich-Schäffer, 1854: 194
Syncopacma azosterella (Herrich-Schäffer, 1854) – Gozmány, 1957: 121, fig. 4.I. (misidentification of *S. albifrontella* Heinemann, 1870).
Syncopacma sp. 1 – Elsner et al. 1999: 52, Farbtaf. 25; Taf. 25, Abb. 306.

Material. Holotype ♂, "Prater" | "Col. Led[erer]." | "ex collect. Staudinger" | "azosterella" | "Genitalpräparat No. 1042 det. J. Klimesch, Linz" | "Holotype" (ZMHU). **France**, Alpes-Maritimes, Domaine de Maure Vieil: 1♂ 26.iv.1999, gen. slide Hendriksen 2462, 3♀ 2–3.vi.2000, gen. slide Hendriksen 2680, leg. H. Hendriksen (ZMUC). **Greece**: Lakonia, 5 km S Monemvasia, 2♀ 8.viii.1979, 1♀ 15.ix.1979, 1♀ 6.vii.1980, 1♀ 13.vi.1981, 1♀, 24.vi.1981, 1♀ 18.viii.1982, 1♀ 26.viii.1982, 1♂ 29.vi.1984, leg. G. Christensen; 2♂ 4.vii.1984, leg. B. Skule, gen. slide Hendriksen 4430; 7 km SW Monemvasia, 150 m, 1♀ 22.ix.1979, leg. G. Christensen, gen. slide Hendriksen 4431; 1♀ 9.iv.1981, leg. B. Skule; 1♀ 2.vii.1982, leg. S. Langemark & B. Skule; Prov. Serra, 20 km E Sidirokastro, Kapnophyton, 450 m, 1♂ 18.vii.1990, leg. M. Fibiger, gen. slide Hendriksen 1170; Ipiros, Konitsa area, below Smolikas, 700–1500 m, 1♂ 21–23.v.1994, leg. O. Karsholt, gen. slide Hendriksen 3615 (all ZMUC). **Hungary**, Veszprem County, 10 km N Veszprem: 47°10'N 17°58'E, 300 m, 2♂ 17.vii.2005, leg. C. Hviid, B. Skule & E. Vesterhede, gen. slide Hendriksen 6209 (ZMUC). **Morocco**, High Atlas Mts, Asni area: 1100–1400 m, 3♂, 3♀ la. 8–10.

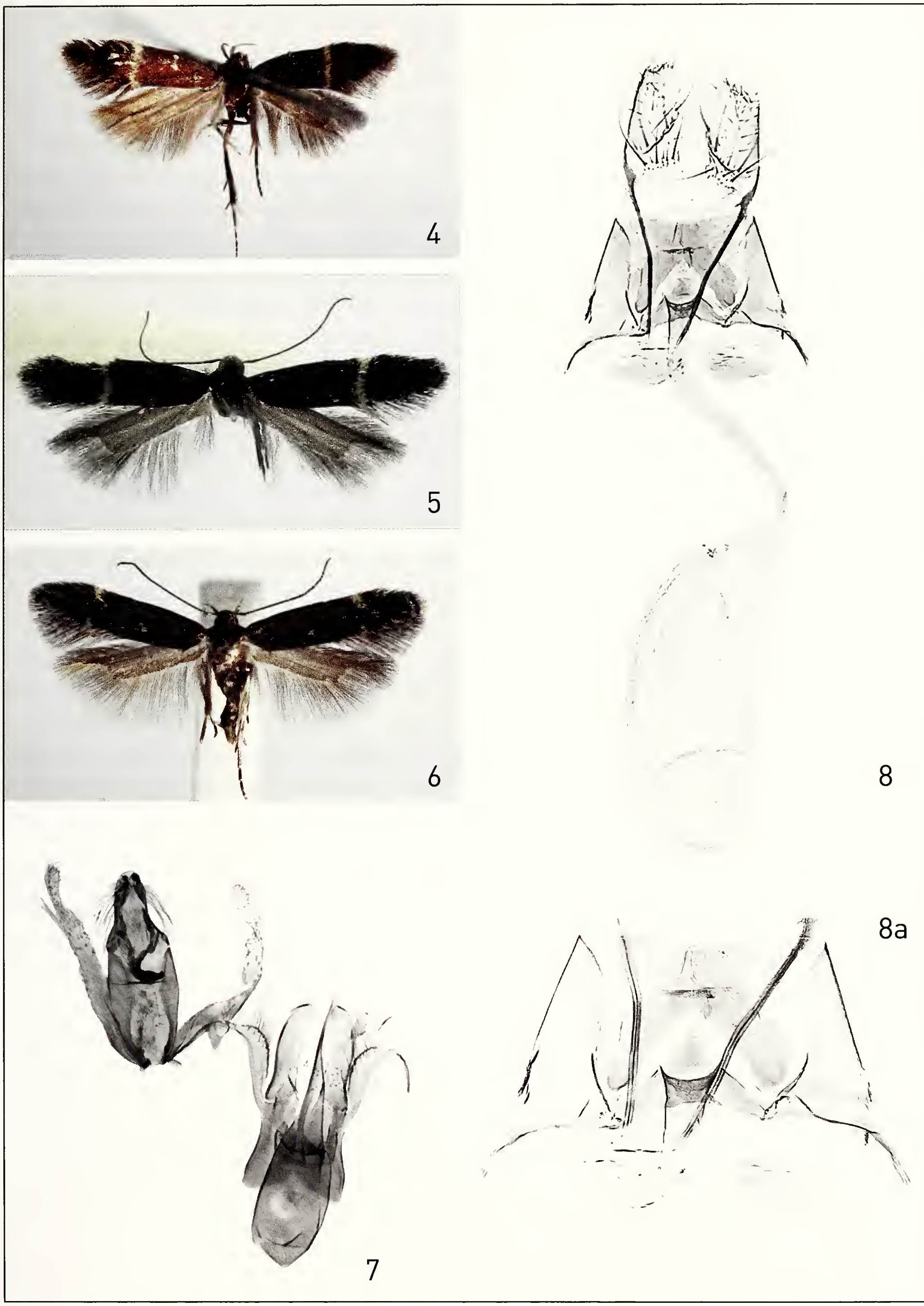
iv.1989, *Cytisus* sp., leg. O. Karsholt, gen. slide Hendriksen 4708 (ZMUC). **Romania**, Carpatii orientali, Cheile Bicazului, 1250 m: 1♂ 11–12.viii.1988, leg. & coll. S. & Z. Kovács. **Slovenia**, SW part, 11 km above Kozina, Stavnik Mts, 45°32'N 13°58E, 950 m: 1♂ 30.vi. 2003, C. Hviid & B. Skule, gen. slide Hendriksen 4876 (ZMUC). **Spain**: Prov. Segovia, San Ildefonso, no date, 1♂, 2♀, gen. slide Karsholt 5006; Prov. Málaga: Camino de Istan, 400 m, 1♀ 25.vi.1975, leg. E. Traugott-Olsen, gen. slide Hendriksen 4547; Sierra de Marbella, El Mirador, 700 m, 1♂ 19.viii.1977, leg. E. Traugott-Olsen, gen. slide Hendriksen 4549; Camino de Ronda, Urb. Madronal, Loma de Colmenas, 500 m, 1♀ 23.v.1986, gen. slide Hendriksen 5271; 1♂ 19.viii.1988, gen. slide Hendriksen 3749; 2♀ 28.vii.1988; 3♂, 1♀ 30.viii.1988, gen. slide Hendriksen 2390; 4♂, 3♀ 4.ix.1988; 2♂ 10.ix.1988; 1♂ 13.ix.1988, leg. E. Traugott-Olsen; Prov. Granada: 10 km NW Otivar, Lopera, 1200 m, 2♂ 24.vii.2003, leg. P. Skou, gen. slide Hendriksen 4677; 25 km N Almunecar, Moscaril, 500 m, 1♂ 28.viii–9.ix.2004, leg. G. Jeppesen, gen. slide Hendriksen 5089 (all ZMUC). **Ukraine**: Lugansk reg., Melovoi distr., Strel'tsovskaya Step Nat. Res., 2♂ 1♀ 10.vii.2002, at light, leg. A. Bidzilya, gen. slide 5/12; Donetsk reg., Kemennye Mogily Nat. Res., 1♀ 18.vii.1989, leg. A. Zhakov (ZMKU).

Redescription. A d u l t (Figs 4–6). Wingspan 9.5–13.5 mm. Head black, frons slightly lighter, dark-grey; labial palpus up-curved, segment 3 about 1.5 times narrower and nearly as long as segment 2, acute, light grey to white, underside black, segment 2 light grey; scapus black, flagellum black, underside white-ringed; thorax and tegulae black; forewing black, subapical fascia white, narrow; cilia grey, black-tipped; hindwing grey. For variation see below.

M a l e g e n i t a l i a (Fig. 7). Uncus twice as long as broad, lateral folds densely setose, apex weakly rounded; gnathos hook stout, curved at nearly right angle in middle, apex tapered, curved; tegumen prolonged with well-developed lateral folds, pedunculi short, slender; valva nearly of equal width, slightly constricted before apex, exceeding apex of uncus; vinculum narrow, band-shaped, posterior-lateral margin bulging, bearing long hair-like setae; vincular projections moderately broad, outer margin evenly curved after half length, inner margin straight, apex weakly pointed; saccus sub-quadrangular, anterior margin weakly emarginated; phallus bulbous in basal half, distal half tapered, apical quarter needle-shaped.

F e m a l e g e n i t a l i a (Figs 8, 8a). Papillae anales subovate, twice as long as wide, about as long as length of segment VIII, covered with short setae, a few long hair-like setae at base. Apophyses anteriores nearly four times shorter than apophyses posteriores and about 3 times shorter than segment VIII. Segment VIII slightly broader than long, trapezoidal, posterior margin nearly straight, anterior margin weakly concave in middle. Lateral folds of sternum VIII broadly separated by medial zone with well-developed Λ-shaped sclerotisation that reaches nearly to the anteromedial corners of these folds. Ostium opening near anterior margin of sternum VIII, posterior subostial sclerite semicircular, anterolateral sclerites joining anteromedial corners of the folds of sternum VIII. Antrum strongly sclerotised, posterior margin evenly concave with tapered posteriolateral corners. Ductus bursae slender, membranous, slightly narrowed near the entrance of corpus bursae. Corpus bursae weakly sclerotised, subovate, about as long as ductus bursae. Signum absent.

Biology. Early stages have not been described. The species has been reared from *Adenocarpus intermedius* DC. (Fabaceae) first by Mendes (1904) from São Fiel in Beira Baixa in Portugal, but it was identified as *Anacampsis vorticella* (Scopoli). According to Mendes (op cit.) the larva is common in March and April on *Adenocarpus*, tying the leaves into a bud-like form (M. Corley in litt.). A small series of moths were bred from



Figs 4–8. *Syncopacma azosterella* (Herrich-Schäffer). **4**. Holotype, Austria, wingspan 12.5 mm. **5**. Specimen from Ukraine, wingspan 11.1 mm. **6**. Specimen from Morocco, wingspan 12.2 mm. **7**. Male genitalia, Ukraine, gen. slide Bidzilya 5/12. **8**. Female genitalia, France, gen. slide Karsholt 5006; a: segment VIII (enlarged).

larvae feeding on broom ('*Cytisus* sp.', Fabaceae) in the High Atlas Mts of Morocco. Adults have been collected from May to September, mostly at light, but in Bulgaria flying around *Genista* sp. (Junnilainen et al. 2010). The species has probably one generation in central Europe and two or three generations in the Mediterranean lowlands.

Distribution. Austria, Bulgaria (Junnilainen et al. 2010), Czech Republic (Elsner et al. 1999), France (new record), Greece (new record), Hungary, Morocco (new record), Romania, southern Ural in Russia (Junnilainen et al. 2010), Slovenia (new record), Spain (new record), Ukraine (new record). In Portugal (new record) *S. azosterella* is a locally common species feeding on *Adenocarpus*. Occasionally larvae may be quite numerous (M. Corley in litt.). Records from Switzerland (e.g., Gozmány 1957) are based on misidentification (SwissLepTeam 2010: 187). Records from Poland (e.g., Karsholt & Riedl 1996) probably date back to Rebel (1901: 154), but were not confirmed and are probably due to misidentification.

Remarks. *Anacampsis azosterella* was described from a single specimen collected by H. Lederer in Austria: Wien (Herrich-Schäffer 1854). The whereabouts of the holotype were unknown for a long time (Hering 1952: 206; Wolff 1958: 258), which made it impossible to correctly apply this name to any taxon. We were able to locate the holotype in the ZMHU but, unfortunately, the corresponding genitalia slide seems to be lost. The type is in rather good condition, although somewhat faded. That may have been the case already when Herrich-Schäffer described it, as he described the (white) subapical fascia as "etwas bräunlich" [somewhat brownish]. In the photograph (Fig. 4) the holotype specimen looks more broad-winged than the specimens shown in Figs 5–6, but that is because it does not have the wings spread to horizontal position. Comparing it to other old, faded specimens of *S. azosterella* gave an exact match. After its description *S. azosterella* remained a poorly known taxon, and it was only mentioned in a few publications. Gozmány (1957: 121) tried to solve the identity of *S. azosterella*, but he mixed it with *S. albifrontella* (Heinemann, 1870) and its synonym *S. ignobiliella* (Heinemann, 1870) (Wolff 1958: 258), causing further misidentifications of *S. azosterella* in the literature. Based on a preliminary study of the holotype, Karsholt & Riedl (1996: 119) reintroduced *S. azosterella* for the species dealt with here, although without an explanation, and that probably caused Elsner et al. (1999) to doubt its identity and treat the species as "*Syncopacma* sp. 1."

We have considered whether the holotype of *S. azosterella* could belong to another *Syncopacma* species, and one could argue that it might be either (a small) *S. cinctella* (Clerck, 1759) or *S. ochrofasciella* (Toll, 1936). However, the species dealt with here is a surprisingly variable species (see below) so it is difficult to argue that the holotype of *S. azosterella* does not belong here. We are, moreover, of the opinion that this solution serves the stability of nomenclature best. We have also considered the possibility of treating *Anacampsis azosterella* Herrich-Schäffer as a *species incertae sedis* and to give a new name to "*Syncopacma* sp. 1" of Elsner et al. (1999), but we prefer not to do so as we find that a less satisfactory solution.

S. azosterella is a variable species. Specimens from southern Greece and southern Spain are small (wingspan 7–11 mm), with the smallest specimens from the summer and autumn generations. They have a clear white subapical band on the forewing and no black spots, and they also look more slender-winged. Specimens from central Spain (San Ildefonso) are larger (wingspan 11–13 mm) but otherwise similar. However, two specimens from southern Spain, prov. Granada (wingspan 11 mm) differ from other Spanish specimens examined in having almost black forewings with only a few lighter scales at the costa near the apex and at the tornus; moreover, they have black spots in the middle of the wing. These two specimens more closely resemble a series of reared specimens from Morocco (wingspan 11–13 mm), which have black spots in the fold and in the middle of the wing followed by a few light yellow scales, and a yellowish white subapical fascia interrupted in the middle.

The examined slides of male genitalia show slight variation, not just in size, but in the relative proportions of the length of the vincular projections and the saccus, and also of the basal, swollen part and the apical, thin part of the phallus. Furthermore, there are small differences in the shape of the phallus. However, we found no correlation between these small differences and the differences in forewing pattern described above. We therefore conclude that this variation is most probably due to differences in preparing the studied genitalia slides, and especially in the pressure put on the genitalia through the cover slip.

Most species of *Syncopacma* are more or less difficult to recognise from external characters, and it is often necessary to examine the genitalia to reach a safe identification. Fortunately, the male genitalia of most species exhibit characteristic differences (e.g., Elsner et al. 1999; Wolff 1958). As no such differences could be found between the more or less different looking populations studied by us, we here conclude, at least tentatively, that they belong to one variable species. Studies of the DNA from different populations may well contradict this, and especially specimens from Spain and Morocco, having an interrupted subapical fascia and black spots in the forewing, may well turn out to represent a distinct species.

S. azosterella may be confused externally with *S. cinctella* (Clerck, 1759) and other *Syncopacma* species with narrow white subapical fascia. The male genitalia of S. *azosterella* most resemble those of *S. suecicella* (Wolff, 1958) and *S. linella* (Chrétien, 1904), but differ from the first mentioned in the basal portion of the phallus being longer and in the absence of a prominent lateral vincular projection. *S. linella* differs in the apically pointed rather than rounded posterior vinculum projections as in *S. azosterella*. Λ-shaped sclerotisation on sternum VIII and semicircular posterior subostial sclerite are characteristic features of the female genitalia.

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P. Huemer 2013. Studiohefte 12. Die Schmetterlinge Österreichs (Lepidoptera). Systematische und faunistische Checkliste. – Tiroler Landesmuseen-Betriebsgesellschaft m. b. H., Innsbruck, Austria. 304 pp. ISBN 978-3-900083-42-7. Price: 14.80 € plus shipping costs. Orders can be placed online at http://www.tiroler-landesmuseen.at/shop.php/de/druckwerke_alle_/studiohefte

Austrian Lepidoptera sparked a great interest in many European lepidopterists who have spent a great deal of their time hunting butterflies and moths in the picturesque alpine valleys and high rocky mountains of the Alps. Austria is one of the most geologically and biogeographically interesting European countries, and therefore it comes as no surprise that the publications on different species of Lepidoptera of this country started in the 18th century, for example the Gracillariidae from Austria being studied already by Fabricius (1798). After two hundred years, this interest in Austrian butterflies and moths is still very much alive. New molecular data, which recently became available, require correct species identification and accompanying taxonomic information, which can be provided only by standardised checklists. This book represents an updated, re-written, and taxonomically improved edition of the Austrian catalogue of Lepidoptera which was published two decades ago (Huemer & Tarmann 1993) and is adapted to the present-day purposes. The novelty of the 2013 edition is summarized on p. 15. A total of 4071 species, presently recorded from Austria, are listed, and 119 species are indicated either as false, ambiguous, or based on accidental records, so the community of lepidopterists is invited to cautiously re-evaluate and re-study these interesting cases. In contrast to many taxonomic catalogues, this systematic and faunistic checklist of Austrian Lepidoptera is the result of a huge collecting effort of generations of lepidopterists and it particularly demonstrates the great field experience of the author himself.

Furthermore, the faunistic data, presented in the form of a table divided per provinces of Austria, are based on voucher specimens deposited in the collection of the Tiroler Landesmuseum Ferdinandeum or associated collections in other museums, so these voucher specimens credit the checklist as a highly reliable reference source. Two new synonymisation acts (in Oecophoridae and Crambidae) are included in the book and one case of synonymy is revised (in Tortricidae). Nine species belonging to the families Gracillariidae, Oecophoridae, Gelechiidae, Elachistidae, Tortricidae, Geometriidae and Noctuidae are presented as new for the Austrian fauna.

The Checklist begins with colour plates containing 128 photographs of butterflies or moths in nature in their resting position. Usually such systematic-faunistic checklists are quite dull publications, so the inclusion of a subset of colourful and high-quality photographs makes this publication visually attractive. The systematic-faunistic checklist, which occupies a major part of the book (p. 32–203), follows van Nieukerken et al. (2011) for the classification of the lepidopteran families and Kaila et al. (2011) for the classification of the superfamily Gelechioidea and hypothesised phylogenetic relationships. The short introductory list of suborders, infraorders, clades and families is presented at the beginning of the chapter allowing the reader to easily spot these higher taxa in the faunistic table. However, for species one needs to look at the index first before trying to find them in the very long faunistic table. The species arrangement within the genera is not as handy for use of this checklist as one could wish. Probably it would have been easier for the reader to find species within the genera if they were arranged alphabetically. The determination of the phylogenetic position of alpine species of Lepidoptera is far from complete. We still lack a clear picture of relationships of species and numerous species complexes, especially in microlepidoptera, and despite the truly rapid advances in molecular techniques, the problems of specific relationships and species delimitations still fall on speculations in many cases, so the alphabetical order of the species within the genera might have its own advantages such as user-friendliness and easy finding of any species of interest.

Synonyms in the species group have been kept to a strict minimum and were subjectively chosen for those cases in which these names have been used often in earlier literature or when they were used as valid species names in the earlier version of the catalogue (Huemer & Tarmann 1993) either as species or subspecies. The author refers to the online world catalogues for a complete synonymy. Synonyms in the genus-group have been kept to a strict minimum as well. At the end of the book (p. 204–243), a comprehensive chapter Comments provides useful and interesting information on the taxonomic and/or distributional peculiarities of certain species indicated by the letter K in the systematic and faunistic checklist. The reference list (p. 244–261) is robust, non-abbreviated and gives a good overview of publications on the Austrian lepidopteran fauna. The book ends with the highly needed index.

To summarise, the author should be cordially thanked for sharing his extraordinary taxonomic and faunistic knowledge of Lepidoptera of his home country and congratulated for the impressive results. This checklist should be in the library of any lepidopterist interested in European Lepidoptera and especially in the libraries of those amateurs and professionals who spend their holidays in this beautiful country or collecting in the SEL study area, which is just across the Austrian border. The book is in German; however, I am very certain that this fact will not hinder any lepidopterist from buying it and admiring this meticulous work.

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Jurate De Prins

P. Leraut 2012. Moths of Europe, volume 3, Zygaenids, Pyralids 1 and Brachodids.
N. A. P. Editions, Verrièrres-le Buisson. ISBN 978-2-913688-15-5. Price: £79.99 plus shipping costs.

This book is an English translation from French of volume 3 of Les Papillons de nuit d'Europe – *Zygènes, Pyrales 1.* The present review deals only with the family Zygaenidae, as we understand that the section on pyralids is being dealt with by a specialist in that group.

Undoubtedly, as with volumes 1 and 2, this book is an excellent identification guide to the moths of Europe, based on the colour illustrations. However, the text is unfortunately marred by scientific error and misinformation, so that it would have benefited greatly, if it had been peer-reviewed by relevant specialists before publication. Moreover, in this respect, members of 'Groupe d'Information de Recherche et d'Animation sur les Zygaenidae – GIRAZ', a society formed by a dedicated team of French entomologists who specialise in making a specific study of the French zygaenid fauna, appear not to have been consulted.

While much of the information provided in the text is compilatory, regarding the Procridinae the now out-of-date *Forester Moths* (Efetov & Tarmann 1999) is the only publication that is cited in the references. However, many publications devoted to the taxonomy of this group have subsequently been published (Efetov 2001c, 2004, 2005; Efetov et al. 2003) but apparently are not referred to.

The characterisation of the Zygaenidae, as defined in this book (p. 41), has several shortcomings. For example, the Phaudinae is included as a subfamily, although quite recently (Nieukerken et al. 2011) it was placed as a family within the Zygaenoidea. All species of Zygaenidae have ocelli (not only in the Zygaeninae, as mentioned) and, together with the presence of the chaetosemata (not mentioned), are two of the most important characters of the family. The antenna of Zygaenidae is bipectinate, biserrate or simple with a clubbed terminal end and not only 'pectinate and club-shaped'. The labial palpi are prominently developed in the tribe Artonini (subfamily Procridinae), of medium length in the tribe Procridini and only in the Chalcosiinae and Zygaeninae are they 'weakly developed'.

The wing venation representing the Zygaeninae (apparently of a *Zygaena* species) is figured (p. 42, fig. 20) but, as there is no indication from which species the drawing was made, the impression is given that this character situation is constant in the Zygaeninae. This is incorrect as there are strong differences in some of the Zygaeninae (e.g., *Pryeria sinica* or *Epizygaenella caschmirensis*, see Alberti 1954: 445, pl. 44, figs 1 and 7, respectively). The same can be said about the figure of the wing venation of the Procridinae (genus *Jordanita*) (p. 43, fig. 21), as there are some important differences within this subfamily. In the case of *Jordanita*, for example in *J.* (*Roccia*) *naufocki*, veins R_4 and R_5 are stalked or connate in the forewing, while in the closely related species *J.* (*R.*) *tianshanica* (pl. 4, fig. 15) R_4 and R_5 arise separately from the cell (Efetov 1990: 11).

The description of the habitus of the Procridinae is misleading; it is incorrect to state that the forewing is 'usually narrow' (p. 42) and that most Procridinae 'have a uniform single-tone colouring'. In fact the habitus of Procridinae is very diverse. In Europe most species do have a uniform colouration with a submetallic sheen on the body and forewing upper side, but some of the tropical species can be very colourful with yellow, red and white spots and stripes, with green or blue metallic pattern, or even with almost completely translucent wings. The antennae in Procridinae are bipectinate in the male, bipectinate or biserrate in the female and only in the Central American genus *Pseudoprocris* do they consist of a simple flagellum without lateral extensions, thus forming a clubbed antenna as in *Zygaena*.

On page 54 it is stated that *Jordanita subsolana* belongs to the subgenus *Lucasiterna*, but *Ino subsolana* is the type-species of the subgenus *Solaniterna*; therefore the correct combination is *Jordanita* (*Solaniterna*) *subsolana* (Efetov 2004: 33, 119). *Jordanita graeca sultana* is cited (p. 55) as a valid subspecies, but this is a synonym under *J. graeca graeca* (Efetov 2001b: 156). It is stated (p. 61) that the larval host plant of *Adscita jordani* is unknown, but the larva feeds on *Rumex* species (Efetov & Tarmann 2003a, 2003c). It should have been mentioned on pages 63 and 64 that *Adscita bolivari* and *A. mannii* belong to the subgenus *Tarmannita* (Efetov 2000: 169). The larval host plants of *Adscita obscura* belong not only to the family Cistaceae, as mentioned on page 66, but also to the Rosaceae and Fabaceae (Tarmann & Tremewan 2001). On page 66 it is considered that *Adscita alpina* has two valid subspecies, viz. *A. alpina alpina* and *A. alpina italica*. However, Efetov & Tarmann (2000) have shown that *A. alpina* and *A. italica* are two well-differentiated species that have strong differences in the female genitalia. *Adscita italica* is found in central and southern Italy, whereas *A. alpina* is only found in the Alps, viz. south-eastern France, southern and south-eastern Switzerland, western Austria and northern Italy (Efetov & Tarmann 2000, 2003b). *Adscita* (*Zygaenoprocris*) *taftana* is briefly mentioned on page 67 but following the revision of the genus *Zygaenoprocris*, the current placement of this species is *Zygaenoprocris* (*Molletia*) *taftana* (Efetov 2001a: 45).

With regard to the distribution of Procridinae species, there are a number of errors. The map on page 47 implies that *Rhagades pruni* inhabits the whole of Spain, but it is found only in a very restricted area in the north-eastern part of the country (Efetov 2004: 14). *Adscita mannii* is regarded as highly local (p. 65), but in Italy, for example, it is widely distributed and even mass occurrences are sometimes found in many habitats. On page 66 it is stated that *Adscita krymensis* was first described in the Crimea and also reported from Ukraine (p. 66), but the species is known only from the Crimea (Efetov 2001c); moreover, the latter is part of southern Ukraine.

Of the 108 *Zygaena* species currently considered to be valid (Hofmann & Tremewan 2010), 63 are listed in the check-list on page 68, but it is rather puzzling that 36 of these are extra-limital to Europe. The criterion for such a selection is not given and it remains unclear why many European species are excluded, e.g., four European endemics (*Z. romeo*, *Z. rhadamanthus*, *Z. oxytropis*, *Z. anthyllidis*) and five species with a wide distribution in Europe, viz. *Z. osterodensis*, *Z. nevadensis*, *Z. filipendulae*, *Z. lonicerae* and *Z. ephialtes*. Moreover, *Z. mana* and *Z. alpherakyi*, two endemics to the Caucasus region and bio-elements of the fauna of the Russian territory, are also excluded. Generally speaking, one can say that the check-list is very poorly compiled, incomplete and inconsistent and without any systematic concept; moreover, it does not reflect the relevant literature (Tremewan 1988; Hofmann & Tremewan 1996: 187–219, 2010).

The arrangement of the genitalia figures is puzzling and it is unclear as to what the author is trying to do in this respect. For example, on page 71 the male genitalia of *Z. exulans*, *Z. minos* and *Z. purpuralis* are compared (the first-mentioned not closely related to the two last-mentioned species), while on page 73 the female genitalia of *Z. purpuralis*, *Z. minos* and *Z. youngi* are figured (the last-mentioned species not closely related to the former two and placed in a different subgenus).

With regard to the distribution of *Zygaena* species, the map on page 69 shows a single record of *Z. purpuralis* from Sicily; presumably this follows Naumann et al. (1984: 96). However, there are no authentic records of this species from the island and even Bertaccini & Fiumi (1999: 65) refer to the distribution map in Naumann et al. According to the distribution map on page 85, *Z. trifolii* occurs throughout Sicily but the species is only known from a few records from the vicinity of Syracusia (Hofmann et al. 1994: 43; Hofmann & Tremewan, 1996: 183). On page 92 it is stated that the Isle of Skye is the sole locality in Scotland for *Z. lonicerae*, but the species has spread during the last few years from northern England into the border counties of Scotland (Bland 2001). It is stated (p. 95) that *Z. nevadensis* possibly occurs in Italy near the frontier with

France, but there are no records of this species from that region. However, it was recently discovered in Calabria (Efetov et al. 2011), a record that has been overlooked in the book. *Zygaena exulans* is said to occur from 1000–3000 m.a.s.l., depending on latitude (p. 120), but in Scotland the species occurs at around 700–850 m, while in northern Scandinavia and the northern part of European Russia it is found near the sea level. *Pryeria sinica*, described from Japan with a distributional range from there to Taiwan, South Korea, China and the Far East of Russia, has recently been reported from Europe (England, Spain); however, it is erroneously stated (p. 123) that the species was originally from western Asia. The distribution of *Z. tamara* is cited as Turkey to Afghanistan but the most easterly known site for *Z. tamara* is in the vicinity of Semnan in the Iranian Alborz mountains and no records are known from further east and, of course, from Afghanistan (A. Hofmann, pers. obs.). For *Z. cambysea* it is stated 'Iran' but in fact this species is also widely distributed in eastern Turkey and Armenia and recorded from Azerbaijan and Iraq (Hofmann & Tremewan 1996). Although *Z. rosinae* (p. 250, pl. 13 fig. 9) is labelled 'Téhéran' (a city of 15 million inhabitants), its distribution is cited as Turkey and Caucasus. As far as Turkey is concerned, the distribution is peripheral and there are only a few records from Transcaucasia, its main occurrence being throughout Iran (A. Hofmann, pers. obs.).

With reference to cyanogenesis and the toxic properties found in the Zygaenidae, it would have been better to use the term 'glucosides' rather than heterosides (p. 44), the latter apparently referring to such compounds found in plants. Moreover, the use of glucoside is well established in the zygaenid literature, e.g., Franzl (1992). It is also stated that linamarin and lotaustralin are biosynthesized by the larvae, which is correct, but these compounds can also be sequestered by the larvae from their host-plants that contain them. On the same page it is stated that '… the caterpillars feed without really hiding themselves', which does apply to many species, but some only feed at dusk and dawn, e.g., those of *Z. transalpina* in Europe, while those of many species in the Middle East feed only at night (Hofmann & Tremewan pers. obs.).

In several places the word 'adrets', meaning 'southerly facing slopes', has been used, with reference to habitats; while 'adrets' is a geographical term acceptable in both French and English, it is rarely if ever used in the latter language and is not included in many English dictionaries.

Greater consistency in the botanical nomenclature would have been desirable. The host plant for Z. *angelicae* is cited as *Coronilla varia* (p. 107), but five pages before it is stated that *Z. ephialtes* lives on *Securigera varia* (the correct combination); one of these two names should also have been mentioned as the host plant of '*Z. hippocrepidis*' (p. 106), which in this book is separated as a valid species from *Z. transalpina*, a placement that is not generally accepted by most *Zygaena* specialists (Hofmann & Tremewan 1996). On page 93 it is stated that a larval host plant for *Z. romeo* is *Trifolium montanum*, but there are no authentic records of the larva of this species ever feeding on this plant or on any members of the genus *Trifolium*.

The flight period of *Z. sedi* is stated to be exclusively May (p. 85), but in the Crimea (Ukraine) the species occurs from the end of May to the beginning of July (Efetov 2005: 170), in Greece it flies from mid-June to the beginning of July and in Turkey from the end of June to mid-July (A. Hofmann & W. G. Tremewan pers. obs.). It is considered that the flight period of *Z. occitanica* is mainly in July (p. 112), but it emerges in many localities (e.g., eastern and southern Spain) in mid-May and its flight period is already over before the end of June; moreover, in the vicinity of Almería it is even found at the end of April (A. Hofmann & W. G. Tremewan pers. obs.).

On a positive note, the reproduction of the photographs of most of the *Zygaena* adults is good and the figures should enable anyone to identify any specimens (if correctly determined by Leraut) that they might encounter except for those that need to be dissected. Even then, the specimens are obviously figured at different scales, e.g., *Z. zuleima* (p. 248, pl. 12 fig. 14) is seemingly larger than *Z. truchmena* and *Z. persephone*. The same can be said about *Z. nevadensis* (p. 265, pl. 20 figs 6–13), for example, the figures being reproduced almost as large as *Z. lavandulae* or *Z. theryi*. In those depicting the Procridinae, the shadow on the right hand side of the specimens is somewhat distracting and gives not only the impression of an unfocused picture but also extends the proportions optically. In this respect, the line drawings of the genitalia should help, but unfortunately these are so finely drawn and reproduced so small that many critical characters are not readily visible. For example, those purporting to illustrate the lamina dorsalis of *Z. minos* and *Z. purpuralis* (p. 71) are inadequate and do not show the diagnostic characters clearly.

This English translation has many typographical and/or translation errors. To give only a few examples, 'reticulum' for retinaculum (p. 41), 'Nedblstreif' for Nebelstreif (p. 103), 'Bade-Wurtemberg' for Baden-Württemberg' (p. 107); such shortcomings are also found in some of the scientific names, e.g. *Z. loyselis* '*unguemachi*' for *Z. loyselis ungemachi* (p. 248).

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